Catsfoot

0.1

Generated by Doxygen 1.7.3

Tue Feb 7 2012 20:23:25

Contents

Chapter 1

Introduction

Contents

Catsfoot is a C++ library providing:

- concept checking,
- concept-based overloading,
- and generating tests automatically from concepts.

In short, it is intended to provide testing utilities for C++ template libraries.

Catsfoot is developed at `Bergen Language Design Laboratory`.

1.1 Concept checking

That part of the library is inspired by `Boost Concept Check Library (BCCL)` and now rejected `concept extension for C++ standard`.

Unlike BCCL, Catsfoot is capable of not failing when concept requirements are not met, and instead use the concept as a static predicate.

C++2011 already provides several predicates in `<type_traits>` (c.f. section 20.7.2). Some other are provided by the library, mostly inspired by `has_member`, but also using interestring properties of `decltype` from C++2011. With this, we are capable for instance of testing the call-ability of functions or operators.

1.2 Concept-based overloading

Since our concepts are testable like predicates, we can then use similar constructs to Boost's `enable_if` to be able to overload function templates based on both static and dynamic properties of our types.

1.3 Axiom testing

The rejected concept proposal provided syntax for axioms. It proved to be useful for automatic testing. Axioms were similar to functions, so making Catsfoot able to treat functions as axioms did the trick.

As in `QuickCheck`, axioms are functions which parameters represent universally quantified variables. Since C++2011 introduced variadic template parameters, it was possible to write test driver "parsing" those parameters and feed the axiom with data from a generator.

Like QuickCheck, Catsfoot provides generator combinators.

The most interesting example of data generator is based on a list of functions, methods and operators which a random generator will use to generate random instances. If the set of functions covers all methods, constructors and friend functions of a class, in theory, it is possible to cover all possible generate-able instances (if we had infinite time and memory).

1.4 Relation to OOP unit testing

It is possible to combine unit testing with axiom testing. However, you should note that several OOP testing techniques become deprecated with concept-based testing.

Fixtures are generally not needed since data set generator will generate them. Probably, it is a bad sign if you have fixtures. Your only fixture should be your data generator.

Mock implementations can be easily made through concept-based programming. Better, you can check the mock implementation itself with the concept it is supposed to implement. Concepts do not require virtual methods nor inheritance. For that case, instead of modifying the original implementation to mock. Which is good, because after all, the implementation you need to mock is probably not your code. You just need first to define its specification as a concept, and then modify your code to accept the implementation to choose as a template parameter.

1.5 Catsfoot can integrate your test suite

Catsfoot is just a library. It leaves you the choice to use any testing framework. Most of the time, you probably want to write small programs making the test. In that case, function `main` will just basically configure the data set generators and test the different concepts. If the environment of your test suite requires a different approach, it will certainly be possible for you use Catsfoot anyway.

Chapter 2

User manual

Contents

An online version of this manual is available on `http://catsfoot.sourceforge.net/manual.html`.

2.1 Reference documentation

- Getting started
- Concepts-only tutorial
- Axioms-only tutorial
- Tutorial

2.2 API documentation

2.3 Package documentation

- README
- INSTALL
- NEWS
- COPYING
- AUTHORS

2.4 Getting started

2.4.1 Requirements

- A compiler supporting a majority of C++2011.
  - GCC >= 4.5.1
  - Known **not** to work (yet):
    * Visual Studio 2010 and before (e.g. no support of variadic template parameters)
    * Xcode 4 and before (old version of GCC)
    * Clang (has probably enough features, but does not support any C++2011 standard library)
    * ICC 11.1.072 and before
    * GCC 4.4.* and before (e.g. std::declval is missing from the library)
- A standard C++ library supporting a majority of C++2011.
  - GCC's libstdc++
  - Known **not** to work (yet):
    * Clang's libc++
  - Untested:
    * STLport

2.4.2 Installation

This describes the installation for development versions of Catsfoot. The run-time shared library contains only testing tools and does not need to be shipped with the software.

Nightly build versions are available from page Download.

2.4.2.1 From package

There are nightly build packages for

- Fedora 14 x86 and x86_64
- Fedora rawhide x86 and x86_64
- Ubuntu 10.04 x86 and x86_64
- Ubuntu 10.10 x86 and x86_64
- Debian sid x86 and x86_64

Those can be installed with `rpm` or `dpkg` depending on the distribution.

Gentoo users can install it with:

```
# emerge -uv layman
# sed -i "/^overlays *:/a http://vfrd-overlay.googlecode.com/svn/trunk/Documentation/vfrd-overlay.xml" /
# layman -a vfrd
# echo "dev-libs/catsfoot ~$(portageq envvar ARCH)" >>"${EPREFIX}/etc/portage/package.keywords"
# emerge -u dev-libs/catsfoot
```

2.4.2.2 From source

Catsfoot uses Autoconf and Automake, so the installation is pretty standard.

```
$ xz -dc /path/to/catsfoot-0.1.tar.gz | tar xf -
$ ./catsfoot-0.1/configure --prefix="/path/where/to/install"
$ make install
```

2.4.2.3 From the repository

We discourage using the version of the repository as some versions might not have passed the test suite. Use a nightly build source package instead.

2.4.3 Using Catsfoot in your build system

Catsfoot installs two `pkg-config` package descriptions:

- `catsfoot` is used only for supporting concepts. It is used for shipped binaries of your project. In this way it does not depend on any run-time library, but still provides static concept checking.
- `catsfoot-rt` is used for your test suite. It links to Catsfoot's runtime library.

2.4.3.1 Automake & Autoconf

In your configure.ac file, you should have a line such as:

```
PKG_CHECK_MODULES([CF_TESTING], [catsfoot-rt])
PKG_CHECK_MODULES([CF_RELEASED], [catsfoot])
```

Then in your Makefile.am file, should have for example (for "check" program "mytest"):

```
mytest_CXXFLAGS=$(CF_TESTING_CFLAGS)
mytest_LDFLAGS=$(CF_TESTING_LIBS)
```

The manual page of `pkg-config` contains more information.

Do not forget to call "configure" with "CXX='g++ -std=c++0x'", or make your configure script to add "-std=c++0x" automatically.

2.4.3.2 Scons

Scons wiki page `PkgConfig` explains how to use pkg-config in your project.

2.4.3.3 By hand

For example:

```
g++-4.6.0 -std=c++0x `pkg-config --cflags --libs catsfoot-rt` yourtest.cc
```

2.4.4 My first test program

Lets write a concept for a set. We can insert an element inside the set, and we can test whether an element has been inserted.

```
# include <catsfoot.hh>

// We define some tools we will need in our concept.
// - has_member_element_type<T> checks for member type
    "T::element_type"
DEF_TYPE_MEMBER_PREDICATE(element_type);
// - member_has(cv-qualifier T&, Args...) is an alias to
//     "T::has(Args...) cv-qualifier"
DEF_MEMBER_WRAPPER(has);
// - member_insert(cv-qualifier T&, Args...) is an alias to
//     "T::insert(Args...) cv-qualifier"
DEF_MEMBER_WRAPPER(insert);
```

```
namespace cf = catsfoot;

// We define a concept "set" for a type we call "Set"
template <typename Set>
struct set: public cf::concept {
  // We define "element_type" to be an alias to Set::element_type if
  // it ever exists. Using has_member_element_type makes sure that
  // we will not get any strange error message in case Set::element_type
  // was not a type, or was not declared.
  // This alias makes the concept more concise, but is not necessary.
  typedef typename has_member_element_type<Set>::member_type element_type;

  // is_callable<C> is a predicate. We declare some aliases to the
  // predicate calling members Set::has(element_type) const, and
  // Set::insert(element_type). Since the predicates will be
  // reused several times, it helps us to make the concept definition
  // more concise. But it is not necessary.
  typedef cf::is_callable<member_has(const Set&, element_type)> has;
  typedef cf::is_callable<member_insert(Set&, element_type)> insert;

  // We declare our static requirements
  typedef cf::concept_list<
    // Set::element_type must exist and define a type.
    has_member_element_type<Set>,
    // Set::has(element_type) const must be callable
    has,
    // Its result should be implicitly convertible to bool.
    std::is_convertible<typename has::result_type, bool>,
    // Set::insert(element_type) must be callable
    insert,
    // We require "operator==(element_type, element_type)" to be defined
    cf::equality<element_type>
    > requirements;

  // For all element e and f, with a reference to set s, this axiom should
  // hold.
  static void insertion(const element_type& e, const element_type& f, Set& s) {
    // Was f already inside?
    bool res = s.has(f);
    s.insert(e);
    if (e != f)
      // if e is not equal to f, then insertion of e should insert nor
      // remove f.
      axiom_assert(res == s.has(f));

    if (e == f)
      // if e and f are equal, then f should be in the set.
      axiom_assert(true == s.has(f));
  }

  // Axioms are usually just static members. We need to declare them as
  // axioms for the test driver to use them.
  AXIOMS(insertion);
};
```

Note that this concept is does not specify everything from the commonly used set implementations. For example, according to the axioms, a type where `has` is always true for any element and where `insert` does not perform any operation, will model the concept `set`.

Let's now define a very simple implementation of `set`. You can note that we can reuse any set type as long as it implements at least concept `set`. The type will actually implement a more specific algebra.

```
template <typename T>
struct slow_set {
public:
  // Required by the concept.
  typedef T element_type;

  // Although this is not required by the concept, we provide
  // some constructors.
  slow_set() = default;
  slow_set(const slow_set&) = default;
  slow_set(std::initializer_list<T>);

  // Required by the concept
  void insert(const T&);
  bool has(const T&) const;

private:
  std::vector<T> values;

  // Because:
  // - we do not resize the vector, we do not need default
      constructible
  // - we do not use move semantic, we can require copy
  // - we do not replace, we do not need assignment
  typedef
  cf::class_assert_concept<
    cf::concept_list<cf::is_constructible<T(const T&)>,
                     cf::equality<T> >
    >
  requirements;
};

template <typename T>
void slow_set<T>::insert(const T& t) {
  for (auto i : values) {
    if (i == t)
      return;
  }
  values.push_back(t);
}

template <typename T>
bool slow_set<T>::has(const T& t) const {
  for (auto i : values) {
    std::cerr << t << " == " << i << std::endl;
    if (i == t)
      return true;
  }
  return false;
}

template <typename T>
slow_set<T>::slow_set(std::initializer_list<T> l) {
```

```
  for (auto i : l) {
    this->insert(i);
  }
}
```

We now want to claim that for any T, slow_set<T> is a set. We can claim this because we made sure that slow_set<T> was not instantiated with an incompatible type through instantiation of slow_set<T>::requirements. The claim is made through type traits.

```
namespace catsfoot {
  template <typename T>
  struct verified<set<slow_set<T> > >
    : public std::true_type {
  };
}
```

To test this claim we now write a test program. We just make a small program that defines the data set we want to use and call the test driver for the concepts we want to check. We could define very complex random term generators, but for now, we will just give a list of sample data.

```
#include <limits>

int main() {
  using cf::list_data_generator;
  using cf::choose;

  // To get better error messages, we should first statically check that
  // we are testing a valid claim.
  cf::assert_concept(set<slow_set<int> >{});

  auto generator =
    choose
    // The generator can generate either:
    // - sets of type slow_set<int>
    (list_data_generator<slow_set<int> >(
      {slow_set<int>{}, slow_set<int>({0, 1}),
       slow_set<int>({0, 0}), slow_set<int>({1, 0})}),
    // - or integers
     list_data_generator<int>({0, 1, 2, 3, -1, -2,
                  std::numeric_limits<int>::min(),
                  std::numeric_limits<int>::max()}));

  // We now test claim "set<slow_set<int> >" against generator.
  bool ret = cf::test_all<set<slow_set<int> > >(generator);

  // In our case, the implementations of the set was complete, so
  // we want to verify that we did cover all conditions in the axioms.
  ret = ret && cf::check_unverified();

  return ret?0:1;
}
```

This is the simplified picture of what testing looks like. The tutorials will cover each point in detail.

2.5 Concepts-only tutorial

In this short tutorial, we introduce only the concept checking facilities of Catsfoot, for people not interested in the testing utilities. We expect that you are familiar with C++ templates.

Concepts in this case are useful for two things:

- giving better error messages to the user of a template library.
- selecting optimized versions of overloaded functions based on run-time behavior.

2.5.1 Concept requirements

Concepts describe a set of requirements, usually representing the existence of members (types, methods, or static methods), the existence of compatible overloaded functions, and the relations between types (convertible, castable, inheriting, same, ...). For instance it is possible to check that a type T has a non-`const` method `get` that returns a type convertible to an instance of type `U`.

These requirements can be represented by these two predicates:

```
is_callable<member_get(T&)>
```

And:

```
is_convertible<typename is_callable<member_get(T&)>::result_type,
               U>
```

`member_get` is a functor produced with macro DEF_MEMBER_WRAPPER(get). But it is possible to write it by hand.

For instance:

```
struct member_get {
  template <typename T, typename... U,
            typename Ret =
            decltype(std::declval<T>()
                     .get(std::declval<U>()...))>
  Ret operator()(T&& t, U&&... u...) const {
    return std::forward<T>(t).get(std::forward<U>(u)...);
  }
};
```

It is not important to make the functor that generic. However, it is very important that the return type of `operator()` is dependant on the existence of the `get` method. Here this is achieved using `decltype`. The `decltype` expression resolves a template parameter involving `operator()` (but not the functor).

If you fail to provide such a functor, errors will not be properly detected.

2.5.2 Specifying a concept

Now we can write our first concept. If axioms do not interest you, you will probably mostly want to use automatic concepts. (Later, in introducing overloading based on concepts, we will use non-automatic concepts.)

Requirements are represented through the member type `requirements` of the concept. For instance.

```
template <typename T, typename U>
struct has_get: public auto_concept {
private:
  //easier with an alias to the predicate
  typedef is_callable<member_get(T&)> call;

public:
  typedef concept_list<
    call,
    is_convertible<typename call::result_type, U>
  > requirements;
};
```

If the concept has several requirements, like here, we just use the `concept_list` class template to list them all.

When asserting a concept, the compiler will report only the missing predicates, not the missing concepts. Predicates should be seen as the lowest level of requirements.

If we have a function requiring the concept `has_get`, we can easily check against the concept.

```
template <typename SimpleStream>
int something_useless(SimpleStream& s) {
  assert_concept(has_get<SimpleStream, int>{});
  int res = 0;
  for (unsigned i = 0; i < 8; ++i) {
    res ^= int(s.get());
  }
  return res;
}
```

If for example, the result of `get` was not convertible to `int`, then we will get this kind of error message:

```
/usr/include/catsfoot/concept/concept_tools.hh: At global scope:
/usr/include/catsfoot/concept/concept_tools.hh: In instantiation of
  'catsfoot::details::class_assert_concept<std::
  is_convertible<return_type, int>, false, false, false>':
[...]
/usr/include/catsfoot/concept/concept_tools.hh:125:7: error: static
  assertion failed: "Missing requirement"
```

If a class template rather than a function has requirements, it is possible to check them like this:

```
template <typename SimpleStream>
struct some_class {
  //[...]
  private:
    class_axiom_assert<has_get<SimpleStream, int> > check;
};
```

2.5.3 Concept-based overloading

If we wanted to have a default implementation for types not implementing `has_get`, we could write functions like this instead:

```
template <typename SimpleStream, ENABLE_IF(has_get<SimpleStream, int>)>
int something_useless(SimpleStream&);

template <typename NotAStream, ENABLE_IF_NOT(has_get<NotAStream, int>),
          typename = void> // work-around to make signatures different
int something_useless(NotAStream&);
```

In this case, the first function would be used if and only if `SimpleStream` implemented `has_get`. The second would be used otherwise.

It is possible to do the same for classes:

```
template <typename SimpleStream, bool = IF(has_get<SimpleStream, int>)>
struct some_class {
  // [...]
};

template <typename SimpleStream>
struct some_class<SimpleStream, false> {
  // [...]
};
```

You should note that here we have used only automatic concepts. A signature does not differentiate between two types. Sometimes two different types with the same signature might need to include different versions of an overloaded algorithm. For instance sorting an ordered container should not do anything whereas a sorting algorithm should be run for other containers. There would not be much difference in the signatures of the types, however. In this case we can use concepts.

```
template <typename C>
struct sorted_container: concept {
  typedef container<C> requirements;
};
```

Since `sorted_container` is not automatic, no type by default implements it.

We can then populate the concept by marking types as "verified" through type traits.

```
namespace catsfoot {
  template <typename T>
  struct verified<sorted_container<std::set<T> > >:
    public std::true_type {};
}
```

Now we can write our two different versions:

```
template <typename C,
          ENABLE_IF(container<C>),
          ENABLE_IF_NOT(sorted_container<C>)>
void sort(C&) {
  // [...]
}

template <typename C,
          ENABLE_IF(sorted_container<C>)>
void sort(C&) {}
```

2.6 Axioms-only tutorial

In this tutorial, we introduce the automated testing utilities of Catsfoot for people who are not interested in concepts, or just not familiar enough with C++ templates.

2.6.1 Axioms

Let's say we have the following implementation of integer exponentiation.

```
unsigned long
pow(unsigned long b,
    unsigned short e) {
  if (e == 0)
    return 1;
  auto rec = pow(b, e/2);
  return ((e%2)?b:1)*rec*rec;
}
```

Axioms are defined as C++ functions containing assertions, possibly conditional. Nevertheless, the user is free to write any kind of code.

If we wanted to test Fermat's theorem on native unsigned integers with the definition of `pow`, we could write an axiom like this:

```
void
fermat(unsigned long x, unsigned long y, unsigned long z,
       unsigned short n) {
  if ((n > 2) && (x > 0) && (y > 0))
    axiom_assert(pow(x, n) + pow(y, n) != pow(z, n));
}
```

The assertion is probably actually not true in case of overflow. We will try to investigate if it fails, and how.

2.6.2 Generators

We want to generate data for the axiom. We need two types of values: `unsigned long` and `unsigned short`. One way is to give lists of values.

```
bool
simple_test() {
  auto generator =
    list_data_generator<unsigned long, unsigned short>(
      {1ul, 2ul, 3ul, 4ul, 5ul, 6ul},
      {3ul, 4ul, 5ul, 6ul});

  if (!test(generator, fermat, "fermat"))
    return false;

  return true;
}
```

The test itself will print information in the error output. It will return true on success. It is then possible build a test suite and directly call the function.

The test will pass here. It does because it is not intensively testing the axiom. If we used random numbers, we would likely eventually discover that for some special values, an overflow will appear to put zeroes in the factors of the exponentiation. Thus, the return value is zero.

We can write a test using random. And we will find that some values break the axiom.

```
bool
random_test(std::mt19937& engine) {
  auto generator =
    term_generator_builder<unsigned long, unsigned short>(10u)
    (engine,
     std::function<unsigned long()>
     ([&engine] () {
       return std::uniform_int_distribution<unsigned long>()(engine);
     }),
     std::function<unsigned short()>
     ([&engine] () {
       return std::uniform_int_distribution<unsigned short>()(engine);
     }));
```

The output will give us some information like:

```
file.cc:14: Axiom void fermat(long unsigned int, long unsigned int, long unsigned int, short

Expression was: pow(x, n) + pow(y, n) != pow(z, n)

Values were:
 * 12775342532353695410
 * 12775342532353695410
 * 8564872738844034446
 * 23302
```

Random generation of integers is not interesting for the purposes of the tutorial, and so we do not explain the example in detail. Basically we give two functions generating two different types.

2.6.2.1 Term generators

We can now start with a new example. We will use an `example from Haskell's Quickcheck`. The example is a function taking a stream as input and returning a list of the first five characters which are in range from `'a'` to `'e'`.

```
std::string getList(std::istream& input) {
  std::string ret = "";
  unsigned count = 0;
  char c;
  while (input >> c) {
    if ((c >= 'a') && (c <= 'e')) {
      ret.push_back(c);
      if (++count >= 5)
        return ret;
    }
  }
  return ret;
}
```

We can now write an axiom verifying that the list is never longer than 5 characters. We can also check that all the contained characters are actually from the valid range. We can make several assertions in the same axiom.

```
void axiom(std::istream& s) {
  std::string str = getList(s);
  axiom_assert(str.length() <= 5);
  for (auto c : str) {
    axiom_assert((c >= 'a') && (c <= 'e'));
  }
}
```

Now we can start to write our test. Generating random strings works well with term generation as strings with concatenation form a free monoid, i.e. for two strings which have just been generated, concatenation will produce a string that hasn't yet been generated. We need to provide 1-letter strings as atoms, however. Since our algorithm cares more about letters between `'a'` and `'e'`, we will influence the distribution.

So we start to write a string generator, we want to generate a kilo of them. We also need a proven pseudo-random engine.

```
bool test_getList(std::mt19937& engine) {
  auto string_generator =
    term_generator_builder<std::string>{1024u}
  (engine,
```

Now we include the first operation, the one that gives 1-letter strings. We try to generate more strings with the letter between `'a'` and `'e'`.

```
   std::function<std::string()>
   ([&engine] () {
     char c;
     if (std::uniform_int_distribution<int>(0,2)(engine))
       c = std::uniform_int_distribution<char>('a', 'e')(engine);
     else
       c = std::uniform_int_distribution<char>()(engine);
     return std::string(1u, c);
   }),
```

Now we can add the concatenation operation.

```
   std::function<std::string(const std::string&,
                             const std::string&)>
   ([] (const std::string& a,
        const std::string& b) { return a + b; }));
```

`string_generator` generates strings. However we need streams. We can make another generator and easily reuse `string_generator`.

There are a few annoying things with generating streams. First, we need to generate `std::istream` which is abstract, which means not copyable and not move-able. The generator will detect it is not possible to store them, and a workaround is required. We could have an operation returning references to `std::istringstream` objects, which are supposed to be normally move-able, but unfortunately are not yet in GCC versions up to 4.6.0. So instead we will deal with pointers. `std::unique_ptr` can be used as it is movable, and it will be just enough to store the streams somewhere in the memory.

We start defining our generator by reusing the previous generator.

```
  auto generator =
    term_generator_builder<std::string,
                           std::unique_ptr<std::istringstream>,
                           std::istream>{1024u}
      (engine,
       pick<std::string>(string_generator),
```

Now we provide a way to construct string streams.

```
       std::function<std::unique_ptr<std::istringstream>(const
           std::string&)>
       ([] (const std::string& s) ->
           std::unique_ptr<std::istringstream>
       { return std::unique_ptr<std::istringstream>(new
           std::istringstream(s)); }
      ),
```

Finally we provide a conversion from string streams to abstract streams.

```
       std::function<std::istream&(std::unique_ptr<std::istringstream>&
           i)>
       ([] (std::unique_ptr<std::istringstream>& i) -> std::istream&
       { return *i; }));
```

This generator will unfortunately never generate the empty string. But since our axiom has only one parameter, we can easily just test this special case manually.

```
  std::istringstream in{std::string{}};
  if (!catch_errors(axiom, in))
    return false;
```

Now we can run the test.

```
  if (!test(generator, axiom, "axiom"))
    return false;

  return true;
}
```

2.7 Tutorial

2.7.1 Introduction

2.7.2 Writing concepts

To illustrate on how to write a concept, we start by showing how to write a simple specification of monoid. A monoid is a set with a binary operator. The set is under the operator. The operator is associative. There is also an identity element in the set.

```
template <typename T, typename Op, typename Id>
struct monoid: public concept {
  typedef concept_list<
    is_callable<Op(T, T)>,
    is_callable<Id()>,
    std::is_convertible<typename is_callable<Op(T, T)>::result_type,
        T>,
    std::is_convertible<typename is_callable<Id()>::result_type, T>
```

```
    > requirements;

  static void associativity(const Op& op, const T& a,
                            const T& b, const T& c) {
    axiom_assert(op(a, op(b, c)) == op(op(a, b), c));
  }

  static void identity(const Op& op, const T& a, const Id& id) {
    axiom_assert((op(id(), a) == a) && (op(a, id()) == a));
  }

  AXIOMS(associativity, identity);
};
```

Our concept is declared as a class inheriting from concept. It is used to distinguish from automatic concepts (which inherit from auto_concept) and also from predicates (which do not inherit from either of those two special types).

We declare our requirements with a member type `requirements`. If we have several requirements we can pack them as parameters of template concept_list.

A requirement can be a concept, an automatic concept, or a predicate. In this example all requirements are predicates.

We require `Op` to be callable with two `T`s, and `Id` with no parameters. We also require that the result of those operations can be implicitly converted (no explicit cast) to `T`.

Then we have axioms describing the run-time behavior. Parameters are universally quantified, meaning that the axioms should hold for any values of the given types.

Then to be able to automatize testing we describe what are the axioms we want to test by using the macro `AXIOMS`.

Here we defined the carrier set and the two operators were declared as type parameters. The point of concepts is to be generic. We want to allow as much signature morphing as possible. Of course we could have fixed the operators, but we can do it afterwards, and reuse the most generic concept. For instance, we can define `monoid_plus` as such:

```
template <typename T>
struct monoid_plus: concept {
  typedef
    monoid<T, op_plus,
           wrapped_constructor<T()> >
    requirements;
};
```

For people familiar with C++, `op_plus` and `wrapped_constructor<T()>` are functor types. That is, they have an operator "parenthesis" to implement the operation. It is usually better to represent operations through a type rather than a function pointer, as the latter would not represent overloaded operations.

It is possible to write your own functor. Nevertheless you need to be aware of some pitfalls. op_plus is defined as:

```
struct op_plus {
  template <typename T, typename U,
            typename Ret = decltype(std::declval<T>() +
                   std::declval<U>())>
  Ret operator()(T&& t, U&& u) const {
```

```
    return std::forward<T>(t) + std::forward<U>(u);
  }
};
```

Using std::plus<T> instead would not give the same behavior in static concept checking. First, std::plus<T> forces the arguments to be converted to T and the return type as well. op_plus does not. Second, predicate is_callable<std::plus<T>(T, T)> would be always true, no matter if an operator has been defined. However using the operator will lead to an error message and would not be caught before by concept checking. Predicate is_callable<op_plus(T, T)> on the other hand, will be true if only if an operator has been defined. The reason is that a failure to detect the return type through decltype() will just make the operator inaccessible. Virtually, the operator will not be defined. This makes op_plus a real alias to operator plus. Finally, op_-plus represents the whole overloaded operator plus, whereas std::plus<T> only represents one version of the operator.

The same is done with the constructor. wrapped_constructor is defined as follows:

```
template <typename T, bool = is_constructible<T>::value>
struct wrapped_constructor;

template <typename T, typename... Args>
struct wrapped_constructor<T(Args...), true> {
  T operator()(Args... args...) const {
    return T(std::forward<Args>(args)...);
  }
};

template <typename T, typename... Args>
struct wrapped_constructor<T(Args...), false> {
};
```

As you see, the template will select between an implementation with or without operator() depending on constructibility of T.

Catsfoot provides wrappers for operators, and also macros for generating wrappers for methods or overloaded functions. The user is invited to use them.

As a side note, there is nothing that says that the default constructor gives us the neutral value, for example for native types like int. Well this is something good to test.

Since our concept monoid is not automatic, we want to specify whether it holds on some set of types. This is a form of contract that the developer signs where he certifies that the axioms will hold. Of course, this can be wrong, but testing is there to determine that.

Automatic concepts do not need such contract. However, we do not have specified run-time behavior for automatic concepts (no axiom). Some overloaded function might need run-time behavior information to select an optimal version.

The only thing these contracts are useful for is with run-time-behavior-based overloading. For example imagine we have an implementation of sum of a set of values in parallel playing on the fact that a monoid is associative, to be able to reorder priorities. The signature of such a function would be:

```
template <typename T,
          ENABLE_IF(monoid_plus<T>)>
T sum(const std::vector<T>& v);
```

Of course, if our T is not a carrier set for a monoid, then we do not want to use this version of the function sum but a more classical one that would use the priority represented by the set. The only way for selecting the right function is to sign contracts asserting that implementations follow the run-time specifications of the concepts.

Even if your point is not to use this overloading feature, you will be required to sign the contracts, otherwise the static concept checking will fail. This is to make sure that other people will be able to use your concepts.

Contracts are "signed" with type traits verified. Its parameter should be a concept instantiation (eventually partial). For example we can state that integer along with operator plus and the default constructor (which might actually be wrong depending on the compiler) forms a monoid.

```
namespace catsfoot {
  template <>
  struct verified<monoid<int, op_plus, wrapped_constructor<int()> > >
    : public std::true_type
  {};
}
```

Now we can automate signing those contracts using partial specialization. For instance, we might say that for all verified monoids with the plus operator and the default constructor, the concept monoid_plus on the same type is verified.

```
namespace catsfoot {
  template <typename T>
  struct verified<monoid_plus<T> >
    : public verified<monoid<T, op_plus, wrapped_constructor<int()> > >
  {};
}
```

The type trait verified does not trigger any testing, but only allows it. Writing tests is still the responsibility of the user.

2.7.3 Automatic concepts and predicates

Automatic concepts and predicates have the same role, but they are defined in different ways. They also behave differently when asserting compile-time requirements. Requiring an automatic concept when some of its requirements are missing will give error messages on specific requirements, whereas requiring a false predicate will result in a simple error message stating that the predicate is false. When composing several requirements it is better to write an automatic concept, as the user will get more detailed error output.

A predicate is a type with a constant member value convertible to a bool.

For example, we can write a predicate like this:

```
template <typename T>
struct is_lvalue_reference: public std::false_type {
};

template <typename T>
struct is_lvalue_reference<T&>: public std::true_type {
};
```

An automatic concept is basically like a concept. However there is no axiom. Any axiom would never be called by the test driver.

```
template <typename T, typename Stream>
struct is_printable: public auto_concept {
  typedef concept_list<
    is_callable<op_lsh(Stream&, T)>,
    std::is_convertible<typename is_callable<op_lsh(Stream&, T)>
                         ::result_type, Stream&>
    > requirements;
};
```

2.7.4 Functions

2.7.4.1 Overloading functions with requirements

Let's say we want to write a function `foo` that takes 3 arguments of any type as long as there is an operator + for the type, the type has a default constructor, and the type with these operations forms a monoid. The following example shows an example of such a function.

```
template <typename T,
          typename NonRefT = typename std::decay<T>::type,
          ENABLE_IF(monoid<NonRefT, op_plus,
                           wrapped_constructor<NonRefT()> >)>
NonRefT foo(T&& a, T&& b, T&& c) {
  // (a * b);
  NonRefT ret = std::forward<T>(a) +
    std::forward<T>(b) + std::forward<T>(c);
  return ret;
}
```

Note that this selection is done with the last template parameter. Macro `ENABLE_IF` verifies like `IF` that the compile-time part of the concept holds. However it enables the version of the function instead of returning a Boolean.

It is possible to get errors if the number of parameters is the same. In this case it is possible to add parameters as `typename = void` in the parameter list.

2.7.4.2 Checking function definitions

If we ever un-commented the line using the multiplication operator (above), the compiler would not see it. It would actually compile if we gave a type `T` which has an operator ∗. We want to verify this.

A requirement for `some_concept<T, T>` is more specific than for `some_concept<T, U>`, then the archetype for `some_concept<T, T>` will need to be more specific. Any function will probably end up in some unique requirement.

Checking that a function has the right requirement is then still a hassle and uses a classic way of writing archetypes.

```
namespace foo_check {
  struct T {
    T() = default;
```

```
    T(const T&) = default;
    ~T() = default;
  };
  T operator+(const T&, const T&) {
    return T();
  }
  bool operator==(const T&, const T&) {
    return true;
  }
}

namespace catsfoot {
  template <>
  struct verified<monoid< ::foo_check::T, op_plus,
                          wrapped_constructor< ::foo_check::T()> > >
    : public std::true_type {
  };
```

2.7.4.3 Static assertion of concepts

Sometimes we do not want to overload for different requirements. We just want to require a concept for any call. Using the previous method will just end up in the compiler claiming it did not find the function for the corresponding parameters. If there is no overloading we probably just want to report the missing requirements.

```
template <typename T,
          typename NonRefT = typename std::decay<T>::type>
NonRefT foo(T&& a, T&& b, T&& c) {
  assert_concept(monoid<NonRefT, op_plus,
                        wrapped_constructor<NonRefT()> >());

  NonRefT ret = std::forward<T>(a) +
    std::forward<T>(b) + std::forward<T>(c);
  return ret;
}
```

In this code we call assert_concept which will provide the right error message if the requirement is not satisfied.

2.7.5 Requirements on class templates

Instantiating class_assert_concept will have the same effect as calling assert_concept. To make sure that the assertion is instantiated at the same time as the class, one can either inherit from the assertion class or to use it as type of a dummy member. For example:

```
template <typename T>
struct Foo
  : public class_assert_concept<monoid<T, op_plus,
                                       wrapped_constructor<T()> > >
{};
```

2.7.5.1 Specialization and requirements

There is no elegant way to use a tool similar to `ENABLE_IF` for overloaded function templates as the number of parameters has to be fixed. Fortunately, it is possible, if we know all the possible specializations when writing the general class template, to use a list of Boolean parameters.

```
template <typename T,
          bool specialize =
          IF(monoid<T, op_plus, wrapped_constructor<int()> >)>
struct Bar {
};

template <typename T>
struct Bar<T, true> {
};
```

2.7.6 Testing

Testing involves calling axioms which are just simple functions. There is nothing complex in this. Nevertheless tools are provided to automatically call the axioms. Those tools will need data set generators to provide input data to the axioms.

Note that the test programs still need to be written. Catsfoot is only a library. This allows Catsfoot to be used in any testing environment. Most common environments will expect you to write programs (with a function `main` in each). This is what you have to do. However, the only things you need to do in your testing functions are:

- to define data generators;
- to call test drivers with concepts (or just axioms) in combination with generators.

2.7.6.1 Writing axioms carefully

Each axiom is a function whose parameters are universally quantified variables. Any possible generated value of the type can be given to the axiom, which should still hold.

The following axiom:

```
static void associativity(const Op& op, const T& a,
                          const T& b, const T& c) {
  axiom_assert(op(a, op(b, c)) == op(op(a, b), c));
}
```

Would translate into:

$$\forall op : OP.\forall a : T.\forall b : T.\forall c : T.op(a,op(b,c)) = op(op(a,b),c)$$

It is important to take advantage of the universal quantifiers in the axioms and let the data generator find the values to be tested. It is tempting in some axioms to have local variables and generate random values locally, but the concept is decoupled from its implementations.

For example, for any stack `s`, the expression `s` should be semantically equivalent to `pop(push(s), some_value)`. However, on the implementation side there might be a difference between the objects even though the equality operator claims they are the same. For instance, one might have more memory allocated than the other. Thus it is not enough to generate stacks only based on `push` and the initial (empty) stack. We could even go further, and define a concept for a list-based stack. A list can behave the same as a stack, even if it has been initialized with values using list operations (insertion in the middle for example). And it better, as otherwise you would need encapsulation rather than template-based generics.

Since knowing how to generate suitable terms requires knowledge of the concrete type, it is not possible to write good axioms by generating terms locally.

For example, do not write:

```
static void erasure(AssociativeContainer c, SizeType i) {
 Iterator it = begin(c)+(i%size(c));
 axiom_assert(size(erase(c, it)) == size(c) - 1);
}
```

But rather:

```
static void erasure(AssociativeContainer c, Iterator i) {
  if ((i == find(c, i)) && (i != end(c)))
    axiom_assert(size(erase(c, i)) == size(c) - 1);
}
```

First, `find(c,i)` is a precondition for `erase(c,i)`, and it has to appear in the axiom. Second, in the former definition we instantiated an iterator by ourselves, which is a bad thing. There are lots of other ways to create iterators for a `std::set`, for example.

2.7.6.1.1 Universality of operators

It is important to use universally quantified operations in testing. Some operators could have state (for example some tables for optimizations), and the state handling should be tested.

Another point is that `int (*)(int, int)` is a valid type for the operator on a monoid, for instance, but not all such pointers point to a function performing a valid monoid operation. You want to forbid the instantiation of the concept for this kind of type. For that reason you need an universal quantifier on the operation.

2.7.6.2 Data generation

A data generator has an operation `Set get<T>()` which returns a data set. The return type is a container of values of type `T&`. One could define one's own generator like this:

```
struct my_int_generator {
  std::vector<int> v;
  my_int_generator(): v{1, 2, 3} {}
  template <typename T, ENABLE_IF(is_same<T, int>)>
  const std::vector<int>& get() {
```

```
    return v;
  }
};
```

2.7.6.2.1 List

It is possible to define a generator by giving a list of values as initializer lists. The template list_data_generator is provided for this purpose.

```
auto mygenerator = list_data_generator<int, float>
    ({-1, 0, 1, 2, 3,
        std::numeric_limits<int>::min(),
        std::numeric_limits<int>::max()},
     {.5, 42.,
        std::numeric_limits<float>::quiet_NaN(),
        std::numeric_limits<float>::denorm_min(),
        std::numeric_limits<float>::infinity()}));
```

2.7.6.2.2 Random terms

It is easy to generate random values for simple types, but it gets more complex to generate them for a type whose signature (all operations available for this type) is big. To be able to generate all kinds of values, the generator has to randomly call functions. For example building a random list is not only about inserting random elements. It is also erasing some.

Also several types have to be built alongside. For example, lists should be generated at the same time as iterators and values. Especially if we want to activate conditional axioms as described in the section Writing axioms carefully.

Random term generation is generic. The only thing that changes is the signature, i.e. the set of operations we can call to generate values.

Since some functions have preconditions, we wrap those functions. At the end we have to define the signature as a list of functions. Those functions must take parameters from the set of types we generate (they can be references), and it must return a type from the set of types.

If we want to generate lists of integers we could write a generator such as:

```
  auto int_list_generator =
    cxx_axioms::term_generator_builder<std::list<int>,
                                       std::list<int>::iterator,
                                       int>()
      (engine,
       std::function<int()>([&engine] () {
           return std::uniform_int_distribution<int>()(engine);
         }),
       constructor<std::list<int>()>(),
       disamb<const int&>()(&std::list<int>::push_back),
       disamb<const int&>()(&std::list<int>::push_front),
       std::function<int(const std::list<int>&)>
       ([] (const std::list<int>& in) {
         if (!in.empty())
           return int(in.front());
         return 0;
```

```
        }),
        std::function<int(const std::list<int>&)>
        ([] (const std::list<int>& in) {
          if (!in.empty())
            return int(in.back());
          return 0;
        }),
        disamb<>()(&std::list<int>::begin),
        disamb<>()(&std::list<int>::end),
        std::function<std::list<int>
                      (std::list<int>)>([] (std::list<int> in) {
                          if (!in.empty())
                            in.pop_back();
                          return in;
                        }),
        std::function<std::list<int>
                      (std::list<int>)>([] (std::list<int> in) {
               if (!in.empty())
                 in.pop_front();
               return in;
                        })
        );
```

2.7.6.2.3 Default constructor

Since operators are usually described as types, and since most of the time these operators will be using wrappers that do not have any state, and just have a default constructor, then it is convenient to just give a generator that returns the default constructor value. Such a genererator can be conveniently declared with default_generator.

```
default_generator mygenerator;
```

2.7.6.2.4 Union with left-priority

It is possible to use a combination of generators. The function choose will build a generator that chooses the left-most generator that can generate the requested type.

For example if we wanted to generate integers from a specific set, and any other types based on their default constructor, we could define a generator as:

```
auto mygenerator =
  choose
    (list_data_generator<int>
      ({-1, 0, 1, 2, 3,
        std::numeric_limits<int>::min(),
        std::numeric_limits<int>::max()}),
     default_generator{});
```

2.7.6.3 Calling test drivers

Once the data generators are defined, it is time to call test drivers. There are two test drivers:

- test: tests an axiom (represented by a function).

- test_all: tests all axioms for a concept (including inherited axioms from requirements).

2.7.6.3.1 On simple axioms

We can test axioms individually:

```
bool res =
  test(mygenerator,
       monoid<int, op_plus, wrapped_constructor<int()> >
         ::associativity,
       "monoid's associativity");
```

We can also test with any function that behaves like an axiom.

2.7.6.3.2 On concepts

It is not very practical to test axioms one by one. Usually the user should prefer to test all the axioms required by a concept.

```
bool res =
  test_all(mygenerator,
           monoid<int, op_plus, wrapped_constructor<int()> >{});
```

2.7.6.3.3 Coverage

It is possible that some conditions are never met. For example, in the following axiom:

```
if ((i == find(c, i)) && (i != end(c)))
  axiom_assert(size(erase(c, i)) == size(c) - 1);
```

If iterator `i` is never found inside container `c`, the axiom is never actually checked. To learn of such cases we can run at the end of the program a function that will verify the coverage of conditions.

```
res &&= check_unverified();
```

It will report any axioms never covered, and return false if any were found.

Note, it might not always be desirable to cover all the axioms. Sometimes conditions might be static:

```
if (std::atomic<T>::is_lock_free())
  axiom_assert(...);
```

The behavior of `std::atomic` is dependent on the architecture. This dependence is represented by member `is_lock_free`. So in this case we would like to have different axioms. But this condition is "static". Coverage checking will probably report this axiom, in the case where the condition is false.

There is an ugly work-around: block delimiters around conditional axioms can be used to disable coverage checking. This is due to the definition of axiom_assert.

```
if (std::atomic<T>::is_lock_free()) {
  axiom_assert(...);
}
```

2.7.6.4 Test error messages and IDE

Error messages output by the library are quite standard and should be already understood by any IDE. However, if you use "parallel-tests" in Automake (which results in redirected output) you need to tell your IDE that the log file is a file of error messages. With Emacs you can insert a mode selection as first line of the output of your test program:

```
std::cout << "-*- mode: compilation -*-" << std::endl;
```

GNU has a documentation page for `Compilation mode`.

2.8 README

Catsfoot is a C++ library providing:

- concept checking,
- concept-based overloading,
- and generating tests automatically from concepts.

In short, it is intended to provide testing utilities for C++ template libraries.

Catsfoot is developed Bergen Language Design Laboratory.

More information is available on `http://catsfoot.sf.net/`

2.9 INSTALL

```
Installation Instructions
*************************

Copyright (C) 1994, 1995, 1996, 1999, 2000, 2001, 2002, 2004, 2005,
2006, 2007, 2008, 2009 Free Software Foundation, Inc.

   Copying and distribution of this file, with or without modification,
are permitted in any medium without royalty provided the copyright
notice and this notice are preserved.  This file is offered as-is,
without warranty of any kind.

Basic Installation
==================

   Briefly, the shell commands `./configure; make; make install' should
configure, build, and install this package.  The following
more-detailed instructions are generic; see the `README' file for
instructions specific to this package.  Some packages provide this
`INSTALL' file but do not implement all of the features documented
below.  The lack of an optional feature in a given package is not
necessarily a bug.  More recommendations for GNU packages can be found
in *note Makefile Conventions: (standards)Makefile Conventions.
```

The ‘configure’ shell script attempts to guess correct values for various system-dependent variables used during compilation. It uses those values to create a ‘Makefile’ in each directory of the package. It may also create one or more ‘.h’ files containing system-dependent definitions. Finally, it creates a shell script ‘config.status’ that you can run in the future to recreate the current configuration, and a file ‘config.log’ containing compiler output (useful mainly for debugging ‘configure’).

It can also use an optional file (typically called ‘config.cache’ and enabled with ‘--cache-file=config.cache’ or simply ‘-C’) that saves the results of its tests to speed up reconfiguring. Caching is disabled by default to prevent problems with accidental use of stale cache files.

If you need to do unusual things to compile the package, please try to figure out how ‘configure’ could check whether to do them, and mail diffs or instructions to the address given in the ‘README’ so they can be considered for the next release. If you are using the cache, and at some point ‘config.cache’ contains results you don’t want to keep, you may remove or edit it.

The file ‘configure.ac’ (or ‘configure.in’) is used to create ‘configure’ by a program called ‘autoconf’. You need ‘configure.ac’ if you want to change it or regenerate ‘configure’ using a newer version of ‘autoconf’.

The simplest way to compile this package is:

1. ‘cd’ to the directory containing the package’s source code and type ‘./configure’ to configure the package for your system.

   Running ‘configure’ might take a while. While running, it prints some messages telling which features it is checking for.

2. Type ‘make’ to compile the package.

3. Optionally, type ‘make check’ to run any self-tests that come with the package, generally using the just-built uninstalled binaries.

4. Type ‘make install’ to install the programs and any data files and documentation. When installing into a prefix owned by root, it is recommended that the package be configured and built as a regular user, and only the ‘make install’ phase executed with root privileges.

5. Optionally, type ‘make installcheck’ to repeat any self-tests, but this time using the binaries in their final installed location. This target does not install anything. Running this target as a regular user, particularly if the prior ‘make install’ required root privileges, verifies that the installation completed correctly.

6. You can remove the program binaries and object files from the source code directory by typing ‘make clean’. To also remove the files that ‘configure’ created (so you can compile the package for a different kind of computer), type ‘make distclean’. There is also a ‘make maintainer-clean’ target, but that is intended mainly for the package’s developers. If you use it, you may have to get all sorts of other programs in order to regenerate files that came with the distribution.

```
  7. Often, you can also type `make uninstall' to remove the installed
     files again.  In practice, not all packages have tested that
     uninstallation works correctly, even though it is required by the
     GNU Coding Standards.

  8. Some packages, particularly those that use Automake, provide `make
     distcheck', which can by used by developers to test that all other
     targets like `make install' and `make uninstall' work correctly.
     This target is generally not run by end users.

Compilers and Options
=====================

   Some systems require unusual options for compilation or linking that
the `configure' script does not know about.  Run `./configure --help'
for details on some of the pertinent environment variables.

   You can give `configure' initial values for configuration parameters
by setting variables in the command line or in the environment.  Here
is an example:

     ./configure CC=c99 CFLAGS=-g LIBS=-lposix

   *Note Defining Variables::, for more details.

Compiling For Multiple Architectures
====================================

   You can compile the package for more than one kind of computer at the
same time, by placing the object files for each architecture in their
own directory.  To do this, you can use GNU `make'.  `cd' to the
directory where you want the object files and executables to go and run
the `configure' script.  `configure' automatically checks for the
source code in the directory that `configure' is in and in `..'.  This
is known as a "VPATH" build.

   With a non-GNU `make', it is safer to compile the package for one
architecture at a time in the source code directory.  After you have
installed the package for one architecture, use `make distclean' before
reconfiguring for another architecture.

   On MacOS X 10.5 and later systems, you can create libraries and
executables that work on multiple system types--known as "fat" or
"universal" binaries--by specifying multiple `-arch' options to the
compiler but only a single `-arch' option to the preprocessor.  Like
this:

     ./configure CC="gcc -arch i386 -arch x86_64 -arch ppc -arch ppc64" \
                 CXX="g++ -arch i386 -arch x86_64 -arch ppc -arch ppc64" \
                 CPP="gcc -E" CXXCPP="g++ -E"

   This is not guaranteed to produce working output in all cases, you
may have to build one architecture at a time and combine the results
using the `lipo' tool if you have problems.

Installation Names
==================

   By default, `make install' installs the package's commands under
`/usr/local/bin', include files under `/usr/local/include', etc.  You
can specify an installation prefix other than `/usr/local' by giving
`configure' the option `--prefix=PREFIX', where PREFIX must be an
```

absolute file name.

You can specify separate installation prefixes for architecture-specific files and architecture-independent files. If you pass the option '--exec-prefix=PREFIX' to 'configure', the package uses PREFIX as the prefix for installing programs and libraries. Documentation and other data files still use the regular prefix.

In addition, if you use an unusual directory layout you can give options like '--bindir=DIR' to specify different values for particular kinds of files. Run 'configure --help' for a list of the directories you can set and what kinds of files go in them. In general, the default for these options is expressed in terms of '${prefix}', so that specifying just '--prefix' will affect all of the other directory specifications that were not explicitly provided.

The most portable way to affect installation locations is to pass the correct locations to 'configure'; however, many packages provide one or both of the following shortcuts of passing variable assignments to the 'make install' command line to change installation locations without having to reconfigure or recompile.

The first method involves providing an override variable for each affected directory. For example, 'make install prefix=/alternate/directory' will choose an alternate location for all directory configuration variables that were expressed in terms of '${prefix}'. Any directories that were specified during 'configure', but not in terms of '${prefix}', must each be overridden at install time for the entire installation to be relocated. The approach of makefile variable overrides for each directory variable is required by the GNU Coding Standards, and ideally causes no recompilation. However, some platforms have known limitations with the semantics of shared libraries that end up requiring recompilation when using this method, particularly noticeable in packages that use GNU Libtool.

The second method involves providing the 'DESTDIR' variable. For example, 'make install DESTDIR=/alternate/directory' will prepend '/alternate/directory' before all installation names. The approach of 'DESTDIR' overrides is not required by the GNU Coding Standards, and does not work on platforms that have drive letters. On the other hand, it does better at avoiding recompilation issues, and works well even when some directory options were not specified in terms of '${prefix}' at 'configure' time.

Optional Features
=================

If the package supports it, you can cause programs to be installed with an extra prefix or suffix on their names by giving 'configure' the option '--program-prefix=PREFIX' or '--program-suffix=SUFFIX'.

Some packages pay attention to '--enable-FEATURE' options to 'configure', where FEATURE indicates an optional part of the package. They may also pay attention to '--with-PACKAGE' options, where PACKAGE is something like 'gnu-as' or 'x' (for the X Window System). The 'README' should mention any '--enable-' and '--with-' options that the package recognizes.

For packages that use the X Window System, 'configure' can usually find the X include and library files automatically, but if it doesn't, you can use the 'configure' options '--x-includes=DIR' and '--x-libraries=DIR' to specify their locations.

```
   Some packages offer the ability to configure how verbose the
execution of `make' will be.  For these packages, running `./configure
--enable-silent-rules' sets the default to minimal output, which can be
overridden with `make V=1'; while running `./configure
--disable-silent-rules' sets the default to verbose, which can be
overridden with `make V=0'.

Particular systems
==================

   On HP-UX, the default C compiler is not ANSI C compatible.  If GNU
CC is not installed, it is recommended to use the following options in
order to use an ANSI C compiler:

     ./configure CC="cc -Ae -D_XOPEN_SOURCE=500"

and if that doesn't work, install pre-built binaries of GCC for HP-UX.

   On OSF/1 a.k.a. Tru64, some versions of the default C compiler cannot
parse its `<wchar.h>' header file.  The option `-nodtk' can be used as
a workaround.  If GNU CC is not installed, it is therefore recommended
to try

     ./configure CC="cc"

and if that doesn't work, try

     ./configure CC="cc -nodtk"

   On Solaris, don't put `/usr/ucb' early in your `PATH'.  This
directory contains several dysfunctional programs; working variants of
these programs are available in `/usr/bin'.  So, if you need `/usr/ucb'
in your `PATH', put it _after_ `/usr/bin'.

   On Haiku, software installed for all users goes in `/boot/common',
not `/usr/local'.  It is recommended to use the following options:

     ./configure --prefix=/boot/common

Specifying the System Type
==========================

   There may be some features `configure' cannot figure out
automatically, but needs to determine by the type of machine the package
will run on.  Usually, assuming the package is built to be run on the
_same_ architectures, `configure' can figure that out, but if it prints
a message saying it cannot guess the machine type, give it the
`--build=TYPE' option.  TYPE can either be a short name for the system
type, such as `sun4', or a canonical name which has the form:

     CPU-COMPANY-SYSTEM

where SYSTEM can have one of these forms:

     OS
     KERNEL-OS

   See the file `config.sub' for the possible values of each field.  If
`config.sub' isn't included in this package, then this package doesn't
need to know the machine type.
```

```
   If you are _building_ compiler tools for cross-compiling, you should
use the option `--target=TYPE' to select the type of system they will
produce code for.

   If you want to _use_ a cross compiler, that generates code for a
platform different from the build platform, you should specify the
"host" platform (i.e., that on which the generated programs will
eventually be run) with `--host=TYPE'.

Sharing Defaults
================

   If you want to set default values for `configure' scripts to share,
you can create a site shell script called `config.site' that gives
default values for variables like `CC', `cache_file', and `prefix'.
`configure' looks for `PREFIX/share/config.site' if it exists, then
`PREFIX/etc/config.site' if it exists.  Or, you can set the
`CONFIG_SITE' environment variable to the location of the site script.
A warning: not all `configure' scripts look for a site script.

Defining Variables
==================

   Variables not defined in a site shell script can be set in the
environment passed to `configure'.  However, some packages may run
configure again during the build, and the customized values of these
variables may be lost.  In order to avoid this problem, you should set
them in the `configure' command line, using `VAR=value'.  For example:

     ./configure CC=/usr/local2/bin/gcc

causes the specified `gcc' to be used as the C compiler (unless it is
overridden in the site shell script).

Unfortunately, this technique does not work for `CONFIG_SHELL' due to
an Autoconf bug.  Until the bug is fixed you can use this workaround:

     CONFIG_SHELL=/bin/bash /bin/bash ./configure CONFIG_SHELL=/bin/bash

`configure' Invocation
======================

   `configure' recognizes the following options to control how it
operates.

`--help'
`-h'
     Print a summary of all of the options to `configure', and exit.

`--help=short'
`--help=recursive'
     Print a summary of the options unique to this package's
     `configure', and exit.  The `short' variant lists options used
     only in the top level, while the `recursive' variant lists options
     also present in any nested packages.

`--version'
`-V'
     Print the version of Autoconf used to generate the `configure'
     script, and exit.

`--cache-file=FILE'
```

```
     Enable the cache: use and save the results of the tests in FILE,
     traditionally `config.cache'.  FILE defaults to `/dev/null' to
     disable caching.

`--config-cache'
`-C'
     Alias for `--cache-file=config.cache'.

`--quiet'
`--silent'
`-q'
     Do not print messages saying which checks are being made.  To
     suppress all normal output, redirect it to `/dev/null' (any error
     messages will still be shown).

`--srcdir=DIR'
     Look for the package's source code in directory DIR.  Usually
     `configure' can determine that directory automatically.

`--prefix=DIR'
     Use DIR as the installation prefix.  *note Installation Names::
     for more details, including other options available for fine-tuning
     the installation locations.

`--no-create'
`-n'
     Run the configure checks, but stop before creating any output
     files.

`configure' also accepts some other, not widely useful, options.  Run
`configure --help' for more details.
```

2.10 NEWS

2.10.1 0.1

Intitial release.

2.11 COPYING

```
   GNU LESSER GENERAL PUBLIC LICENSE
                       Version 3, 29 June 2007

 Copyright (C) 2007 Free Software Foundation, Inc. <http://fsf.org/>
 Everyone is permitted to copy and distribute verbatim copies
 of this license document, but changing it is not allowed.


  This version of the GNU Lesser General Public License incorporates
the terms and conditions of version 3 of the GNU General Public
License, supplemented by the additional permissions listed below.

  0. Additional Definitions.

  As used herein, "this License" refers to version 3 of the GNU Lesser
```

```
General Public License, and the "GNU GPL" refers to version 3 of the GNU
General Public License.

  "The Library" refers to a covered work governed by this License,
other than an Application or a Combined Work as defined below.

  An "Application" is any work that makes use of an interface provided
by the Library, but which is not otherwise based on the Library.
Defining a subclass of a class defined by the Library is deemed a mode
of using an interface provided by the Library.

  A "Combined Work" is a work produced by combining or linking an
Application with the Library.  The particular version of the Library
with which the Combined Work was made is also called the "Linked
Version".

  The "Minimal Corresponding Source" for a Combined Work means the
Corresponding Source for the Combined Work, excluding any source code
for portions of the Combined Work that, considered in isolation, are
based on the Application, and not on the Linked Version.

  The "Corresponding Application Code" for a Combined Work means the
object code and/or source code for the Application, including any data
and utility programs needed for reproducing the Combined Work from the
Application, but excluding the System Libraries of the Combined Work.

  1. Exception to Section 3 of the GNU GPL.

  You may convey a covered work under sections 3 and 4 of this License
without being bound by section 3 of the GNU GPL.

  2. Conveying Modified Versions.

  If you modify a copy of the Library, and, in your modifications, a
facility refers to a function or data to be supplied by an Application
that uses the facility (other than as an argument passed when the
facility is invoked), then you may convey a copy of the modified
version:

   a) under this License, provided that you make a good faith effort to
   ensure that, in the event an Application does not supply the
   function or data, the facility still operates, and performs
   whatever part of its purpose remains meaningful, or

   b) under the GNU GPL, with none of the additional permissions of
   this License applicable to that copy.

  3. Object Code Incorporating Material from Library Header Files.

  The object code form of an Application may incorporate material from
a header file that is part of the Library.  You may convey such object
code under terms of your choice, provided that, if the incorporated
material is not limited to numerical parameters, data structure
layouts and accessors, or small macros, inline functions and templates
(ten or fewer lines in length), you do both of the following:

   a) Give prominent notice with each copy of the object code that the
   Library is used in it and that the Library and its use are
   covered by this License.

   b) Accompany the object code with a copy of the GNU GPL and this license
   document.
```

```
  4. Combined Works.

  You may convey a Combined Work under terms of your choice that,
taken together, effectively do not restrict modification of the
portions of the Library contained in the Combined Work and reverse
engineering for debugging such modifications, if you also do each of
the following:

   a) Give prominent notice with each copy of the Combined Work that
   the Library is used in it and that the Library and its use are
   covered by this License.

   b) Accompany the Combined Work with a copy of the GNU GPL and this license
   document.

   c) For a Combined Work that displays copyright notices during
   execution, include the copyright notice for the Library among
   these notices, as well as a reference directing the user to the
   copies of the GNU GPL and this license document.

   d) Do one of the following:

       0) Convey the Minimal Corresponding Source under the terms of this
       License, and the Corresponding Application Code in a form
       suitable for, and under terms that permit, the user to
       recombine or relink the Application with a modified version of
       the Linked Version to produce a modified Combined Work, in the
       manner specified by section 6 of the GNU GPL for conveying
       Corresponding Source.

       1) Use a suitable shared library mechanism for linking with the
       Library.  A suitable mechanism is one that (a) uses at run time
       a copy of the Library already present on the user's computer
       system, and (b) will operate properly with a modified version
       of the Library that is interface-compatible with the Linked
       Version.

   e) Provide Installation Information, but only if you would otherwise
   be required to provide such information under section 6 of the
   GNU GPL, and only to the extent that such information is
   necessary to install and execute a modified version of the
   Combined Work produced by recombining or relinking the
   Application with a modified version of the Linked Version. (If
   you use option 4d0, the Installation Information must accompany
   the Minimal Corresponding Source and Corresponding Application
   Code. If you use option 4d1, you must provide the Installation
   Information in the manner specified by section 6 of the GNU GPL
   for conveying Corresponding Source.)

  5. Combined Libraries.

  You may place library facilities that are a work based on the
Library side by side in a single library together with other library
facilities that are not Applications and are not covered by this
License, and convey such a combined library under terms of your
choice, if you do both of the following:

   a) Accompany the combined library with a copy of the same work based
   on the Library, uncombined with any other library facilities,
   conveyed under the terms of this License.
```

```
   b) Give prominent notice with the combined library that part of it
   is a work based on the Library, and explaining where to find the
   accompanying uncombined form of the same work.

  6. Revised Versions of the GNU Lesser General Public License.

  The Free Software Foundation may publish revised and/or new versions
of the GNU Lesser General Public License from time to time. Such new
versions will be similar in spirit to the present version, but may
differ in detail to address new problems or concerns.

  Each version is given a distinguishing version number. If the
Library as you received it specifies that a certain numbered version
of the GNU Lesser General Public License "or any later version"
applies to it, you have the option of following the terms and
conditions either of that published version or of any later version
published by the Free Software Foundation. If the Library as you
received it does not specify a version number of the GNU Lesser
General Public License, you may choose any version of the GNU Lesser
General Public License ever published by the Free Software Foundation.

  If the Library as you received it specifies that a proxy can decide
whether future versions of the GNU Lesser General Public License shall
apply, that proxy's public statement of acceptance of any version is
permanent authorization for you to choose that version for the
Library.
```

2.12 AUTHORS

- Valentin David <valentin@ii.uib.no>

Chapter 3

Download

No stable releases are available yet.

Unstable pre-releases might be available from the `nightly tarball repository` if the build farm is being nice enough.

The last option is to use the Subversion repository `https://catsfoot.svn.sourceforge.net/svnroot/catsf` . You will then need recent versions of Autoconf and Automake.

Chapter 4

Support

Contents

4.1 Mailing lists

To subscribe to any of the mailing lists, just email

- `catsfoot-bugs@lists.sourceforge.net`
- `catsfoot-svn@lists.sourceforge.net`
- `catsfoot-users@lists.sourceforge.net`

4.2 Bug tracker

Please send bug reports via the SourceForge page (`quick link`).

Chapter 5

Publications

Contents

Anya Helene Bagge, Valentin David, and Magne Haveraaen. 2009. **The axioms strike back: testing with concepts and axioms in C++.** SIGPLAN Not. 45, 2 (October 2009), 15-24. DOI=10.1145/1837852.1621612.

Anya Helene Bagge, Valentin David, and Magne Haveraaen. 2011. **Testing with Axioms in C++ 2011**. Journal of Object Technology, Volume 10, (2011), pp. 10:1-32. DOI=10.5381/jot.2011.10.1.a10. Figures.

5.1 Figures

This is the exact source code used in the code listings of the article **Testing with Axioms in C++ 2011**. Each listing is delimited by a "\start" and an "\end" command.

```
//%% Use non-used C++ characters for block.
//\catcode`\}=9
//\catcode`\{=9
//\catcode`\$=2
//\catcode`\`=1
//\ignoreinput

// Checked with r49

#include <catsfoot_testing.hh>

namespace testerns {
  using namespace catsfoot;

template <typename... T>
struct tester {
};
//\start`tester$
template <>
struct tester<> {
  template <typename Generator, typename Fun, typename... Params>
```

```
  static bool call(Generator, Fun f, Params... values) {
    try {
      f(values...);
      return true;
    } catch (axiom_failure af) {
      return false;
    }
  }
};

template <typename T, typename... U>
struct tester<T, U...> {
  template <typename Generator, typename Fun, typename... Params>
  static bool call(Generator g, Fun f, Params... values) {
    auto container = g.get(selector<T>());
    for (auto i = container.begin();
         i != container.end(); ++i) {
      if (!tester<U...>::call(g, f, values..., *i))
        return false;
    }
    return true;
  }
};

template <typename Generator,
          typename... T>
bool test(Generator g, void f(T...)) {
  return tester<T...>::call(g, f);
}
//\end

  void axiom(int a, int b, int c) {
    if ((a == b) && (b == c))
      axiom_assert(a == c);
  }

  void axiom_fail(int a, int b, int c) {
    if ((a == b) && (b == c))
      axiom_assert(a != c);
  }

  bool dotest() {
    auto generator =
      choose(list_data_generator<int>
             ({0, 1, 2, -1, 41, 52}),
             default_generator());
    if ( ::testerns::test(generator, axiom_fail))
      return false;
    return ::testerns::test(generator, axiom);
  }
}

namespace equivalencens {
  using namespace catsfoot;

//\start `equivalence$
template <typename T, typename Rel>
struct equivalence: public concept {
  typedef concept_list<
    is_callable<Rel(T, T)>,
    std::is_convertible<typename is_callable<Rel(T, T)>::result_type,
                        bool>
```

```
    > requirements;
  static void reflexivity(const Rel& rel, const T& a) {
    axiom_assert(rel(a,a));
  }
  static void symmetry(const Rel& rel, const T& a, const T& b) {
    if (rel(a, b))
      axiom_assert(rel(b, a));
  }
  static void transitivity(const Rel& rel,
                           const T& a, const T& b, const T& c) {
    if (rel(a, b) && rel(b, c))
      axiom_assert(rel(a, c));
  }
  AXIOMS(reflexivity, symmetry, transitivity);
};
//\end

#ifdef SHOULDBE
//\start `congruence$
template <typename Rel, typename Op, typename... Args>
struct congruence: public concept {
  typedef concept_list<
    equivalence<Args, Rel>...,
    is_callable<Op(Args...)>,
    equivalence<typename is_callable<Op(Args...)>::result_type,
                Rel>
    > requirements;
  static void congruence_axiom(const Args&... args1, const Args&...
      args2,
                               const Op& op, const Rel& rel) {
    if (rel(args1, args2)...)
      axiom_assert(rel(op(args1...), op(args2...)));
  }
  AXIOMS(congruence_axiom);
};
//\end
#else
template <typename Rel, typename Op, typename... Args>
struct congruence: public concept {
  typedef concept_list<
    equivalence<Args, Rel>...,
    is_callable<Op(Args...)>,
    equivalence<typename is_callable<Op(Args...)>::result_type,
                Rel>
    > requirements;
  static void congruence_axiom(const std::tuple<Args...>& args1,
                               const std::tuple<Args...>& args2,
                               const Op& op,
                               const Rel& rel) {
    if (tuple_rel(rel,args1, args2))
      axiom_assert(rel(call_with(op,args1), call_with(op,args2)));
  }
  AXIOMS(congruence_axiom);
};
#endif

}

# include <drivers/test_driver.hh>
# include <drivers/test_all_driver.hh>
# include <dataset/choose.hh>
```

```
namespace equivalencens {
  bool f() {
    auto generator =
      choose(list_data_generator<int>
             ({0, 1, 2, -1, 41, 52}),
             default_generator());
return
//\start`testall$
test_all<congruence<op_eq, op_plus, int, int> >(generator);
//\end
  }

}

namespace wrapped {
//\start`wrappingmethods$
struct foo_wrapped {
  template<typename T, typename... Args,
           typename Ret = decltype(std::declval<T>()
                                   .foo(std::declval<Args>()...))>
  Ret operator()(T&& object, Args&&... args) const {
    return std::forward<T>(object).foo(std::forward<Args>(args)...);
  }
};

struct foo_functionalized {
  template<typename T, typename... Args,
           typename = decltype(std::declval<T>()
                               .foo(std::declval<Args>()...))>
  T operator()(const T& object, Args&&... args) const {
    T ret(object);
    ret.foo(std::forward<Args>(args)...);
    return ret;
  }
};
//\end

  struct A {
    bool flag;
    A(): flag(false) {}
    A(const A& other): flag(other.flag) {
    }

    A* clone() {
      return new A(*this);
    }

    void foo() {
      flag = true;
    }
  };

  bool test() {
    A a;
    A other = foo_functionalized()(a);
    if (!(other.flag && !a.flag))
      return false;
    foo_wrapped()(a);
    return other.flag && a.flag;
  }

}
```

```
namespace wrapped2 {
  template <typename T>
  struct clone_ptr {
  private:
    T* ptr;
  public:
    ~clone_ptr() {
      delete ptr;
    }

    template <typename... Args>
    explicit
    clone_ptr(Args&&... args): ptr(new T(std::forward<Args>(args)...))
        {}

    explicit clone_ptr(T* ptr): ptr(ptr) {}

    clone_ptr(const T& t): ptr(t->clone()) {}

    template <typename U,
              typename = typename
              std::enable_if<std::is_base_of<T, U>::value>::type>
    clone_ptr(const clone_ptr<T>& other):
      ptr(other.ptr->clone()) {
    }

    clone_ptr(const clone_ptr& other):
      ptr(other.ptr->clone()) {
    }

    template <typename U,
              typename = typename
              std::enable_if<std::is_base_of<T, U>::value>::type>
    clone_ptr(clone_ptr<U>&& other):
      ptr(other.ptr) {
      other.ptr = NULL;
    }

    clone_ptr(clone_ptr&& other):
      ptr(other.ptr) {
      other.ptr = NULL;
    }

    T* get() {
      return ptr;
    }

    const T* get() const {
      return ptr;
    }

    T& operator*() {
      return *get();
    }

    const T& operator*() const {
      return *get();
    }

    T* operator->() {
      return get();
```

```
    }

    const T* operator->() const {
      return get();
    }
  };

//\start`inheritanceclone$
struct foo_functionalized {
  template<typename T, typename... Args,
           typename = decltype(std::declval<T>()
                        .foo(std::declval<Args>()...))>
  clone_ptr<T> operator()(clone_ptr<T> object, Args&&... args) const {
    object->foo(std::forward<Args>(args)...);
    return std::move(object);
  }
};
//\end
  struct A {
    bool flag;
    A(): flag(false) {}
    A(const A& other): flag(other.flag) {
    }

    A* clone() {
      return new A(*this);
    }

    void foo() {
      flag = true;
    }
  };

  bool test() {
    clone_ptr<A> a;
    clone_ptr<A> other = foo_functionalized()(a);
    return other->flag && !a->flag;
  }
}

namespace codeforannotation {
  using namespace catsfoot;
  template <typename T>
  struct verified;

  template <typename T>
  struct container;

  template <typename T>
  struct plus_monoid;

//\start`codeforannotation$
template <typename T, typename Op, typename Id>
struct monoid: public concept {
  typedef concept_list<
    is_callable<Op(T, T)>,
    is_callable<Id()>,
    std::is_convertible<typename is_callable<Op(T, T)>
                        ::result_type, T>,
    std::is_convertible<typename is_callable<Id()>
                        ::result_type, T>
    > requirements;
```

```

  static void associativity(const Op& op, const T& a,
                            const T& b, const T& c) {
    axiom_assert(op(a, op(b, c)) == op(op(a, b), c));
  }

  static void identity(const Op& op, const T& a, const Id& id) {
    axiom_assert((op(id(), a) == a) && (op(a, id()) == a));
  }

  AXIOMS(associativity, identity);
};

// This predicate is a example of predicate coming from the
// standard library.
template <typename T>
struct is_lvalue_reference: public std::false_type {
};

template <typename T>
struct is_lvalue_reference<T&>: public std::true_type {
};


template <>
struct verified<monoid<int, op_plus, constant<int, 0> > >
 : public std::true_type
{};

template <typename C,
          ENABLE_IF(container<C>),
          typename T = typename container<C>::element_type,
          ENABLE_IF(plus_monoid<T>)>
T sum(C set);
//\end
}

#include <limits>
#include <dataset/dataset.hh>

bool g()
{
  using namespace catsfoot;
//\start`static_list$
auto generator =
  choose
  (list_data_generator<int>
   ({-1, 0, 1, 2, 3,
        std::numeric_limits<int>::min(),
        std::numeric_limits<int>::max()}),
   default_generator());
//\end
 generator.get(selector<int>{});
 return true;
}

#include <dataset/random_term_generator.hh>

#include <set>

bool h()
{
```

```
  using namespace catsfoot;
  std::mt19937 engine;


//\start `randomterm$
auto int_set_generator =
  term_generator_builder
    <std::set<int>,                       // list of supported types
     std::set<int>::iterator,
     int>()
  (engine,                                // random generator engine

   // generate random integers
   std::function<int()>([&engine] () {
     return std::uniform_int_distribution<int>()(engine);
   }),

   // generate set: initial
   constructor<std::set<int>()>(),

   // generate set: insert
   std::function<std::set<int>(std::set<int>, int)>
   ([](std::set<int> in, int i) {
       in.insert(i);
       return std::move(in);
     }),

   // generate random iterator for a given set
   std::function<std::set<int>::iterator(std::set<int>&)>
   ([&engine] (std::set<int>& s) {
      auto n = std::uniform_int_distribution<decltype(s.size())>
        (0, s.size())(engine);
      auto i = s.begin();
      for (decltype(n) j = 0; j < n; ++j, ++i) ;
      return i; // will point to random element in s
    }));
//\end
 int_set_generator.get(selector<int>{});

//\start `powerset$
typedef std::set<int> elt;
auto power_set_generator =
  term_generator_builder
    <std::set<elt>,                       // list of supported types
     std::set<elt>::iterator,
     elt>()
  (engine,                                // random generator engine

   // generate random sets
   pick<elt>(int_set_generator),

   // generate set: initial
   constructor<std::set<elt>()>(),

   // generate set: insert
   std::function<std::set<elt>(std::set<elt>, const elt&)>
   ([](std::set<elt> in, const elt& i) {
       in.insert(i);
       return std::move(in);
     }),

   // generate random iterator for a given set
```

```
    std::function<std::set<elt>::iterator(std::set<elt>&)>
    ([&engine] (std::set<elt>& s) {
       auto n = std::uniform_int_distribution<decltype(s.size())>
         (0, s.size())(engine);
       auto i = s.begin();
       for (decltype(n) j = 0; j < n; ++j, ++i) ;
       return i; // will point to random element in s
     }));
//\end

  power_set_generator.get(selector<std::set<int> >{});

  return true;
}

template <typename AssociativeContainer, typename Iterator>
struct something {
  //\start `erasure$
static void erasure(AssociativeContainer c, Iterator i) {
  if ((i == find(c, i)) && (i != end(c)))
    axiom_assert(size(erase(c, i)) == size(c) - 1);
}
  //\end
};

namespace monoiddef {
  using namespace catsfoot;

//\start `monoid$
template <typename T, typename Op, typename Id>
struct monoid: public concept {
  typedef concept_list<
    is_callable<Op(T, T)>,
    is_callable<Id()>,
    std::is_convertible<typename is_callable<Op(T, T)>
                        ::result_type, T>,
    std::is_convertible<typename is_callable<Id()>
                        ::result_type, T>
    > requirements;

   static void associativity(const Op& op, const T& a,
                             const T& b, const T& c) {
     axiom_assert(op(a, op(b, c)) == op(op(a, b), c));
   }

   static void identity(const Op& op, const T& a, const Id& id) {
     axiom_assert((op(id(), a) == a) && (op(a, id()) == a));
   }

  AXIOMS(associativity, identity);
};
//\end
}

//\start `predicate_dflt$
template <typename T>
struct is_lvalue_reference: public std::false_type {
};
//\end

//\start `predicate$
template <typename T>
```

```
struct is_lvalue_reference<T&>: public std::true_type {
};
//\end

namespace catsfoot {
  using namespace monoiddef;
//\start`verified_monoid$
template <>
struct verified<monoid<int, op_plus, constant<int, 0> > >
 : public std::true_type
{};
//\end
}

namespace monoiddef {
  template <typename T>
  struct verified {};
//\start`monoid_plus$
template <typename T>
struct plus_monoid: public concept {
  typedef
    monoid<T, op_plus, wrapped_constructor<T()> >
    requirements;
};

template <typename T>
struct verified<monoid<T, op_plus, wrapped_constructor<T()> > >
 : public verified<plus_monoid<T> >
{};
//\end
}

namespace monoiddef {
  template <typename T>
  struct container;
//\start`sum$
template <typename C,
          ENABLE_IF(container<C>),
          typename T = typename container<C>::element_type,
          ENABLE_IF(plus_monoid<T>)>
T sum(C set);
//\end
}

namespace monoiddecomposed {
  using namespace catsfoot;
//\start`monoidhead$
template <typename T, typename Op, typename Id>
struct monoid: public concept {
//\end
//\start`monoidreqs$
  typedef concept_list<
    // operations are callable with the given parameter types
    is_callable<Op(T, T)>,
    is_callable<Id()>,
    // results are convertible to T
    std::is_convertible<typename is_callable<Op(T, T)>
                        ::result_type, T>,
    std::is_convertible<typename is_callable<Id()>
                        ::result_type, T>
  > requirements;
//\end
```

```
//\start `monoidaxioms$
  static void associativity(const Op& op, const T& a,
                            const T& b, const T& c) {
    axiom_assert(op(a, op(b, c)) == op(op(a, b), c));
  }

  static void identity(const Op& op, const T& a, const Id& id) {
    axiom_assert((op(id(), a) == a) && (op(a, id()) == a));
  }
//\end
//\start `monoidgetaxioms$
  AXIOMS(associativity, identity);
}; // end of concept monoid
//\end

template <typename T>
struct verified;
//\start `monoidverified$
template <>
struct verified<monoid<int, op_plus, constant<int,0> > >
 : public std::true_type
{};
//\end
}

namespace ringdef {
  using namespace monoiddef;

  template <typename T, typename Op, typename Minus,
            typename Id>
  struct group: public concept {
    typedef concept_list<
      monoid<T, Op, Id>
      > requirements;
    static void inverse(const T& a,
                        const Id& id,
                        const Minus& minus,
                        const Op& op) {
      axiom_assert(op(a, minus(a)) == id());
      axiom_assert(op(minus(a), a) == id());
    }

    AXIOMS(inverse);
  };

  template <typename T, typename Op>
  struct commutative: public concept {
    typedef concept_list<
    is_callable<Op(T, T)>,
    std::is_convertible<typename is_callable<Op(T, T)>
                        ::result_type, T>,
      > requirements;

    static void commutativity(const T& a, const T& b,
                              const Op& op) {
      axiom_assert(op(a, b) == op(b, a));
    }

    AXIOMS(commutativity);
  };

  template <typename T, typename MOp, typename AOp>
```

```
  struct distributive {
  typedef concept_list<
    is_callable<MOp(T, T)>,
    is_callable<AOp(T, T)>,
    std::is_convertible<typename is_callable<MOp(T, T)>
                        ::result_type, T>,
    std::is_convertible<typename is_callable<AOp(T, T)>
                        ::result_type, T>
    > requirements;

    static void distributivity(const T& a, const T& b, const T& c,
                               const MOp& mop, const AOp& aop) {
      axiom_assert(mop(a, aop(b, c)) == aop(mop(a, b), mop(a, c)));
      axiom_assert(mop(aop(a, b), c) == aop(mop(a, c), mop(a, c)));
    }

    AXIOMS(distributivity);
  };

//\start`ring$
template <typename T, typename MOp, typename AOp,
          typename Minus, typename Zero, typename One>
struct ring: public concept {
  typedef monoid<T, AOp, Zero> add_monoid;
  typedef group<T, AOp, Minus, Zero> add_group;
  typedef monoid<T, MOp, One> mul_monoid;

  typedef concept_list<
    mul_monoid,
    add_group, // implies add_monoid
    distributive<T, MOp, AOp>,
    commutative<T, AOp>
    > requirements;

  // check that we also have add_monoid
  class_assert_concept<add_monoid> check;
};
//\end

  struct op_minus {
    template <typename T,
              typename Ret = decltype(-std::declval<T>())>
    Ret operator()(T&& t) const {
      return -std::forward<T>(t);
    }
  };
}

namespace ringdef {
bool test()
{
  auto generator =
    choose
    (list_data_generator<int>
     ({-1, 0, 1, 2, 3,
         std::numeric_limits<int>::min(),
         std::numeric_limits<int>::max()}),
     default_generator());

  return test_all<ring<int, op_times, op_plus, op_minus,
                       constant<int, 0>, constant<int, 1> > >
                  (generator);
```

```
}

}

namespace monoiddef {
bool test()
{
  using catsfoot::test;

  auto generator =
    choose
    (list_data_generator<int>
     ({-1, 0, 1, 2, 3,
          std::numeric_limits<int>::min(),
          std::numeric_limits<int>::max()}),
     default_generator());

//\start`monoiddef_test$
  test(generator,
       monoid<int, op_plus, constant<int, 0>>::associativity);
//\end

  if (!test(generator,
            monoid<int, op_plus, constant<int, 0>>::associativity,
            "associativity"))
    return false;

  return
//\start`monoiddef_testall$
  test_all<monoid<int, op_plus, constant<int, 0>>>(generator);
//\end
}
bool test_fail()
{
  auto generator =
    choose
    (list_data_generator<int>
     ({-1, 0, 1, 2, 3,
          std::numeric_limits<int>::min(),
          std::numeric_limits<int>::max()}),
     default_generator());

  return
//\start`monoiddef_testfail$
  test_all<monoid<int, op_plus, constant<int, 1>>>(generator);
//\end
}

}

namespace hashdef {
  using namespace catsfoot;
//\start`hash$
template <typename T, typename Hash>
struct hash: public concept {
  typedef concept_list<
    congruence<op_eq, Hash, T>
    > requirements;
};
//\end
  bool test() {
    auto generator =
```

```
        choose
        (list_data_generator<std::string>
         ({"aaa", "bbb", "ccc"}),
         default_generator());
      return test_all<hash<std::string, std::hash<std::string> > >
        (generator);
    }
}

namespace orderdef {
  using namespace catsfoot;
//\start `strict_weak_order$
template <typename T, typename Rel>
struct strict_weak_order: public concept {
  typedef concept_list<
    is_callable<Rel(T, T)>,
    std::is_convertible<typename is_callable<Rel(T, T)>
                         ::result_type, bool>,
    > requirements;

  static void irreflexivity(const T& a, const Rel& rel) {
    axiom_assert(!rel(a, a));
  }

  static void asymmetry(const T& a, const T& b, const Rel& rel) {
    if (a != b)
      axiom_assert(!(rel(a,b) && rel(b,a)));
  }
  static void transitivity(const T& a, const T& b, const T& c,
                           const Rel& rel) {
    if ((rel(a, b) && rel(b, c)))
      axiom_assert(rel(a,c));
  }
  static void transitivity_of_equivalence
  (const T& a, const T&b, const T& c, const Rel& rel) {
    if (rel(a, b))
      axiom_assert(rel(a, c) || rel(c, b));
  }

  AXIOMS(irreflexivity,
         asymmetry,
         transitivity,
         transitivity_of_equivalence)
};
//\end
  bool test() {
    auto generator =
      choose
      (list_data_generator<int>
       ({-1, 0, 1, 2, 3,
           std::numeric_limits<int>::min(),
           std::numeric_limits<int>::max()}),
       default_generator());
    return test_all<strict_weak_order<int, op_lt> >
      (generator);
  }
}


namespace exception {
  using namespace catsfoot;
//\start `exception$
```

```
template <typename T,
          typename Fun, typename... Args,
          ENABLE_IF(is_callable<Fun(Args...)>)>
bool throwing(Fun&& fun, Args&&... args) {
  try {
    std::forward<Fun>(fun)(std::forward<Args>(args)...);
  } catch (T) {
    return true;
  }
  return false;
}
//\end
  struct Bidule {};
  void f(int i) {
    if (i == 0)
      throw Bidule();
  }

  bool test() {
    return throwing<Bidule>(f, 0) && !throwing<Bidule>(f, 1);
  }
}

int main() {
  bool ret = true;
  ret = ret && equivalencens::f();
  ret = ret && g();
  ret = ret && h();
  ret = ret && ringdef::test();
  ret = ret && monoiddef::test();
  ret = ret && !monoiddef::test_fail();
  ret = ret && exception::test();
  ret = ret && orderdef::test();
  ret = ret && hashdef::test();
  ret = ret && wrapped::test();
  ret = ret && wrapped2::test();
  ret = ret && testerns::dotest();
  return !ret;
}

//\endignore
```

Chapter 6

Todo List

Class catsfoot::container< T, ValueType > Check the returns are iterators.

Member catsfoot::details::try_all_compare< T, std::function< Ret(Args...)> >::doit(Generator &, const std::functio
If == does not exist?

Chapter 7

Module Index

Contents

7.1 Modules

Here is a list of all modules:

Chapter 8

Namespace Index

Contents

8.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

Chapter 9

Class Index

Contents

9.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 10

Class Index

Contents

10.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 11

Module Documentation

Contents

11.1 User type traits

Classes

- struct catsfoot::verified< T >

  User type traits for validating models.

11.2 Concepts

Classes

- struct catsfoot::equality< T, U >

  Check whether T is comparable to U by ==.

- struct catsfoot::printable< T, U >

  Check whether U is printable on a stream T.

- struct catsfoot::is_same< T, U >

  Check whether T and U are the same type.

- struct catsfoot::equivalence< T, Rel >

  Generic concept for equivalence relation.

- struct catsfoot::equivalence_eq< T >

  Concept for equivalence relation with operator==.

- struct catsfoot::congruence< Rel, Op, Args >

  Check whether an operation sees equality as congruence relation.

- struct catsfoot::congruence_eq< T, Args >

  Concept for congruence relation with operator==.

- struct catsfoot::container< T, ValueType >
- struct catsfoot::generator_for< T, Type >

  Whether T is a generator of Type.

11.3 Predicates

Classes

- struct catsfoot::eval< T >

  Predicate evaluating models and predicates.

- struct catsfoot::is_auto_concept< T >

  Checks if T is an auto concept model.

- struct catsfoot::is_concept< T >

  Checks if T is a concept model.

- struct catsfoot::is_callable< T(U...)>

  Tells whether T is callable with (U...)

- struct catsfoot::is_constructible< T(U...)>

  Tells whether T is constructible with {U...}.

11.4 Data generators

Classes

- struct catsfoot::default_generator

Generator that build default constructors.

- struct catsfoot::list_data_generator< T >

  Generator using lists of data provided by the user.

Functions

- template<typename... T>
  details::generator_choose< typename std::decay< T >::type...> catsfoot::choose (T &&...t)

  Combines generators.
  Picks the left-most generator capable or generating the requested data set.

- template<typename Generator >
  details::tuple_generator< typename std::decay< Generator >::type > catsfoot::tuple_-gen (Generator &&g)

  Builds a tuple generator from element generators.

11.5 Type traits

Classes

- struct catsfoot::wrapped< T >

  Get the return type of the wrap function.

11.6 Macro definitions

Defines

- #define axiom_assert(expr)

  Throws an axiom failure if expr is false.

- #define ENABLE_IF(X...) typename = typename std::enable_if< ::catsfoot::eval< X >::value>::type

  Enable function definition if concept is fulfilled.

- #define ENABLE_IF_NOT(X...) typename = typename std::enable_if<!::catsfoot::eval< X >::value>::type

  Enable function definition if concept has no model.

- #define IF(X...) ::catsfoot::eval< X >::value

Tells whether a concept is fulfilled.

- #define AXIOMS(X...)

  Defines a list of axiom in a concept.

- #define DEF_MEMBER_WRAPPER(X...)

  Defines a wrapper for calling a member of a class.

- #define DEF_STATIC_MEMBER_WRAPPER(X...)

  Defines a wrapper for calling a static member of a class.

- #define DEF_FUNCTION_WRAPPER(X...)

  Defines a function wrapper for calling a function.

11.6.1 Define Documentation

11.6.1.1 #define axiom_assert(*expr*)

Value:

```
_catsfoot__test_axiom("<unknown>", \
                                     "<unknown>", \
                                     0, \
                                     expr)
```

Throws an axiom failure if *expr* is false.

11.6.1.2 #define AXIOMS(*X...*)

Value:

```
static auto get_axioms() ->                                              \
    decltype(::catsfoot::details::zip_vec_tuple                          \
              (::catsfoot::details::split_identifiers(#X),               \
               std::make_tuple(X))) {                                    \
    return ::catsfoot::details::zip_vec_tuple                            \
      (::catsfoot::details::split_identifiers(#X),                       \
       std::make_tuple(X));                                              \
  }
```

Defines a list of axiom in a concept.

11.6.1.3 #define DEF_FUNCTION_WRAPPER(*X...*)

Value:

```
struct function_##X {                                                    \
    template <typename... U,                                             \
              typename Ret =                                             \
              decltype(X(std::declval<U>()...))>                         \
    Ret operator()(U&&... u...) const {                                  \
```

```
      return X(std::forward<U>(u)...);                              \
    }                                                               \
  };
```

Defines a function wrapper for calling a function.

11.6.1.4 #define DEF_MEMBER_WRAPPER(*X...*)

Value:

```
struct member_##X {                                              \
    template <typename T, typename... U,                         \
              typename Ret =                                     \
              decltype(std::declval<T>()                         \
                       .X(std::declval<U>()...))>                \
    Ret operator()(T&& t, U&&... u) const {                      \
      return std::forward<T>(t).X(std::forward<U>(u)...);        \
    }                                                            \
  };
```

Defines a wrapper for calling a member of a class.

It can be useful for such a case:

```
DEF_MEMBER_WRAPPER(foo);
template <typename T, ENABLE_IF(callable<member_foo(T, int)>)>
  [...]
    t.foo(20);
```

11.6.1.5 #define DEF_STATIC_MEMBER_WRAPPER(*X...*)

Value:

```
template <typename T>                                        \
  struct static_member_##X {                                 \
    template <typename... U,                                 \
              typename Ret =                                 \
              decltype(T::X(std::declval<U>()...))>          \
    Ret operator()(U&&... u) const {                         \
      return T::X(std::forward<U>(u)...);                    \
    }                                                        \
  };
```

Defines a wrapper for calling a static member of a class.

It can be useful for such a case:

```
DEF_MEMBER_WRAPPER(foo);
template <typename T, ENABLE_IF(callable<static_member_foo<T>(int)>)>
  [...]
    T::foo(20);
```

11.6.1.6 #define ENABLE_IF(*X...*) typename = typename std::enable_if$<$ ::catsfoot::eval$<$ X $>$::value$>$::type

Enable function definition if concept is fulfilled.

It should be used in the parameter list a function template.

11.6.1.7 #define ENABLE_IF_NOT(*X...*) typename = typename std::enable_if<!::catsfoot::eval< X >::value>::type

Enable function definition if concept has no model.

It should be used in the parameter list a function template.

11.6.1.8 #define IF(*X...*) ::catsfoot::eval< X >::value

Tells whether a concept is fulfilled.

It makes a constant expression of type *bool*.

11.7 Operator wrappers

Classes

- struct catsfoot::op_eq
  Wraps operator==.
- struct catsfoot::op_neq
  Wraps operator!=.
- struct catsfoot::op_plus
  Wraps operator+.
- struct catsfoot::op_times
  Wraps operator.*
- struct catsfoot::op_lsh
  Wraps operator<<.
- struct catsfoot::op_lt
  Wraps operator<.
- struct catsfoot::op_inc
  Wraps operator++.
- struct catsfoot::op_post_inc
  Wraps operator++(T&, int)
- struct catsfoot::op_star
  Wraps operator.*
- struct catsfoot::wrapped_constructor< T >
  Wraps constructor T.

Chapter 12

Namespace Documentation

Contents

12.1 catsfoot Namespace Reference

Main namespace for Catsfoot.

Namespaces

- namespace details

  Implementation details for Catsfoot.

Classes

- struct axiom_failure

  Exception class for axiom failure.

- struct verified

  User type traits for validating models.

- struct concept_list

List representation of several concepts.

- struct eval

  Predicate evaluating models and predicates.

- struct class_assert_concept

  Checks that a concept is.

- struct equality

  Check whether T is comparable to U by ==.

- struct printable

  Check whether U is printable on a stream T.

- struct is_same

  Check whether T and U are the same type.

- struct equivalence

  Generic concept for equivalence relation.

- struct equivalence_eq

  Concept for equivalence relation with operator==.

- struct verified< equivalence_eq< T > >

  If == is an equivalence relation to T, then T is equivalence_eq.

- struct verified< equivalence< T, op_eq > >

  If T is equivalence_eq, then == is an equivalence relation to T.

- struct congruence

  Check whether an operation sees equality as congruence relation.

- struct congruence_eq

  Concept for congruence relation with operator==.

- struct verified< congruence_eq< T, Args...> >

  When T is a congruence for ==, then T is a congruence_eq.

- struct verified< congruence< op_eq, T, Args...> >

  When T is a congruence_eq, then T is a congruence for ==.

- struct concept

  Base marker for concepts.

- struct auto_concept

  Base marker for auto concepts.

- struct is_auto_concept

  Checks if T is an auto concept model.

- struct is_concept

  Checks if T is a concept model.

- struct product
- struct simple_product
- struct verified< product< Type, constructor_wrap< Type >, Projections...> >
- struct selector

  Constructible type used to select a type for overloaded functions.

- struct container
- struct generator_for

  Whether T is a generator of Type.

- struct default_generator

  Generator that build default constructors.

- struct list_data_generator

  Generator using lists of data provided by the user.

- struct pick_functor
- struct term_generator_builder

  Builds random term generators.

- struct undefined_return

  Return type used in case of error for is_callable.

- struct is_callable

  Default case: callable without parameters?

- struct is_callable< T(U...)>

  Tells whether T is callable with (U...)

- struct is_callable< void(U...)>

  Void is a special type that may induce extra error messages.

- struct is_constructible

  Undefined.

- struct is_constructible< T(U...)>

  Tells whether T is constructible with {U...}.

- struct is_constructible< void(U...)>

Void is a special type that may induce extra error messages.

- struct undefined_member_type

  Type used return by has_member_... in case member does not exist.

- struct build_comparer

  This is class is used to build an black box equality engine.

- struct constant

  Functor returning and integral constant.

- struct wrapped

  Get the return type of the wrap function.

- struct disamb

  Disambiguates an overloaded functions address.

- struct disamb_const

  Disambiguates an overloaded const member.

- struct constructor_wrap

  Wraps constructors.

- struct op_eq

  Wraps operator==.

- struct op_neq

  Wraps operator!=.

- struct op_plus

  Wraps operator+.

- struct op_times

  Wraps operator.*

- struct op_lsh

  Wraps operator<<.

- struct op_lt

  Wraps operator<.

- struct op_inc

  Wraps operator++.

- struct op_post_inc

  Wraps operator++(T&, int)

- struct op_star

    Wraps operator∗.*

- struct wrapped_constructor

    Wraps constructor T.

Functions

- EXTERN bool check_unverified (std::ostream &s=std::cerr)

    Tells whether some conditional axioms where never reached.

- template< typename T >
  void assert_concept (const T &)

    Assert that the concept T holds.

- template< typename Rel , typename... E, typename Index = std::integral_constant< size_t, 0>, typename = typename std::enable_if <(Index::value == sizeof...(E))>::type, typename = void>
  bool tuple_rel (Rel, const std::tuple< E...> &, const std::tuple< E...> &, Index=Index())

    Check that a relation holds for all elements on a pair of tuples.

- template< typename Rel , typename... E, typename Index = std::integral_constant< size_t, 0>, typename >
  bool tuple_rel (Rel rel, const std::tuple< E...> &a, const std::tuple< E...> &b, Index=Index())

    Check that a relation holds for all elements on a pair of tuples.

- template< typename... T>
  details::generator_choose< typename std::decay< T >::type...> choose (T &&...t)

    Combines generators.
    Picks the left-most generator capable or generating the requested data set.

- **DEF_MEMBER_WRAPPER** (begin)
- **DEF_MEMBER_WRAPPER** (end)
- **DEF_MEMBER_WRAPPER** (get)
- template< typename T , typename Generator >
  std::function< T()> **pick** (Generator &g)
- template< typename Generator >
  details::tuple_generator< typename std::decay< Generator >::type > tuple_gen (Generator &&g)

    Builds a tuple generator from element generators.

- template< typename Model , typename Generator , typename Stream = decltype(std::cerr)>
  bool test_all (Generator &g, Stream &s=std::cerr)

Tests all axioms of model Model and its sub-models.

- template<typename Generator , typename... T, typename Stream = decltype(std::cerr)>
bool test (Generator &g, void f(T...), std::string name="<unknown>", Stream &s=std::cerr)

  This will call f with parameters from g.

- template<typename Fun , typename... Params>
bool catch_errors (Fun f, Params &&...values)

  This will call f with the parameters and catch any axiom error.

- template<typename Op , typename Tuple >
details::call_with_ret< Op, Tuple >::type call_with (Op &&op, Tuple &&args)

  Calls a function with arguments from a std::tuple.

- template<typename Ret , typename... Args>
std::function< Ret(Args...)> wrap (Ret(∗f)(Args...))

  Wraps a function.

- template<typename T >
std::function< T > wrap (const std::function< T > &f)

  Forwards function.

- template<typename T >
std::function< T > wrap (std::function< T > &&f)

  Forwards function.

- template<typename T >
std::function< T > constructor ()

  Wraps a constructor.

- template<typename T >
details::remove_side_effect_helper< typename std::decay< T >::type > **remove_side_effect** (T t)

Variables

- std::tuple< typename std::decay< typename is_callable< const Functions(const Parameter &)>::result_type >::type...> call_tuple (const std::tuple< Functions...> &functions, const Parameter &param)

  Calls a tuple of functions with an argument.

- std::function< Ret(T &, Args...)> wrap (Ret(T::∗f)(Args...))

  Wraps a non-const member function.

12.1.1 Detailed Description

Main namespace for Catsfoot.

12.1.2 Function Documentation

12.1.2.1 template<typename T > void catsfoot::assert_concept (const T &)

Assert that the concept T holds.

This function does not do anything. It will however raise a static assertion in case T is not a valid concept.

12.1.2.2 template<typename Op , typename Tuple > details::call_with_ret<Op, Tuple>::type catsfoot::call_with (Op && *op*, Tuple && *args*)

Calls a function with arguments from a *std::tuple*.

Parameters

op	A function.
args	The tuple of arguments

Returns

the result of op(args...)

12.1.2.3 template<typename Fun , typename... Params> bool catsfoot::catch_errors (Fun *f*, Params &&... *values*)

This will call *f* with the parameters and catch any axiom error.

It is a shortcut for

```
try {
  f(values...);
} catch (axiom_failure af) {
  std::cerr << /*... */;
}
```

12.1.2.4 template<typename T > std::function<T> catsfoot::constructor ( )

Wraps a constructor.

Template Parameters

T	Signature where return type is the class.

12.1.3 Variable Documentation

12.1.3.1 std::tuple<typename std::decay <typename is_callable <const Functions(const Parameter&)>::result_type>::type...> catsfoot::call_tuple(const std::tuple< Functions...> &functions, const Parameter &param)

Calls a tuple of functions with an argument.

Parameters

functions	The functions
param	The parameter for calling the function

Returns

the tuple of results

12.1.3.2 std::function< Ret(const T &, Args...)> catsfoot::wrap

Wraps a non-const member function.

Wraps a const member function.

We "functionalize" the method here.

12.2 catsfoot::details Namespace Reference

Implementation details for Catsfoot.

Classes

- struct eval

  Default case: predicate.

- struct eval< T, true, true, B >

  If T is a concept model.

- struct eval< T, true, false, true >

  If T is an auto-concept model.

- struct eval< concept_list< T...>, false, false, false >

  If the parameter is a list of requirements.

- struct class_assert_verified

  Check that T is a verified model.

- struct class_assert_concept

Concept checking: predicate.

- struct class_assert_concept< concept_list< F, T...>, A, B, C >

  Concept checking: recursion on a list of requirements.

- struct class_assert_concept< concept_list<>, A, B, C >

  Concept checking: empty list of requirements.

- struct class_assert_concept< T, true, B, true >

  Concept checking: T is a concept model.

- struct class_assert_concept< T, false, true, true >

  Concept checking: T is a auto-concept model.

- struct is_same
- struct is_same< T, T >
- struct has_requirements

  Check whether T has a member type `requirements`*.*

- struct static_binary_and

  Predicate true if all predicate parameters are true.

- struct static_binary_and< T, U, true >

  Predicate true if all predicate parameters are true.

- struct static_and< F, T...>

  Predicate true if all predicate parameters are true.

- struct static_and<>

  Predicate true if all predicate parameters are true.

- struct generator_choose
- struct generator_choose< T, Other...>
- struct position_impl

  Finds the first occurrence of a type in a list.

- struct position_impl< N, T, T, U...>

  Finds the first occurrence of a type in a list.

- struct position_impl< N, T, U, V...>

  Finds the first occurrence of a type in a list.

- struct position

  Finds the first occurrence of a type in a list.

- struct number_function_returns< T >

No function given.

- struct number_function_returns< T, std::function< T(Args...)>, Functions...>

  The first function returns a T.

- struct number_function_returns< T, std::function< const T &(Args...)>, Functions...>

  The first function returns a T.

- struct number_function_returns< T, std::function< T &(Args...)>, Functions...>

  The first function returns a T.

- struct number_function_returns< T, std::function< T &&(Args...)>, Functions...>

  The first function returns a T.

- struct number_function_returns< T, std::function< Ret(Args...)>, Functions...>

  The first function does not return a T.

- struct number_ground_terms< T >

  No function.

- struct number_ground_terms< T, std::function< T()>, Functions...>

  First function is ground term.

- struct number_ground_terms< T, std::function< const T &()>, Functions...>

  First function is ground term.

- struct number_ground_terms< T, std::function< T &()>, Functions...>

  First function is ground term.

- struct number_ground_terms< T, std::function< T &&()>, Functions...>

  First function is ground term.

- struct number_ground_terms< T, std::function< Ret(Args...)>, Functions...>

  First function is not ground term.

- struct tuple_generator_tool
- struct tuple_generator_tool< std::tuple< U...> & >

  Generates containers of tuples std::tuple<U...>

- struct tuple_generator_tool< const std::tuple< U...> & >

  Generates containers of tuples std::tuple<U...>

- struct tuple_generator_tool< std::tuple< U...> >

Generates containers of tuples std::tuple<U...>

- struct tuple_generator

  Generates tuple from generator.

- struct has_get_axiom

  Predicate testing that U has static member get_axioms()

- struct test_all

  Test axioms of a predicate (always true)

- struct test_all< T, true, false >

  Test axioms of a concept with no local axioms.

- struct test_all< T, true, true >

  Test axioms of a concept with local axioms.

- struct test_all< concept_list< T, U...>, false, B >

  Test axioms of a list of requirements.

- struct tester<>
- struct tester< T, U...>
- struct always_false

  Predicate always false but depending on type parameters.

- struct always_true

  Predicate always true but depending on type parameters.

- struct callable_real_map

  Traits to use when everything is OK.

- struct callable_bad_map

  Traits to use on error.

- struct callable_real_map< T(U...)>

  Traits defining the return type.

- struct callable_bad_map< T(U...)>

  Traits defining an undefined return type.

- struct is_constructible_work_around< false, T(U...)>

  If T is not a class, it cannot be built with several parameter.

- struct is_constructible_work_around< false, T()>

  If not a class, is it always default constructible (maybe)

- struct is_constructible_work_around< false, T(U)>

  If is explicitly convertible and not a class, then it is like constructible.

- struct is_constructible_work_around< true, T(U...)>

  If T is a class, then use the standard library.

- struct try_first

  Tag for prioritizing some overloaded functions.

- struct try_second

  Tag for prioritizing some overloaded functions.

- struct try_all_compare< T, std::function< Ret(Args...)> >
- struct compare< Generator, T >

  No left operation.

- struct compare< Generator, T, Op, Ops...>

  Compare using the first operator and recurse.

- struct compare_top

  Builds a black-box comparator.

- struct call_tuple_helper
- struct add_const_ref
- struct add_ref
- struct call_with_ret
- struct call_with_ret< Op, std::tuple< Args...> & >
- struct call_with_ret< Op, std::tuple< Args...> >
- struct call_with_ret< Op, const std::tuple< Args...> & >
- struct member_wrapper< Ret(T::∗)(Args...)>

  Wraps a non-const member.

- struct member_wrapper< void(T::∗)(Args...)>

  Wraps a non-const void returning member.

- struct member_wrapper< Ret(T::∗)(Args...) const >

  Wraps a const member.

- struct return_of
- struct return_of< T(Args...)>
- struct remove_side_effect_helper
- struct wrapped_constructor< T(Args...), true >

  Wraps constructor T(Args...)

- struct wrapped_constructor< T(Args...), false >

  T(Args...) is not constructible.

Functions

- tmp tmp aLqmiBCgXn catsfoot src axioms axioms hh EXTERN void reached_-function (std::string &&func, std::string &&file, unsigned line)

    Counts axiom as reached.

- EXTERN void register_function (std::string &&func, std::string &&file, unsigned line)

    Ensures the axiom as a counter.

- template<typename T , typename = typename T::requirements>
  std::true_type **has_requirements_helper** (try_first, T &&)
- template<typename T >
  std::false_type **has_requirements_helper** (try_second, T &&)
- template<typename T , typename... U, typename... V, typename = typename std::enable_if<sizeof...(V) == sizeof...(U)>::type>
  std::tuple< std::pair< T, U >...> zip_vec_tuple (const std::vector< T > &vec, const std::tuple< U...> &, V &&...v)

    Zip a vector of T with a tuple of U...

- template<typename T , typename... U, typename... V, typename = void, typename >
  std::tuple< std::pair< T, U >...> zip_vec_tuple (const std::vector< T > &v, const std::tuple< U...> &t, V &&...values)

    Zip a vector of T with a tuple of U...

- EXTERN std::vector< std::string > split_identifiers (const std::string &)

    Splits a comma separated list of C++ identifiers into a vector.

- template<typename U >
  std::false_type has_get_axiom_helper (try_second, U &&)

    Selected only when U has no static member get_axioms()

- template<typename U , typename = decltype(U::get_axioms())>
  std::true_type has_get_axiom_helper (try_first, U &&)

    Selected only when U has a static member get_axioms()

- template<typename Stream , typename T , ENABLE_IF(printable< Stream &, T >) >
  void print_if_printable (Stream &s, T &&t)

    Prints the value if printable.

- template<typename Stream , typename T , ENABLE_IF_NOT(printable< Stream &, T >) , typename = void>
  void print_if_printable (Stream &s, T &&)

    Prints type name of value if not printable.

- void display_values ()

    Prints a list of values.

- template<typename T , typename... U>
  void display_values (T &&t, U &&...u)

  Prints a list of values.

- template<typename T , typename... U>
  std::false_type is_callable_helper (try_second, T &&, U &&...)

  Selected when T is not callable with U...

- template<typename T , typename... U, typename = decltype(std::declval<T>()(std::declval<U>()...))>
  std::true_type is_callable_helper (try_first, T &&, U &&...)

  Selected when T is callable with U...

- template<typename Op , typename Tuple , typename... Given, typename = typename std::enable_-if<(sizeof...(Given) == call_with_ret<Op, Tuple>::size)>::type>
  call_with_ret< Op, Tuple >::type **call_with_it** (Op &&op, Tuple &&, Given &&...args)
- template<typename Op , typename Tuple , typename... OtherArgs, typename = typename std::enable_-if<(sizeof...(OtherArgs) != call_with_ret<Op, Tuple>::size)>::type, typename = void>
  call_with_ret< Op, Tuple >::type **call_with_it** (Op &&op, Tuple &&args, Other-Args &&...otherargs)
- template<typename T >
  std::string type_to_string ()

  Gives a string of the type T.

- template<typename T , typename = typename std::enable_if<!std::is_reference<T>::value>::type>
  T **copy_if_non_const** (T &&t)
- template<typename T >
  T **copy_if_non_const** (T &t)
- template<typename T >
  const T & **copy_if_non_const** (const T &t)

12.2.1 Detailed Description

Implementation details for Catsfoot.

12.2.2 Function Documentation

12.2.2.1 template<typename T > std::string catsfoot::details::type_to_string ( )

Gives a string of the type *T*.

Template Parameters

T	a type

Returns

A possibly demangled string representation of *T*

Chapter 13

Class Documentation

Contents

13.1 catsfoot::details::add_const_ref< T > Struct Template Reference

Public Types

- typedef const T & **type**

template<typename T> struct catsfoot::details::add_const_ref< T >

The documentation for this struct was generated from the following file:

- utils/call_with.hh

13.2 catsfoot::details::add_ref< T > Struct Template Reference

Public Types

- typedef T & **type**

template<typename T> struct catsfoot::details::add_ref< T >

The documentation for this struct was generated from the following file:

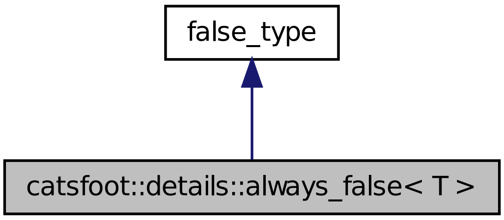
- utils/call_with.hh

13.3 catsfoot::details::always_false< T > Struct Template Reference

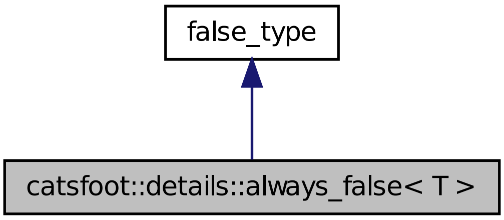
Predicate always false but depending on type parameters.

```
#include <always_false.hh>
```

Inheritance diagram for catsfoot::details::always_false< T >:



Collaboration diagram for catsfoot::details::always_false< T >:



13.3.1 Detailed Description

template<typename... T> struct catsfoot::details::always_false< T >

Predicate always false but depending on type parameters.

The documentation for this struct was generated from the following file:

- type_traits/always_false.hh

13.4 catsfoot::details::always_true< T > Struct Template Reference

Predicate always true but depending on type parameters.

#include <always_false.hh>

13.4.1 Detailed Description

template<typename... T> struct catsfoot::details::always_true< T >

Predicate always true but depending on type parameters.

The documentation for this struct was generated from the following file:

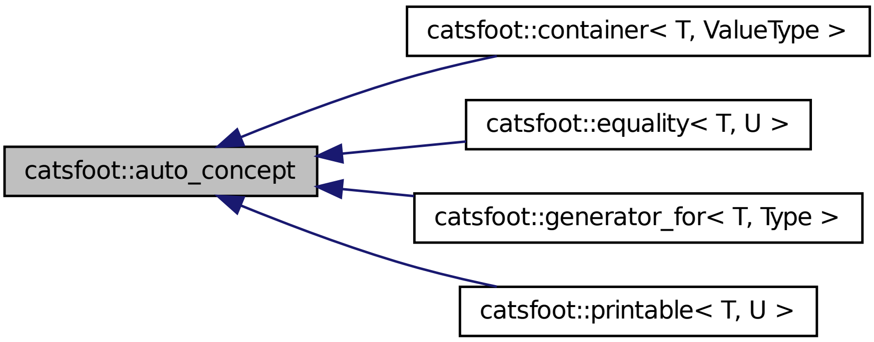
- type_traits/always_false.hh

13.5 catsfoot::auto_concept Struct Reference

Base marker for auto concepts.

#include <is_concept.hh>

Inheritance diagram for catsfoot::auto_concept:



13.5.1 Detailed Description

Base marker for auto concepts.

The documentation for this struct was generated from the following file:

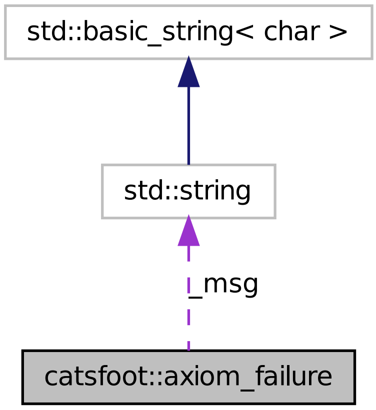
- concept/is_concept.hh

13.6 catsfoot::axiom_failure Struct Reference

Exception class for axiom failure.

`#include <axioms.hh>`

Collaboration diagram for catsfoot::axiom_failure:



Public Member Functions

- const std::string & msg () const

  Returns the message explaining the axiom failure.

- **axiom_failure** (const std::string &_msg)
- **axiom_failure** (std::string &&_msg)
- **axiom_failure** (std::string &&func, std::string &&file, unsigned line, std::string &&expr)
- axiom_failure (const axiom_failure &)

  Copy constructor.

- axiom_failure (axiom_failure &&other)

  Move constructor.

- axiom_failure & operator= (axiom_failure &&other)

  Swap.

- axiom_failure & operator= (const axiom_failure &other)

Assignment.

13.6.1 Detailed Description

Exception class for axiom failure.

The documentation for this struct was generated from the following file:

- axioms/axioms.hh

13.7 catsfoot::build_comparer< T > Struct Template Reference

This is class is used to build an black box equality engine.

`#include <black_box_equal.hh>`

Public Member Functions

- template<typename Generator , typename... Functions, typename G = typename std::decay<Generator>::type>
details::compare_top< G, T, typename wrapped< Functions >::type...> **operator()** (Generator g, Functions &&...functions...) const

13.7.1 Detailed Description

template<typename T> struct catsfoot::build_comparer< T >

This is class is used to build an black box equality engine.

Template Parameters

T	is the type to provide equality

The documentation for this struct was generated from the following file:

- utils/black_box_equal.hh

13.8 catsfoot::details::call_tuple_helper< Parameter, Functions > Struct Template Reference

Public Types

- typedef std::tuple< typename std::decay< typename is_callable< const Functions(const Parameter &)>::result_type >::type...> **return_type**

Static Public Member Functions

- static return_type **call** (const std::tuple< Functions...> &, const Parameter &, typename is_callable< const Functions(const Parameter &)>::result_type...args)
- template<typename... Args>
  static return_type **call** (const std::tuple< Functions...> &functions, const Parameter &param, Args...args)

template<typename Parameter, typename... Functions> struct catsfoot::details::call_tuple_helper< Parameter, Functions >

The documentation for this struct was generated from the following file:

- utils/call_tuple.hh

13.9 catsfoot::details::call_with_ret< Op, Tuple > Struct Template Reference

template<typename Op, typename Tuple> struct catsfoot::details::call_with_ret< Op, Tuple >

The documentation for this struct was generated from the following file:

- utils/call_with.hh

13.10 catsfoot::details::call_with_ret< Op, const std::tuple< Args...> & > Struct Template Reference

Public Member Functions

- typedef **decltype** (std::declval< Op >()(std::declval< typename add_const_ref< Args >::type >()...)) type

Static Public Attributes

- static const size_t **size** = sizeof...(Args)

template<typename Op, typename... Args> struct catsfoot::details::call_with_ret< Op, const std::tuple< Args...> & >

The documentation for this struct was generated from the following file:

- utils/call_with.hh

13.11 catsfoot::details::call_with_ret< Op, std::tuple< Args...> & > Struct Template Reference

Public Member Functions

- typedef **decltype** (std::declval< Op >()(std::declval< typename add_ref< Args >::type >()...)) type

Static Public Attributes

- static const size_t **size** = sizeof...(Args)

template<typename Op, typename... Args> struct catsfoot::details::call_with_ret< Op, std::tuple< Args...> & >

The documentation for this struct was generated from the following file:

- utils/call_with.hh

13.12 catsfoot::details::call_with_ret< Op, std::tuple< Args...> > Struct Template Reference

Public Member Functions

- typedef **decltype** (std::declval< Op >()(std::declval< typename add_ref< Args >::type >()...)) type

Static Public Attributes

- static const size_t **size** = sizeof...(Args)

template<typename Op, typename... Args> struct catsfoot::details::call_with_ret< Op, std::tuple< Args...> >

The documentation for this struct was generated from the following file:

- utils/call_with.hh

13.13 catsfoot::details::callable_bad_map< T > Struct Template Reference

Traits to use on error.

#include <is_callable.hh>

13.13.1 Detailed Description

template<typename T> struct catsfoot::details::callable_bad_map< T >

Traits to use on error.

The documentation for this struct was generated from the following file:

- type_traits/is_callable.hh

13.14 catsfoot::details::callable_bad_map< T(U...)> Struct Template Reference

Traits defining an undefined return type.

#include <is_callable.hh>

Public Types

- typedef undefined_return< T(U...)> **result_type**

13.14.1 Detailed Description

template<typename T, typename... U> struct catsfoot::details::callable_bad_map< T(U...)>

Traits defining an undefined return type.

The documentation for this struct was generated from the following file:

- type_traits/is_callable.hh

13.15 catsfoot::details::callable_real_map< T > Struct Template Reference

Traits to use when everything is OK.

#include <is_callable.hh>

13.15.1 Detailed Description

template<typename T> struct catsfoot::details::callable_real_map< T >

Traits to use when everything is OK.

The documentation for this struct was generated from the following file:

- type_traits/is_callable.hh

13.16 catsfoot::details::callable_real_map< T(U...)> Struct Template Reference

Traits defining the return type.

`#include <is_callable.hh>`

Public Member Functions

- typedef **decltype** (std::declval< T >()(std::declval< U >()...)) result_type

13.16.1 Detailed Description

template<typename T, typename... U> struct catsfoot::details::callable_real_map< T(U...)>

Traits defining the return type.

The documentation for this struct was generated from the following file:

- type_traits/is_callable.hh

13.17 catsfoot::details::class_assert_concept< T, bool, bool, bool > Struct Template Reference

Concept checking: predicate.

`#include <concept_tools.hh>`

Public Member Functions

- **static_assert** (T::value,"Missing requirement")

13.17.1 Detailed Description

template<typename T, bool = is_concept<T>::value, bool = is_auto_concept<T>::value, bool = has_requirements<T>::value> struct catsfoot::details::class_assert_concept< T, bool, bool, bool >

Concept checking: predicate.

The documentation for this struct was generated from the following file:

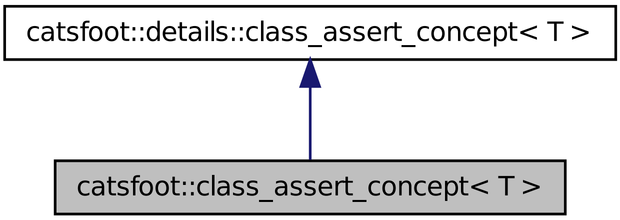
- concept/concept_tools.hh

13.18 catsfoot::class_assert_concept< T > Struct Template Reference

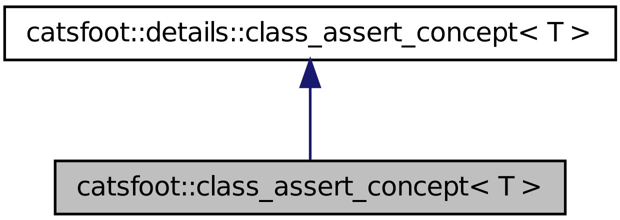
Checks that a concept is.

`#include <concept_tools.hh>`

Inheritance diagram for catsfoot::class_assert_concept< T >:



Collaboration diagram for catsfoot::class_assert_concept< T >:



13.18.1 Detailed Description

template<typename T> struct catsfoot::class_assert_concept< T >

Checks that a concept is. This type will raise a static assertion on when instantiating its concrete type if T is not a valid concept. It is intended to be used in a class template. For example:

```
template <typename T>
struct foo {
  //...
  class_assert_verified<some_concept<T> > check;
};
```

The documentation for this struct was generated from the following file:

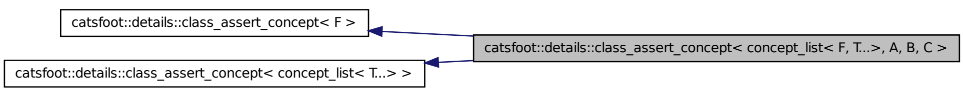
- concept/concept_tools.hh

13.19 catsfoot::details::class_assert_concept< concept_list< F, T...>, A, B, C > Struct Template Reference

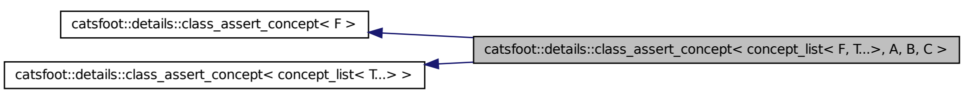
Concept checking: recursion on a list of requirements.

`#include <concept_tools.hh>`

Inheritance diagram for catsfoot::details::class_assert_concept< concept_list< F, T...>, A, B, C >:



Collaboration diagram for catsfoot::details::class_assert_concept< concept_list< F, T...>, A, B, C >:



13.19.1 Detailed Description

template<typename F, typename... T, bool A, bool B, bool C> struct catsfoot::details::class_assert_concept< concept_list< F, T...>, A, B, C >

Concept checking: recursion on a list of requirements.

The documentation for this struct was generated from the following file:

- concept/concept_tools.hh

13.20 catsfoot::details::class_assert_concept< concept_list<>, A, B, C > Struct Template Reference

Concept checking: empty list of requirements.

```
#include <concept_tools.hh>
```

13.20.1 Detailed Description

template<bool A, bool B, bool C> struct catsfoot::details::class_assert_concept< concept_list<>, A, B, C >

Concept checking: empty list of requirements.

The documentation for this struct was generated from the following file:

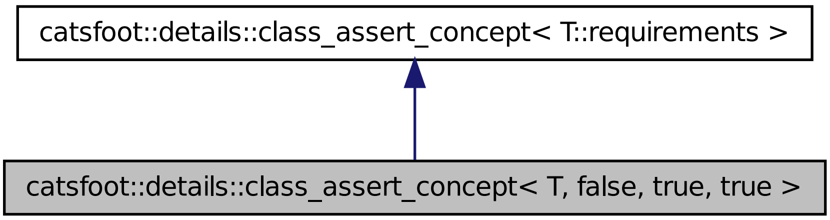
- concept/concept_tools.hh

13.21 catsfoot::details::class_assert_concept< T, false, true, true > Struct Template Reference

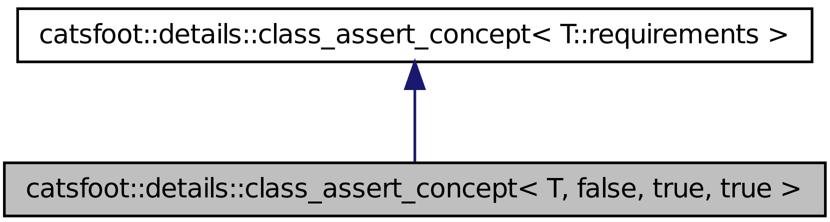
Concept checking: T is a auto-concept model.

```
#include <concept_tools.hh>
```

Inheritance diagram for catsfoot::details::class_assert_concept< T, false, true, true >:



Collaboration diagram for catsfoot::details::class_assert_concept< T, false, true, true >:



13.21.1 Detailed Description

template<typename T> struct catsfoot::details::class_assert_concept< T, false, true, true >

Concept checking: T is a auto-concept model.

The documentation for this struct was generated from the following file:

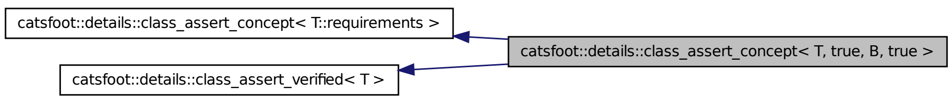
- concept/concept_tools.hh

13.22 catsfoot::details::class_assert_concept< T, true, B, true > Struct Template Reference

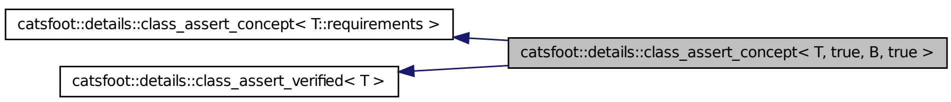
Concept checking: T is a concept model.

#include <concept_tools.hh>

Inheritance diagram for catsfoot::details::class_assert_concept< T, true, B, true >:



Collaboration diagram for catsfoot::details::class_assert_concept< T, true, B, true >:



13.22.1 Detailed Description

template< typename T, bool B > struct catsfoot::details::class_assert_concept< T, true, B, true >

Concept checking: T is a concept model.

The documentation for this struct was generated from the following file:

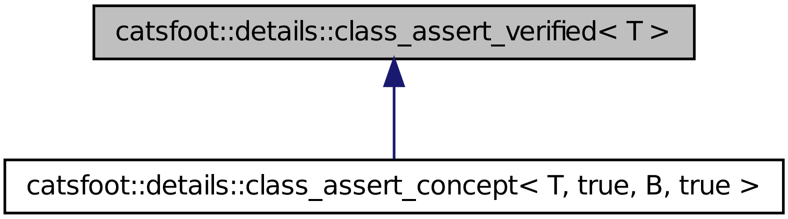
- concept/concept_tools.hh

13.23 catsfoot::details::class_assert_verified< T > Struct Template Reference

Check that T is a verified model.

#include <concept_tools.hh>

Inheritance diagram for catsfoot::details::class_assert_verified< T >:



Public Member Functions

- **static_assert** (verified< T >::value,"Concept was not verified")

13.23.1 Detailed Description

template<typename T> struct catsfoot::details::class_assert_verified< T >

Check that T is a verified model.

The documentation for this struct was generated from the following file:

- concept/concept_tools.hh

13.24 catsfoot::details::compare< Generator, T > Struct Template Reference

No left operation.

```
#include <black_box_equal.hh>
```

Public Member Functions

- bool **operator()** (Generator &, const T &, const T &) const

13.24.1 Detailed Description

template<typename Generator, typename T> struct catsfoot::details::compare< Generator, T >

No left operation.

The documentation for this struct was generated from the following file:

- utils/black_box_equal.hh

13.25 catsfoot::details::compare< Generator, T, Op, Ops...> Struct Template Reference

Compare using the first operator and recurse.

`#include <black_box_equal.hh>`

Public Member Functions

- **compare** (Op &&op, Ops &&...ops...)
- bool **operator()** (Generator &g, const T &a, const T &b) const

13.25.1 Detailed Description

template<typename Generator, typename T, typename Op, typename... Ops> struct catsfoot::details::compare< Generator, T, Op, Ops...>

Compare using the first operator and recurse.

The documentation for this struct was generated from the following file:

- utils/black_box_equal.hh

13.26 catsfoot::details::compare_top< Generator, T, Ops > Struct Template Reference

Builds a black-box comparator.

`#include <black_box_equal.hh>`

Public Member Functions

- **compare_top** (const Generator &g, Ops &&...ops...)
- **compare_top** (Generator &&g, Ops &&...ops...)
- bool **operator()** (const T &a, const T &b) const

13.26.1 Detailed Description

template<typename Generator, typename T, typename... Ops> struct catsfoot::details::compare_-top< Generator, T, Ops >

Builds a black-box comparator.

The documentation for this struct was generated from the following file:

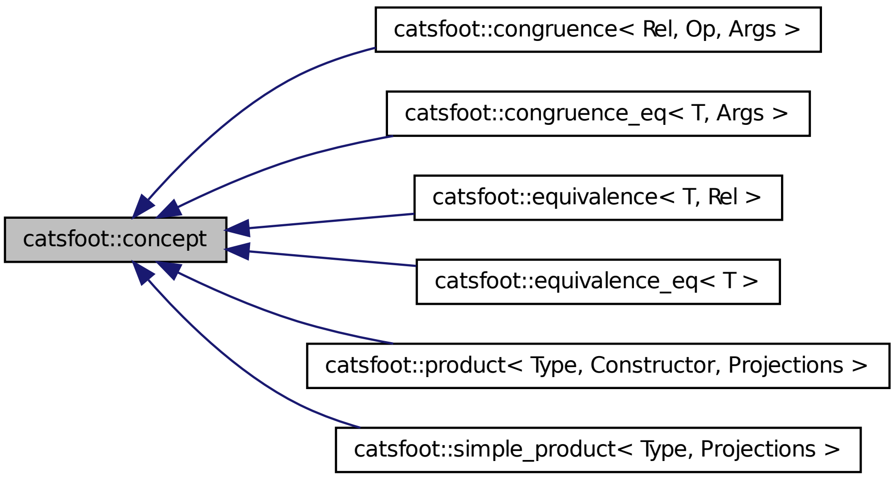
- utils/black_box_equal.hh

13.27 catsfoot::concept Struct Reference

Base marker for concepts.

`#include <is_concept.hh>`

Inheritance diagram for catsfoot::concept:



13.27.1 Detailed Description

Base marker for concepts.

The documentation for this struct was generated from the following file:

- concept/is_concept.hh

13.28 catsfoot::concept_list< T > Struct Template Reference

List representation of several concepts.

`#include <concept_tools.hh>`

13.28.1 Detailed Description

template<typename... T> struct catsfoot::concept_list< T >

List representation of several concepts.

The documentation for this struct was generated from the following file:

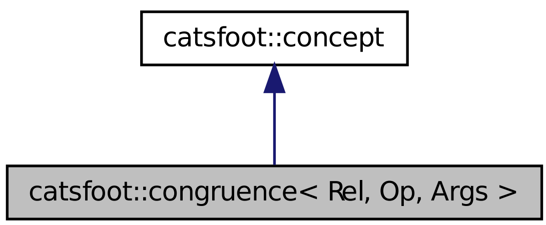
- concept/concept_tools.hh

13.29 catsfoot::congruence< Rel, Op, Args > Struct Template Reference

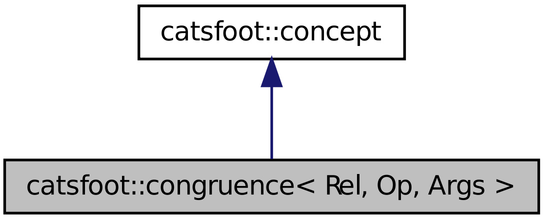
Check whether an operation sees equality as congruence relation.

`#include <congruence.hh>`

Inheritance diagram for catsfoot::congruence< Rel, Op, Args >:



Collaboration diagram for catsfoot::congruence< Rel, Op, Args >:



Public Types

- typedef concept_list< equivalence< Args, Rel >..., is_callable< Op(Args...)>, equivalence< typename is_callable< Op(Args...)>::result_type, Rel > > **requirements**

Public Member Functions

- **AXIOMS** (congruence_axiom)

Static Public Member Functions

- static void **congruence_axiom** (const std::tuple< Args...> &args1, const std::tuple< Args...> &args2, const Op &op, const Rel &rel)

13.29.1 Detailed Description

template<typename Rel, typename Op, typename... Args> struct catsfoot::congruence< Rel, Op, Args >

Check whether an operation sees equality as congruence relation.

The documentation for this struct was generated from the following file:

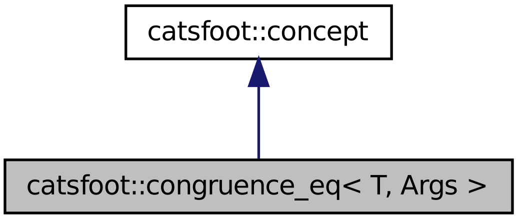
- concept/congruence.hh

13.30 catsfoot::congruence_eq< T, Args > Struct Template Reference

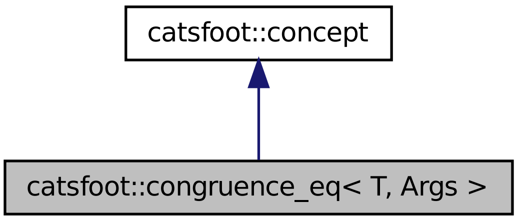
Concept for congruence relation with operator==.

`#include <congruence.hh>`

Inheritance diagram for catsfoot::congruence_eq< T, Args >:



Collaboration diagram for catsfoot::congruence_eq< T, Args >:



Public Types

- typedef concept_list< congruence< op_eq, T, Args...> > **requirements**

13.30.1 Detailed Description

template<typename T, typename... Args> struct catsfoot::congruence_eq< T, Args >

Concept for congruence relation with operator==.

The documentation for this struct was generated from the following file:

- concept/congruence.hh

13.31 catsfoot::constant< T, Value > Struct Template Reference

Functor returning and integral constant.

```
#include <constant.hh>
```

Public Member Functions

- T **operator()** () const

13.31.1 Detailed Description

template<typename T, T Value> struct catsfoot::constant< T, Value >

Functor returning and integral constant.

The documentation for this struct was generated from the following file:

- wrappers/constant.hh

13.32 catsfoot::constructor_wrap< T > Struct Template Reference

Wraps constructors.

```
#include <function_wrappers.hh>
```

Public Member Functions

- template<typename... Args>
  T **operator()** (Args &&...args) const

13.32.1 Detailed Description

template<typename T> struct catsfoot::constructor_wrap< T >

Wraps constructors.

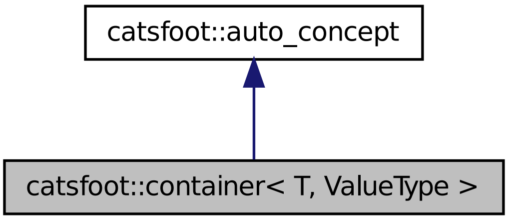
The documentation for this struct was generated from the following file:

- wrappers/function_wrappers.hh

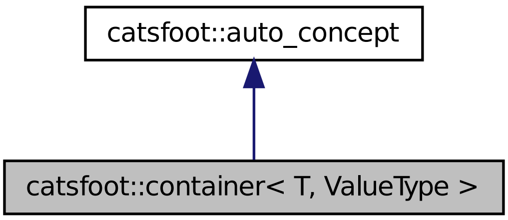
13.33 catsfoot::container< T, ValueType > Struct Template Reference

`#include <dataset.hh>`

Inheritance diagram for catsfoot::container< T, ValueType >:



Collaboration diagram for catsfoot::container< T, ValueType >:



Public Types

- typedef concept_list< is_callable< member_begin(T)>, is_callable< member_-end(T)> > **requirements**

13.33.1 Detailed Description

template<typename T, typename ValueType> struct catsfoot::container< T, ValueType >

Todo

Check the returns are iterators.

The documentation for this struct was generated from the following file:

- dataset/dataset.hh

13.34 catsfoot::default_generator Struct Reference

Generator that build default constructors.

```
#include <dataset.hh>
```

Public Member Functions

- template<typename Return , typename NonRefReturn = typename std::decay<Return>::type>
  std::list< NonRefReturn > **get** (selector< Return >) const

13.34.1 Detailed Description

Generator that build default constructors.

The documentation for this struct was generated from the following file:

- dataset/dataset.hh

13.35 catsfoot::disamb< Args > Struct Template Reference

Disambiguates an overloaded functions address.

```
#include <function_wrappers.hh>
```

Classes

- struct **fun**
- struct **member**

Public Member Functions

- template<typename Ret , typename T >
  member< Ret, T >::type **operator()** (Ret(T::*f)(Args...)) const

- template<typename Ret >
  fun< Ret >::type **operator()** (Ret(∗f)(Args...)) const

13.35.1 Detailed Description

template<typename... Args> struct catsfoot::disamb< Args >

Disambiguates an overloaded functions address.

Template Parameters

Args	The types of the arguments

The documentation for this struct was generated from the following file:

- wrappers/function_wrappers.hh

13.36 catsfoot::disamb_const< Args > Struct Template Reference

Disambiguates an overloaded const member.

```
#include <function_wrappers.hh>
```

Classes

- struct **fun**

Public Member Functions

- template<typename Ret , typename T >
  fun< Ret, T >::const_type **operator()** (Ret(T::∗f)(Args...) const) const

13.36.1 Detailed Description

template<typename... Args> struct catsfoot::disamb_const< Args >

Disambiguates an overloaded const member.

Template Parameters

Args	The types of the arguments

The documentation for this struct was generated from the following file:

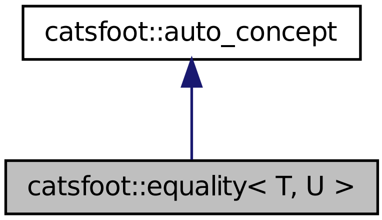
- wrappers/function_wrappers.hh

13.37 catsfoot::equality< T, U > Struct Template Reference

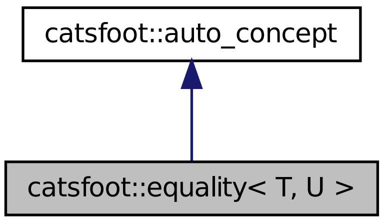
Check whether *T* is comparable to *U* by ==.

`#include <concepts.hh>`

Inheritance diagram for catsfoot::equality< T, U >:



Collaboration diagram for catsfoot::equality< T, U >:



Public Types

- typedef concept_list< is_callable< op_eq(T, U)>, std::is_convertible< typename is_callable< op_eq(T, U)>::result_type, bool > > **requirements**

13.37.1 Detailed Description

template<typename T, typename U = T> struct catsfoot::equality< T, U >

Check whether *T* is comparable to *U* by ==.

The documentation for this struct was generated from the following file:

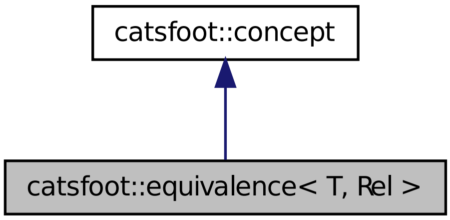
- concept/concepts.hh

13.38 catsfoot::equivalence< T, Rel > Struct Template Reference

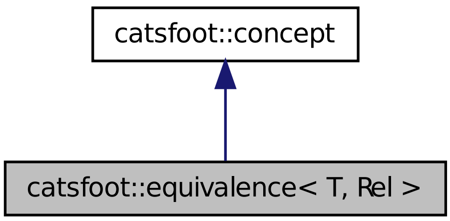
Generic concept for equivalence relation.

`#include <congruence.hh>`

Inheritance diagram for catsfoot::equivalence< T, Rel >:



Collaboration diagram for catsfoot::equivalence< T, Rel >:



Public Types

- typedef concept_list< is_callable< Rel(T, T)>, std::is_convertible< typename is_callable< Rel(T, T)>::result_type, bool > > **requirements**

Public Member Functions

- **AXIOMS** (reflexivity, symmetry, transitivity)

Static Public Member Functions

- static void **reflexivity** (const Rel &rel, const T &a)
- static void **symmetry** (const Rel &rel, const T &a, const T &b)
- static void **transitivity** (const Rel &rel, const T &a, const T &b, const T &c)

13.38.1 Detailed Description

template<typename T, typename Rel> struct catsfoot::equivalence< T, Rel >

Generic concept for equivalence relation.

The documentation for this struct was generated from the following file:

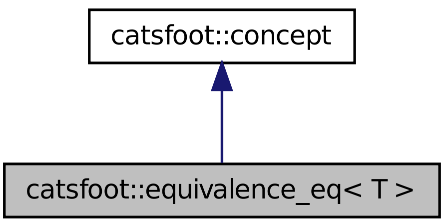
- concept/congruence.hh

13.39 catsfoot::equivalence_eq< T > Struct Template Reference

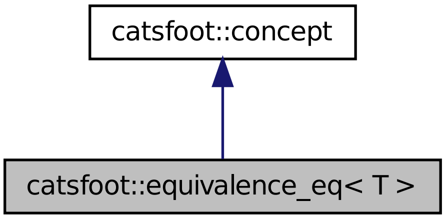
Concept for equivalence relation with operator==.

`#include <congruence.hh>`

Inheritance diagram for catsfoot::equivalence_eq< T >:



Collaboration diagram for catsfoot::equivalence_eq< T >:



Public Types

- typedef concept_list< equality< T >, equivalence< T, op_eq > > **requirements**

13.39.1 Detailed Description

template<typename T> struct catsfoot::equivalence_eq< T >

Concept for equivalence relation with operator==.

The documentation for this struct was generated from the following file:

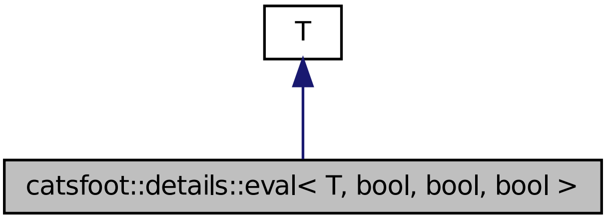
- concept/congruence.hh

13.40 catsfoot::details::eval< T, bool, bool, bool > Struct Template Reference

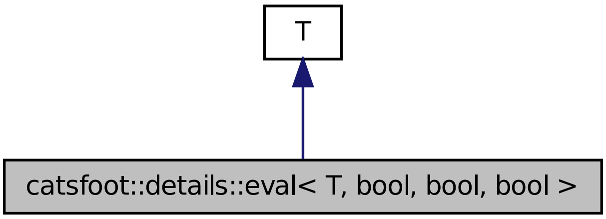
Default case: predicate.

```
#include <concept_tools.hh>
```

Inheritance diagram for catsfoot::details::eval< T, bool, bool, bool >:



Collaboration diagram for catsfoot::details::eval< T, bool, bool, bool >:



13.40.1 Detailed Description

template<typename T, bool = has_requirements<T>::value, bool = is_concept<T>::value, bool = is_auto_concept<T>::value> struct catsfoot::details::eval< T, bool, bool, bool >

Default case: predicate.

The documentation for this struct was generated from the following file:

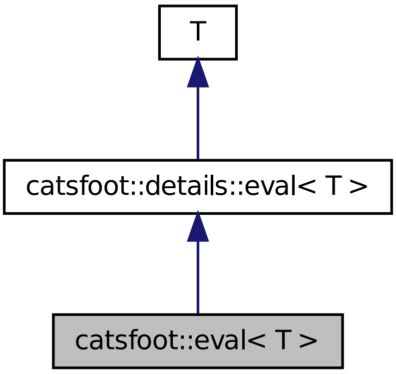
- concept/concept_tools.hh

13.41 catsfoot::eval< T > Struct Template Reference

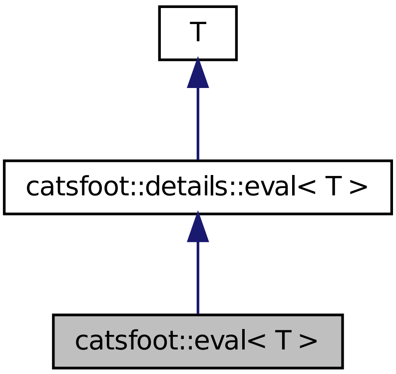
Predicate evaluating models and predicates.

`#include <concept_tools.hh>`

Inheritance diagram for catsfoot::eval< T >:



Collaboration diagram for catsfoot::eval< T >:



13.41.1 Detailed Description

template<typename T> struct catsfoot::eval< T >

Predicate evaluating models and predicates.

The documentation for this struct was generated from the following file:

- concept/concept_tools.hh

13.42 catsfoot::details::eval< concept_list< T...>, false, false, false > Struct Template Reference

If the parameter is a list of requirements.

`#include <concept_tools.hh>`

13.42.1 Detailed Description

template<typename... T> struct catsfoot::details::eval< concept_list< T...>, false, false, false >

If the parameter is a list of requirements.

The documentation for this struct was generated from the following file:

- concept/concept_tools.hh

13.43 catsfoot::details::eval< T, true, false, true > Struct Template Reference

If T is an auto-concept model.

`#include <concept_tools.hh>`

13.43.1 Detailed Description

template<typename T> struct catsfoot::details::eval< T, true, false, true >

If T is an auto-concept model.

The documentation for this struct was generated from the following file:

- concept/concept_tools.hh

13.44 catsfoot::details::eval< T, true, true, B > Struct Template Reference

If T is a concept model.

`#include <concept_tools.hh>`

13.44.1 Detailed Description

template< typename T, bool B > struct catsfoot::details::eval< T, true, true, B >

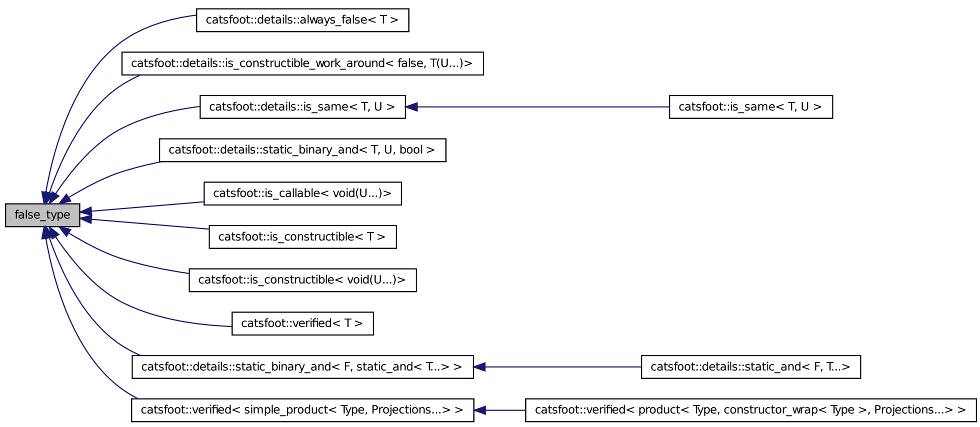
If T is a concept model.

The documentation for this struct was generated from the following file:

- concept/concept_tools.hh

13.45 false_type Class Reference

Inheritance diagram for false_type:

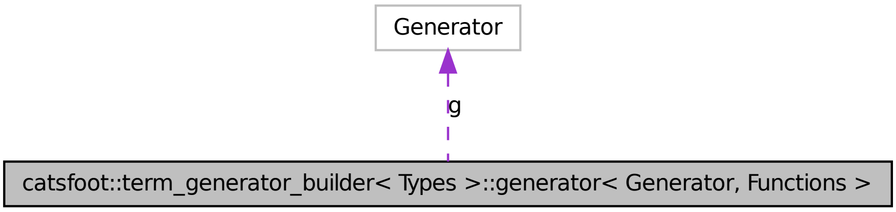


The documentation for this class was generated from the following file:

- concept/static_and.hh

13.46 catsfoot::term_generator_builder< Types >::generator< Generator, Functions > Struct Template Reference

Collaboration diagram for catsfoot::term_generator_builder< Types >::generator< Generator, Functions >:



Classes

- struct **random_container< Return, false >**

Public Member Functions

- template<typename... F>
  generator (size_t size, Generator &g, F &&...functions)

template<typename... Types>template<typename Generator, typename... Functions> struct catsfoot::term_generator_builder< Types >::generator< Generator, Functions >

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.47 catsfoot::details::generator_choose<> Struct Template Reference

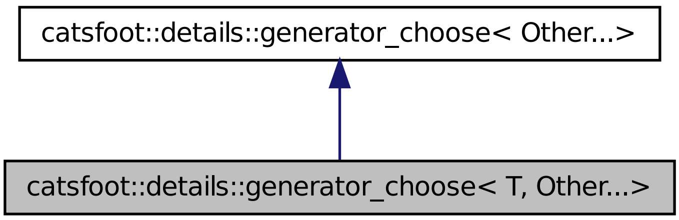
template<typename...> struct catsfoot::details::generator_choose<>

The documentation for this struct was generated from the following file:

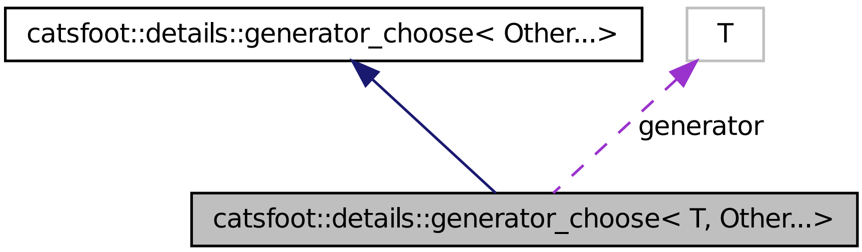
- dataset/choose.hh

13.48 catsfoot::details::generator_choose< T, Other...> Struct Template Reference

Inheritance diagram for catsfoot::details::generator_choose< T, Other...>:



Collaboration diagram for catsfoot::details::generator_choose< T, Other...>:



Public Member Functions

- **generator_choose** (T t, Other...other)
- template<typename Return , ENABLE_IF(generator_for< T, Return >) , typename Ret = typename is_callable<member_get(T&, selector<Return>)>::result_type>
  Ret **get** (selector< Return > s)
- template<typename Return , ENABLE_IF_NOT(generator_for< T, Return >) , ENABLE_IF(generator_-for< super, Return >) , typename Ret = typename is_callable<member_get(super&, selector<Return>)>::result_-

type>
Ret **get** (selector< Return > s...)

template< typename T, typename... Other > struct catsfoot::details::generator_choose< T, Other... >

The documentation for this struct was generated from the following file:

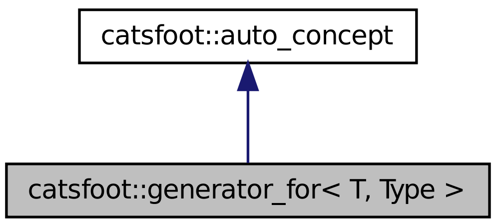
- dataset/choose.hh

13.49 catsfoot::generator_for< T, Type > Struct Template Reference

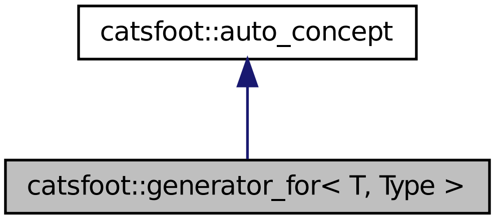
Whether T is a generator of Type.

`#include <dataset.hh>`

Inheritance diagram for catsfoot::generator_for< T, Type >:



Collaboration diagram for catsfoot::generator_for< T, Type >:



Public Types

- typedef concept_list< is_callable< member_get(T, selector< Type >)>, container< typename is_callable< member_get(T, selector< Type >)>::result_type, Type > > **requirements**

13.49.1 Detailed Description

template<typename T, typename Type> struct catsfoot::generator_for< T, Type >

Whether T is a generator of Type.

The documentation for this struct was generated from the following file:

- dataset/dataset.hh

13.50 catsfoot::details::has_get_axiom< U > Struct Template Reference

Predicate testing that U has static member get_axioms()

`#include <test_all_driver.hh>`

13.50.1 Detailed Description

template<typename U> struct catsfoot::details::has_get_axiom< U >

Predicate testing that U has static member get_axioms()

The documentation for this struct was generated from the following file:

- drivers/test_all_driver.hh

13.51 catsfoot::details::has_requirements< T > Struct Template Reference

Check whether T has a member type `requirements`.

`#include <has_requirements.hh>`

13.51.1 Detailed Description

template<typename T> struct catsfoot::details::has_requirements< T >

Check whether T has a member type `requirements`.

The documentation for this struct was generated from the following file:

- concept/has_requirements.hh

13.52 catsfoot::is_auto_concept< T > Struct Template Reference

Checks if T is an auto concept model.

`#include <is_concept.hh>`

13.52.1 Detailed Description

template<typename T> struct catsfoot::is_auto_concept< T >

Checks if T is an auto concept model.

The documentation for this struct was generated from the following file:

- concept/is_concept.hh

13.53 catsfoot::is_callable< T > Struct Template Reference

Default case: callable without parameters?

`#include <is_callable.hh>`

13.53.1 Detailed Description

template<typename T> struct catsfoot::is_callable< T >

Default case: callable without parameters?

The documentation for this struct was generated from the following file:

- type_traits/is_callable.hh

13.54 catsfoot::is_callable< T(U...)> Struct Template Reference

Tells whether T is callable with (U...)

`#include <is_callable.hh>`

Public Types

- typedef std::conditional< super::value, details::callable_real_map< T(U...)>, details::callable_bad_map< T(U...)> >::type::result_type **result_type**

Public Member Functions

- typedef **decltype** (details::is_callable_helper(details::try_first(), std::declval< T >(), std::declval< U >()...)) super

13.54.1 Detailed Description

template<typename T, typename... U> struct catsfoot::is_callable< T(U...)>

Tells whether T is callable with (U...)

The documentation for this struct was generated from the following file:

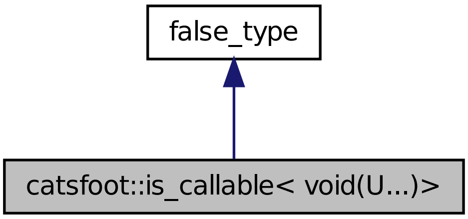
- type_traits/is_callable.hh

13.55 catsfoot::is_callable< void(U...)> Struct Template Reference

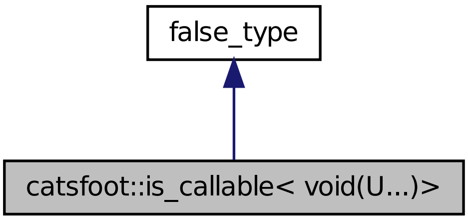
Void is a special type that may induce extra error messages.

`#include <is_callable.hh>`

Inheritance diagram for catsfoot::is_callable< void(U...)>:



Collaboration diagram for catsfoot::is_callable< void(U...)>:



Public Types

- typedef undefined_return< void(U...)> **result_type**

13.55.1 Detailed Description

template<typename... U> struct catsfoot::is_callable< void(U...)>

Void is a special type that may induce extra error messages.

The documentation for this struct was generated from the following file:

- type_traits/is_callable.hh

13.56 catsfoot::is_concept< T > Struct Template Reference

Checks if T is a concept model.

`#include <is_concept.hh>`

13.56.1 Detailed Description

template<typename T> struct catsfoot::is_concept< T >

Checks if T is a concept model.

The documentation for this struct was generated from the following file:

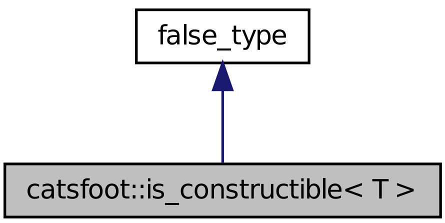
- concept/is_concept.hh

13.57 catsfoot::is_constructible< T > Struct Template Reference

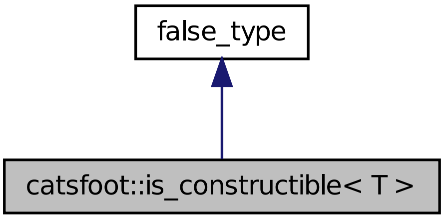
Undefined.

`#include <is_constructible.hh>`

Inheritance diagram for catsfoot::is_constructible< T >:



Collaboration diagram for catsfoot::is_constructible< T >:



Public Member Functions

- **static_assert** (details::always_false< T >::value,"Bad format of parameter")

13.57.1 Detailed Description

template< typename T > struct catsfoot::is_constructible< T >

Undefined.

The documentation for this struct was generated from the following file:

- type_traits/is_constructible.hh

13.58 catsfoot::is_constructible< T(U...)> Struct Template Reference

Tells whether T is constructible with {U...}.

```
#include <is_constructible.hh>
```

13.58.1 Detailed Description

template< typename T, typename... U > struct catsfoot::is_constructible< T(U...)>

Tells whether T is constructible with {U...}.

The documentation for this struct was generated from the following file:

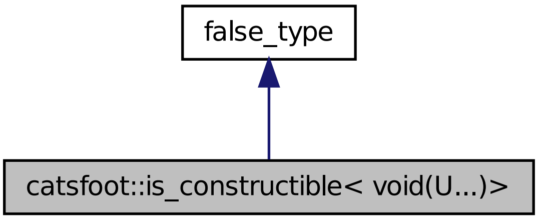
- type_traits/is_constructible.hh

13.59 catsfoot::is_constructible< void(U...)> Struct Template Reference

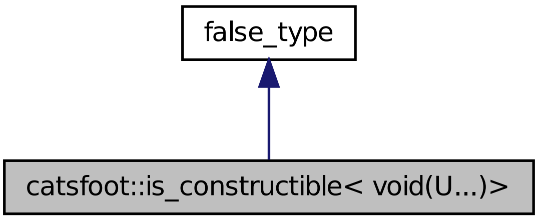
Void is a special type that may induce extra error messages.

`#include <is_constructible.hh>`

Inheritance diagram for catsfoot::is_constructible< void(U...)>:



Collaboration diagram for catsfoot::is_constructible< void(U...)>:



13.59.1 Detailed Description

template<typename... U> struct catsfoot::is_constructible< void(U...)>

Void is a special type that may induce extra error messages.

The documentation for this struct was generated from the following file:

- type_traits/is_constructible.hh

13.60 catsfoot::details::is_constructible_work_around< false, T()> Struct Template Reference

If not a class, is it always default constructible (maybe)

`#include <is_constructible.hh>`

13.60.1 Detailed Description

template<typename T> struct catsfoot::details::is_constructible_work_around< false, T()>

If not a class, is it always default constructible (maybe)

The documentation for this struct was generated from the following file:

- type_traits/is_constructible.hh

13.61 catsfoot::details::is_constructible_work_around< false, T(U)> Struct Template Reference

If is explicitly convertible and not a class, then it is like constructible.

`#include <is_constructible.hh>`

13.61.1 Detailed Description

template<typename T, typename U> struct catsfoot::details::is_constructible_work_around< false, T(U)>

If is explicitly convertible and not a class, then it is like constructible.

The documentation for this struct was generated from the following file:

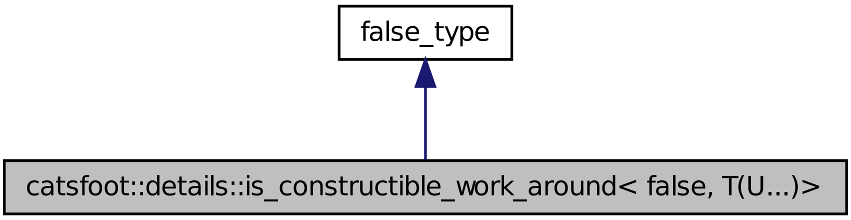
- type_traits/is_constructible.hh

13.62 catsfoot::details::is_constructible_work_around< false, T(U...)> Struct Template Reference

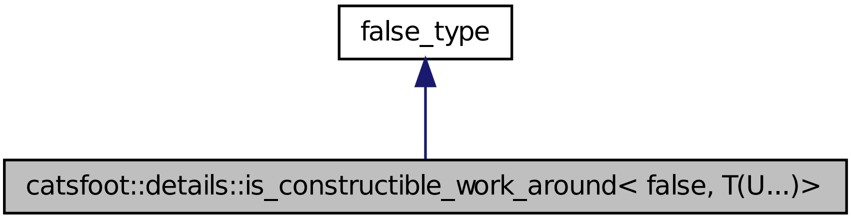
If T is not a class, it cannot be built with several parameter.

`#include <is_constructible.hh>`

Inheritance diagram for catsfoot::details::is_constructible_work_around< false, T(U...)>:



Collaboration diagram for catsfoot::details::is_constructible_work_around< false, T(U...)>:



13.62.1 Detailed Description

template<typename T, typename... U> struct catsfoot::details::is_constructible_work_around< false, T(U...)>

If T is not a class, it cannot be built with several parameter.

The documentation for this struct was generated from the following file:

- type_traits/is_constructible.hh

13.63 catsfoot::details::is_constructible_work_around< true, T(U...)> Struct Template Reference

If T is a class, then use the standard library.

```
#include <is_constructible.hh>
```

13.63.1 Detailed Description

template<typename T, typename... U> struct catsfoot::details::is_constructible_work_around< true, T(U...)>

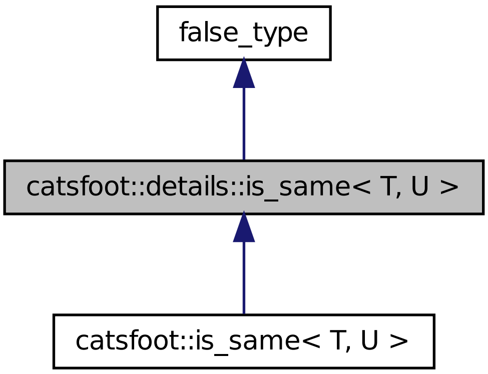
If T is a class, then use the standard library.

The documentation for this struct was generated from the following file:

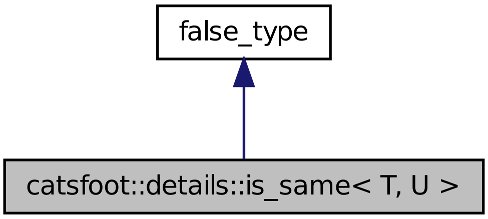
- type_traits/is_constructible.hh

13.64 catsfoot::details::is_same< T, U > Struct Template Reference

Inheritance diagram for catsfoot::details::is_same< T, U >:



Collaboration diagram for catsfoot::details::is_same< T, U >:



template<typename T, typename U> struct catsfoot::details::is_same< T, U >

The documentation for this struct was generated from the following file:

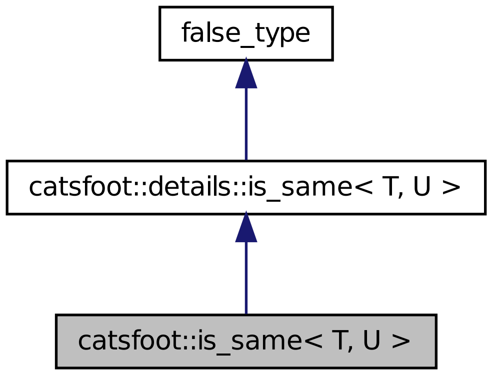
- concept/concepts.hh

13.65 catsfoot::is_same< T, U > Struct Template Reference

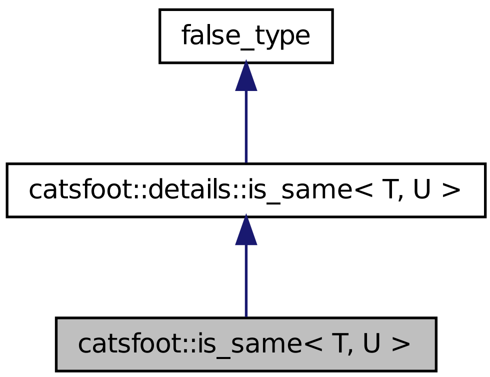
Check whether *T* and *U* are the same type.

```
#include <concepts.hh>
```

Inheritance diagram for catsfoot::is_same< T, U >:



Collaboration diagram for catsfoot::is_same< T, U >:



13.65.1 Detailed Description

template<typename T, typename U> struct catsfoot::is_same< T, U >

Check whether *T* and *U* are the same type.

The documentation for this struct was generated from the following file:

- concept/concepts.hh

13.66 catsfoot::details::is_same< T, T > Struct Template Reference

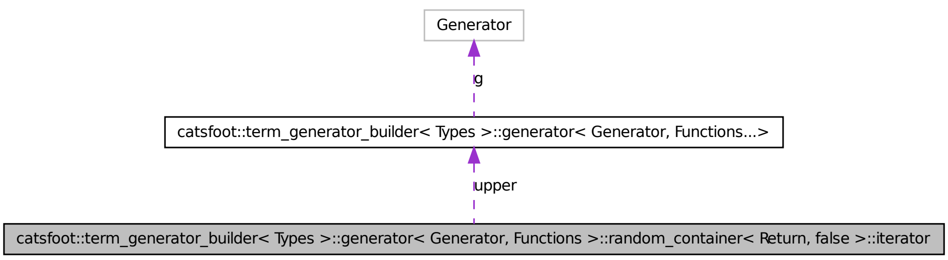
template<typename T> struct catsfoot::details::is_same< T, T >

The documentation for this struct was generated from the following file:

- concept/concepts.hh

13.67 catsfoot::term_generator_builder< Types >::generator< Generator, Functions >::random_container< Return, false >::iterator Struct Reference

Collaboration diagram for catsfoot::term_generator_builder< Types >::generator< Generator, Functions >::random_container< Return, false >::iterator:



Public Member Functions

- **iterator** (generator< Generator, Functions...> &upper, size_t pos=0u)
- **iterator** (const iterator &other)
- Return & **operator**∗ () const
- iterator & **operator++** ()

- iterator & **operator++** (int)
- bool **operator==** (const iterator &other) const
- bool **operator!=** (const iterator &other) const
- iterator & **operator=** (iterator &&other)
- iterator & **operator=** (const iterator &other)

template< typename... Types >template< typename Generator, typename... Functions >template< typename Return > struct catsfoot::term_generator_builder< Types >::generator< Generator, Functions >::random_-container< Return, false >::iterator

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.68 catsfoot::list_data_generator< T > Struct Template Reference

Generator using lists of data provided by the user.

`#include <dataset.hh>`

Public Member Functions

- **list_data_generator** (std::initializer_list< T >...lists)
- **list_data_generator** (const list_data_generator &)
- template< typename Return , typename NonRefReturn = typename std::decay< Return >::type, typename pos = typename details::position< NonRefReturn, T... >::type >
  std::list< NonRefReturn > & **get** (selector< Return >)
- template< typename Return , typename NonRefReturn = typename std::decay< Return >::type, typename pos = typename details::position< NonRefReturn, T... >::type >
  const std::list< NonRefReturn > & **get** (selector< Return >) const

13.68.1 Detailed Description

template< typename... T > struct catsfoot::list_data_generator< T >

Generator using lists of data provided by the user.

The documentation for this struct was generated from the following file:

- dataset/dataset.hh

13.69 catsfoot::details::member_wrapper< Ret(T::*)(Args...) const > Struct Template Reference

Wraps a const member.

`#include <function_wrappers.hh>`

Public Member Functions

- **member_wrapper** (Ret(T::*f)(Args...) const)
- Ret **operator()** (const T &t, Args &&...args...) const

13.69.1 Detailed Description

template<typename T, typename Ret, typename... Args> struct catsfoot::details::member_wrapper< Ret(T::*)(Args...) const >

Wraps a const member.

The documentation for this struct was generated from the following file:

- wrappers/function_wrappers.hh

13.70 catsfoot::details::member_wrapper< Ret(T::*)(Args...)> Struct Template Reference

Wraps a non-const member.

`#include <function_wrappers.hh>`

Public Member Functions

- **member_wrapper** (Ret(T::*f)(Args...))
- Ret **operator()** (T &t, Args &&...args...) const

13.70.1 Detailed Description

template<typename T, typename Ret, typename... Args> struct catsfoot::details::member_wrapper< Ret(T::*)(Args...)>

Wraps a non-const member.

The documentation for this struct was generated from the following file:

- wrappers/function_wrappers.hh

13.71 catsfoot::details::member_wrapper< void(T::*)(Args...)> Struct Template Reference

Wraps a non-const void returning member.

`#include <function_wrappers.hh>`

Public Member Functions

- **member_wrapper** (void(T::*f)(Args...))
- T **operator()** (T t, Args &&...args...) const

13.71.1 Detailed Description

template<typename T, typename... Args> struct catsfoot::details::member_wrapper< void(T::*)(Args...)>

Wraps a non-const void returning member.

The documentation for this struct was generated from the following file:

- wrappers/function_wrappers.hh

13.72 catsfoot::details::number_function_returns< T > Struct Template Reference

No function given.

`#include <random_term_generator.hh>`

Static Public Attributes

- static const size_t **value** = 0u

13.72.1 Detailed Description

template<typename T> struct catsfoot::details::number_function_returns< T >

No function given.

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.73 catsfoot::details::number_function_returns< T, std::function< const T &(Args...)>, Functions...> Struct Template Reference

The first function returns a T.

```
#include <random_term_generator.hh>
```

Static Public Attributes

- static const size_t **value**

13.73.1 Detailed Description

template<typename T, typename... Args, typename... Functions> struct catsfoot::details::number_function_returns< T, std::function< const T &(Args...)>, Functions...>

The first function returns a T.

13.73.2 Member Data Documentation

13.73.2.1 template<typename T , typename... Args, typename... Functions> const size_t catsfoot::details::number_function_returns< T, std::function< const T &(Args...)>, Functions...>::value [static]

Initial value:

```

        number_function_returns<T, Functions...>::value + 1
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.74 catsfoot::details::number_function_returns< T, std::function< Ret(Args...)>, Functions...> Struct Template Reference

The first function does not return a T.

```
#include <random_term_generator.hh>
```

Static Public Attributes

- static const size_t **value**

13.74.1 Detailed Description

template<typename T, typename Ret, typename... Args, typename... Functions> struct catsfoot::details::number_function_returns< T, std::function< Ret(Args...)>, Functions...>

The first function does not return a T.

13.74.2 Member Data Documentation

13.74.2.1 template<typename T , typename Ret , typename... Args, typename... Functions> const size_t catsfoot::details::number_function_returns< T, std::function< Ret(Args...)>, Functions...>::value [static]

Initial value:

```

        number_function_returns<T, Functions...>::value
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.75 catsfoot::details::number_function_returns< T, std::function< T &&(Args...)>, Functions...> Struct Template Reference

The first function returns a T.

`#include <random_term_generator.hh>`

Static Public Attributes

- static const size_t **value**

13.75.1 Detailed Description

template<typename T, typename... Args, typename... Functions> struct catsfoot::details::number_function_returns< T, std::function< T &&(Args...)>, Functions...>

The first function returns a T.

13.75.2 Member Data Documentation

13.75.2.1 template<typename T , typename... Args, typename... Functions> const size_t catsfoot::details::number_function_returns< T, std::function< T &&(Args...)>, Functions...>::value [static]

Initial value:

```

        number_function_returns<T, Functions...>::value + 1
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.76 catsfoot::details::number_function_returns< T, std::function< T &(Args...)>, Functions...> Struct Template Reference

The first function returns a T.

```
#include <random_term_generator.hh>
```

Static Public Attributes

- static const size_t **value**

13.76.1 Detailed Description

template<typename T, typename... Args, typename... Functions> struct catsfoot::details::number_function_returns< T, std::function< T &(Args...)>, Functions...>

The first function returns a T.

13.76.2 Member Data Documentation

13.76.2.1 template<typename T , typename... Args, typename... Functions> const size_t catsfoot::details::number_function_returns< T, std::function< T &(Args...)>, Functions...>::value [static]

Initial value:

```

        number_function_returns<T, Functions...>::value + 1
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.77 catsfoot::details::number_function_returns< T, std::function< T(Args...)>, Functions...> Struct Template Reference

The first function returns a T.

```
#include <random_term_generator.hh>
```

Static Public Attributes

- static const size_t **value**

13.77.1 Detailed Description

template< typename T, typename... Args, typename... Functions> struct catsfoot::details::number_function_returns< T, std::function< T(Args...)>, Functions...>

The first function returns a T.

13.77.2 Member Data Documentation

13.77.2.1 template< typename T , typename... Args, typename... Functions> const size_t catsfoot::details::number_function_returns< T, std::function< T(Args...)>, Functions...>::value [static]

Initial value:

```

                number_function_returns<T, Functions...>::value + 1
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.78 catsfoot::details::number_ground_terms< T > Struct Template Reference

No function.

```
#include <random_term_generator.hh>
```

Static Public Attributes

- static const size_t **value** = 0u

13.78.1 Detailed Description

template<typename T> struct catsfoot::details::number_ground_terms< T >

No function.

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.79 catsfoot::details::number_ground_terms< T, std::function< const T &()>, Functions...> Struct Template Reference

First function is ground term.

```
#include <random_term_generator.hh>
```

Static Public Attributes

- static const size_t **value**

13.79.1 Detailed Description

template<typename T, typename... Functions> struct catsfoot::details::number_ground_terms< T, std::function< const T &()>, Functions...>

First function is ground term.

13.79.2 Member Data Documentation

13.79.2.1 template<typename T , typename... Functions> const size_t catsfoot::details::number_ground_terms< T, std::function< const T &()>, Functions...>::value [static]

Initial value:

```

    number_ground_terms<T, Functions...>::value + 1
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.80 catsfoot::details::number_ground_terms< T, std::function< Ret(Args...)>, Functions...> Struct Template Reference

First function is not ground term.

`#include <random_term_generator.hh>`

Static Public Attributes

- static const size_t **value**

13.80.1 Detailed Description

template<typename T, typename Ret, typename... Args, typename... Functions> struct catsfoot::details::number_ground_terms< T, std::function< Ret(Args...)>, Functions...>

First function is not ground term.

13.80.2 Member Data Documentation

13.80.2.1 template<typename T , typename Ret , typename... Args, typename... Functions> const size_t catsfoot::details::number_ground_terms< T, std::function< Ret(Args...)>, Functions...>::value [static]

Initial value:

```

        number_ground_terms<T, Functions...>::value
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.81 catsfoot::details::number_ground_terms< T, std::function< T &&()>, Functions...> Struct Template Reference

First function is ground term.

`#include <random_term_generator.hh>`

Static Public Attributes

- static const size_t **value**

13.81.1 Detailed Description

template<typename T, typename... Functions> struct catsfoot::details::number_ground_terms< T, std::function< T &&()>, Functions...>

First function is ground term.

13.81.2 Member Data Documentation

13.81.2.1 template<typename T , typename... Functions> const size_t catsfoot::details::number_ground_terms< T, std::function< T &&()>, Functions...>::value [static]

Initial value:

```

        number_ground_terms<T, Functions...>::value + 1
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.82 catsfoot::details::number_ground_terms< T, std::function< T &()>, Functions...> Struct Template Reference

First function is ground term.

`#include <random_term_generator.hh>`

Static Public Attributes

- static const size_t **value**

13.82.1 Detailed Description

template<typename T, typename... Functions> struct catsfoot::details::number_ground_terms< T, std::function< T &()>, Functions...>

First function is ground term.

13.82.2 Member Data Documentation

13.82.2.1 template< typename T , typename... Functions> const size_t catsfoot::details::number_ground_terms< T, std::function< T &()>, Functions...>::value [static]

Initial value:

```

        number_ground_terms<T, Functions...>::value + 1
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.83 catsfoot::details::number_ground_terms< T, std::function< T()>, Functions...> Struct Template Reference

First function is ground term.

`#include <random_term_generator.hh>`

Static Public Attributes

- static const size_t **value**

13.83.1 Detailed Description

template<typename T, typename... Functions> struct catsfoot::details::number_ground_terms< T, std::function< T()>, Functions...>

First function is ground term.

13.83.2 Member Data Documentation

13.83.2.1 template< typename T , typename... Functions> const size_t catsfoot::details::number_ground_terms< T, std::function< T()>, Functions...>::value [static]

Initial value:

```

        number_ground_terms<T, Functions...>::value + 1
```

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.84 catsfoot::op_eq Struct Reference

Wraps *operator==*.

`#include <operators.hh>`

Public Member Functions

- template<typename T , typename U , typename Ret = decltype(std::declval<T>() == std::declval<U>())>
  Ret **operator()** (T &&t, U &&u) const

13.84.1 Detailed Description

Wraps *operator==*.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.85 catsfoot::op_inc Struct Reference

Wraps *operator++*.

`#include <operators.hh>`

Public Member Functions

- template<typename T , typename Ret = decltype(++std::declval<T>())>
  Ret **operator()** (T &&t) const

13.85.1 Detailed Description

Wraps *operator++*.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.86 catsfoot::op_lsh Struct Reference

Wraps *operator<<*.

`#include <operators.hh>`

Public Member Functions

- template<typename T , typename U , typename Ret = decltype(std::declval<T>() << std::declval<U>())>
  Ret **operator()** (T &&t, U &&u) const

13.86.1 Detailed Description

Wraps *operator<<*.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.87 catsfoot::op_lt Struct Reference

Wraps *operator<*.

```
#include <operators.hh>
```

Public Member Functions

- template<typename T , typename U , typename Ret = decltype(std::declval<T>() < std::declval<U>())>
  Ret **operator()** (T &&t, U &&u) const

13.87.1 Detailed Description

Wraps *operator<*.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.88 catsfoot::op_neq Struct Reference

Wraps *operator!=*.

```
#include <operators.hh>
```

Public Member Functions

- template<typename T , typename U , typename Ret = decltype(std::declval<T>() != std::declval<U>())>
  Ret **operator()** (T &&t, U &&u) const

13.88.1 Detailed Description

Wraps *operator!=*.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.89 catsfoot::op_plus Struct Reference

Wraps *operator+*.

`#include <operators.hh>`

Public Member Functions

- template<typename T , typename U , typename Ret = decltype(std::declval<T>() + std::declval<U>())>
  Ret **operator()** (T &&t, U &&u) const

13.89.1 Detailed Description

Wraps *operator+*.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.90 catsfoot::op_post_inc Struct Reference

Wraps *operator++(T&, int)*

`#include <operators.hh>`

Public Member Functions

- template<typename T , typename Ret = decltype(++std::declval<T>())>
  Ret **operator()** (T &&t) const

13.90.1 Detailed Description

Wraps *operator++(T&, int)*

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.91 catsfoot::op_star Struct Reference

Wraps *operator∗*.

`#include <operators.hh>`

Public Member Functions

- template<typename T , typename Ret = decltype(∗std::declval<T>())>
  Ret **operator()** (T &&t) const

13.91.1 Detailed Description

Wraps *operator∗*.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.92 catsfoot::op_times Struct Reference

Wraps *operator∗*.

`#include <operators.hh>`

Public Member Functions

- template<typename T , typename U , typename Ret = decltype(std::declval<T>() ∗ std::declval<U>())>
  Ret **operator()** (T &&t, U &&u) const

13.92.1 Detailed Description

Wraps *operator∗*.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.93 catsfoot::pick_functor< T, Generator > Struct Template Reference

Public Member Functions

- **pick_functor** (Generator &g)

- **pick_functor** (const pick_functor &other)
- **pick_functor** (pick_functor &&other)
- pick_functor & **operator=** (pick_functor &&other)
- pick_functor & **operator=** (const pick_functor &other)
- T & **operator()** ()

template< typename T, typename Generator > struct catsfoot::pick_functor< T, Generator >

The documentation for this struct was generated from the following file:

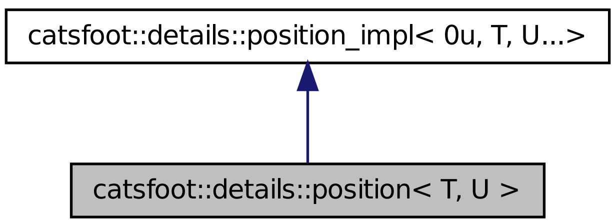
- dataset/pick.hh

13.94 catsfoot::details::position< T, U > Struct Template Reference

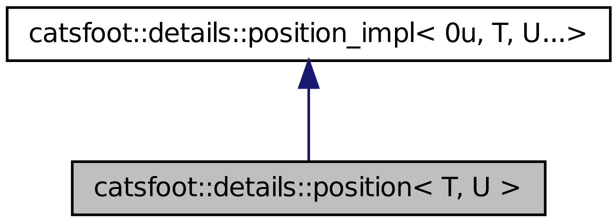
Finds the first occurrence of a type in a list.

#include <position.hh>

Inheritance diagram for catsfoot::details::position< T, U >:



Collaboration diagram for catsfoot::details::position< T, U >:



13.94.1 Detailed Description

template<typename T, typename... U> struct catsfoot::details::position< T, U >

Finds the first occurrence of a type in a list.

The documentation for this struct was generated from the following file:

- dataset/position.hh

13.95 catsfoot::details::position_impl< size_t, typename, > Struct Template Reference

Finds the first occurrence of a type in a list.

```
#include <position.hh>
```

13.95.1 Detailed Description

template<size_t, typename, typename...> struct catsfoot::details::position_impl< size_t, typename, >

Finds the first occurrence of a type in a list.

The documentation for this struct was generated from the following file:

- dataset/position.hh

13.96 catsfoot::details::position_impl< N, T, T, U...> Struct Template Reference

Finds the first occurrence of a type in a list.

```
#include <position.hh>
```

13.96.1 Detailed Description

template<size_t N, typename T, typename... U> struct catsfoot::details::position_impl< N, T, T, U...>

Finds the first occurrence of a type in a list.

The documentation for this struct was generated from the following file:

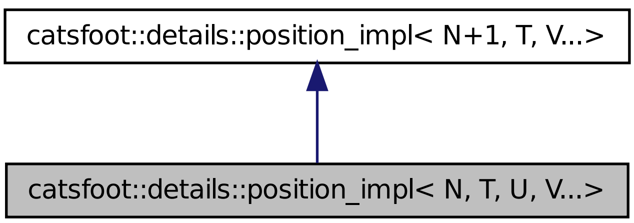
- dataset/position.hh

13.97 catsfoot::details::position_impl< N, T, U, V...> Struct Template Reference

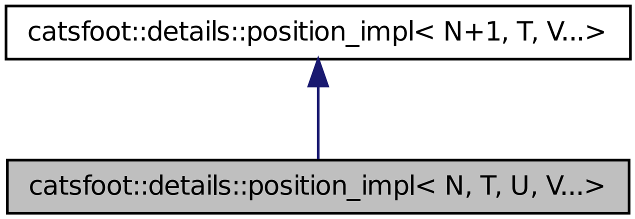
Finds the first occurrence of a type in a list.

```
#include <position.hh>
```

Inheritance diagram for catsfoot::details::position_impl< N, T, U, V...>:



Collaboration diagram for catsfoot::details::position_impl< N, T, U, V...>:



13.97.1 Detailed Description

template<size_t N, typename T, typename U, typename... V> struct catsfoot::details::position_impl< N, T, U, V...>

Finds the first occurrence of a type in a list.

The documentation for this struct was generated from the following file:

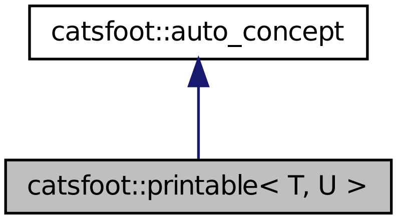
- dataset/position.hh

13.98 catsfoot::printable< T, U > Struct Template Reference

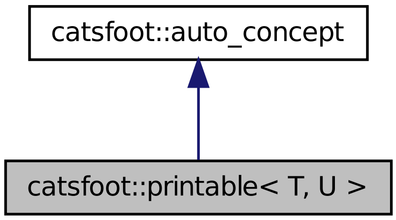
Check whether *U* is printable on a stream *T*.

```
#include <concepts.hh>
```

Inheritance diagram for catsfoot::printable< T, U >:



Collaboration diagram for catsfoot::printable< T, U >:



Public Types

- typedef concept_list< is_callable< op_lsh(T, U)> > **requirements**

13.98.1 Detailed Description

template<typename T, typename U> struct catsfoot::printable< T, U >

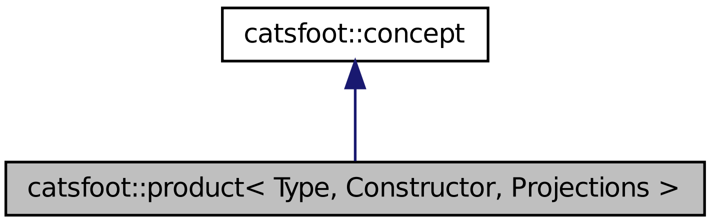
Check whether *U* is printable on a stream *T*.

The documentation for this struct was generated from the following file:

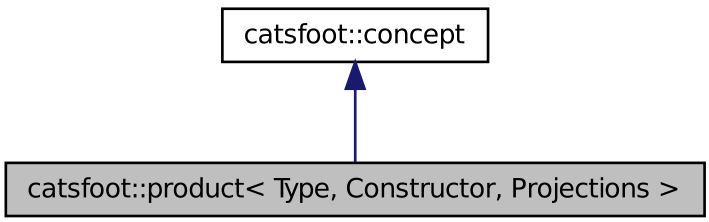
- concept/concepts.hh

13.99 catsfoot::product< Type, Constructor, Projections > Struct Template Reference

Inheritance diagram for catsfoot::product< Type, Constructor, Projections >:



Collaboration diagram for catsfoot::product< Type, Constructor, Projections >:



Public Types

- typedef concept_list< is_callable< Projections(const Type &)>..., is_callable< Constructor(typename is_callable< Projections(const Type &)>::result_type...)>, std::is_convertible< typename is_callable< Constructor(typename is_callable< Projections(const Type &)>::result_type...)>::result_type, Type >, equivalence_eq< Type >, equivalence_eq< typename is_callable< Projections(const Type &)>::result_type >... > **requirements**

Public Member Functions

- **AXIOMS** (projections, universality)

Static Public Member Functions

- static void **projections** (const std::tuple< typename is_callable< Projections(const Type &)>::result_type...> &comps, const std::tuple< Projections...> &p, const Constructor &constr)
- static void **universality** (const Type &t, const std::tuple< Projections...> &p, const Constructor &constr)

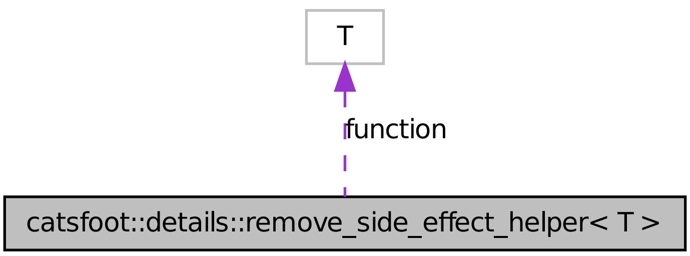
template<typename Type, typename Constructor, typename... Projections> struct catsfoot::product< Type, Constructor, Projections >

The documentation for this struct was generated from the following file:

- concept/product.hh

13.100 catsfoot::details::remove_side_effect_helper< T > Struct Template Reference

Collaboration diagram for catsfoot::details::remove_side_effect_helper< T >:



Public Member Functions

- template<typename U , typename = typename std::enable_if <std::is_same<typename std::decay<U>::type, T>::value> ::type>
  remove_side_effect_helper (U &&u)

- **remove_side_effect_helper** (const remove_side_effect_helper &other)
- **remove_side_effect_helper** (remove_side_effect_helper &&other)
- template<typename... Args, typename Ret = decltype(std::declval<T>()(std::declval<Args>()...))>
  Ret **operator()** (Args &&...args) const

template<typename T> struct catsfoot::details::remove_side_effect_helper< T >

The documentation for this struct was generated from the following file:

- wrappers/function_wrappers.hh

13.101 catsfoot::details::return_of< T > Struct Template Reference

template<typename T> struct catsfoot::details::return_of< T >

The documentation for this struct was generated from the following file:

- wrappers/function_wrappers.hh

13.102 catsfoot::details::return_of< T(Args...)> Struct Template Reference

Public Types

- typedef T **type**

template<typename T, typename... Args> struct catsfoot::details::return_of< T(Args...)>

The documentation for this struct was generated from the following file:

- wrappers/function_wrappers.hh

13.103 catsfoot::selector< T > Struct Template Reference

Constructible type used to select a type for overloaded functions.

`#include <dataset.hh>`

Public Types

- typedef T **type**

13.103.1 Detailed Description

template<typename T> struct catsfoot::selector< T >

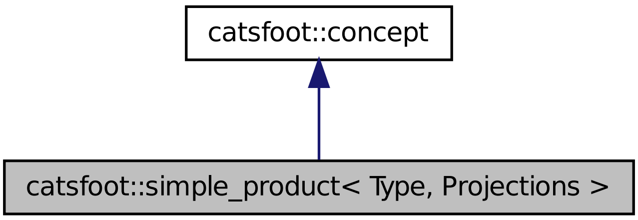
Constructible type used to select a type for overloaded functions.

The documentation for this struct was generated from the following file:

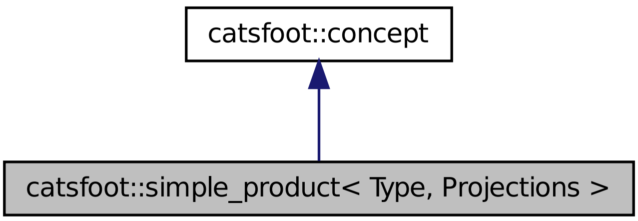
- dataset/dataset.hh

13.104 catsfoot::simple_product< Type, Projections > Struct Template Reference

Inheritance diagram for catsfoot::simple_product< Type, Projections >:



Collaboration diagram for catsfoot::simple_product< Type, Projections >:



Public Types

- typedef concept_list< is_constructible< Type(typename is_callable< Projections(const Type &)>::result_type...)>, product< Type, constructor_wrap< Type >, Projections...> > **requirements**

template<typename Type, typename... Projections> struct catsfoot::simple_product< Type, Projections >

The documentation for this struct was generated from the following file:

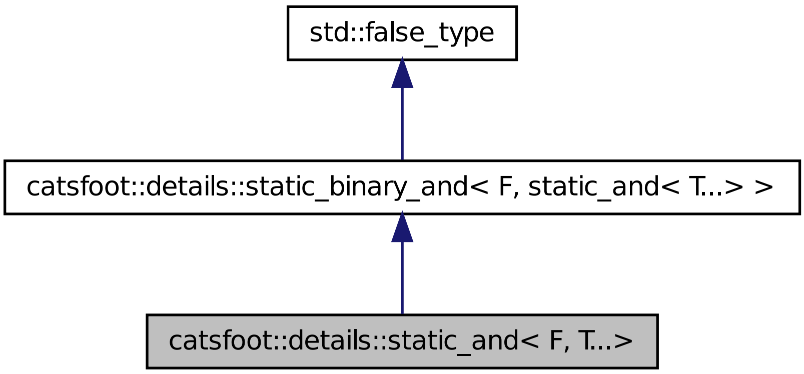
- concept/product.hh

13.105 catsfoot::details::static_and< F, T...> Struct Template Reference

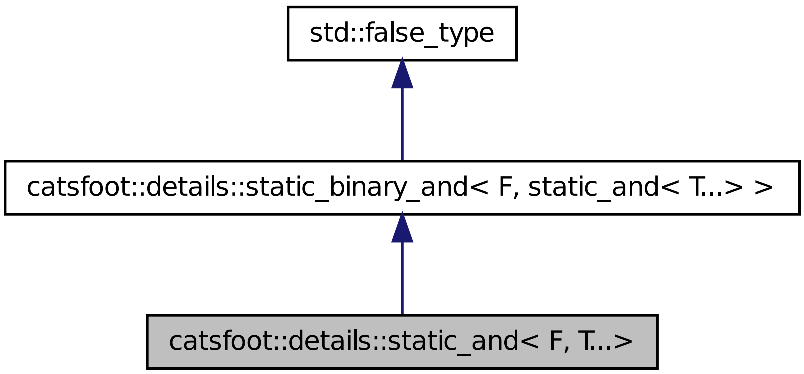
Predicate true if all predicate parameters are true.

`#include <static_and.hh>`

Inheritance diagram for catsfoot::details::static_and< F, T...>:



Collaboration diagram for catsfoot::details::static_and< F, T...>:



13.105.1 Detailed Description

template<typename F, typename... T> struct catsfoot::details::static_and< F, T...>

Predicate true if all predicate parameters are true.

The documentation for this struct was generated from the following file:

- concept/static_and.hh

13.106 catsfoot::details::static_and<> Struct Template Reference

Predicate true if all predicate parameters are true.

```
#include <static_and.hh>
```

13.106.1 Detailed Description

template<> struct catsfoot::details::static_and<>

Predicate true if all predicate parameters are true.

The documentation for this struct was generated from the following file:

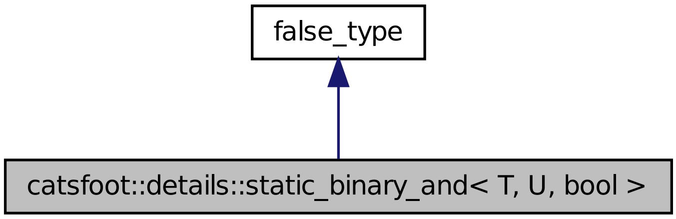
- concept/static_and.hh

13.107 catsfoot::details::static_binary_and< T, U, bool > Struct Template Reference

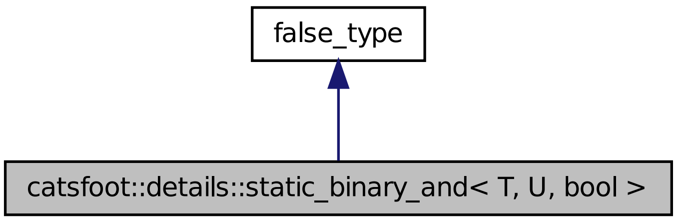
Predicate true if all predicate parameters are true.

`#include <static_and.hh>`

Inheritance diagram for catsfoot::details::static_binary_and< T, U, bool >:



Collaboration diagram for catsfoot::details::static_binary_and< T, U, bool >:



13.107.1 Detailed Description

template<typename T, typename U, bool = T::value> struct catsfoot::details::static_binary_and< T, U, bool >

Predicate true if all predicate parameters are true.

The documentation for this struct was generated from the following file:

- concept/static_and.hh

13.108 catsfoot::details::static_binary_and< T, U, true > Struct Template Reference

Predicate true if all predicate parameters are true.

```
#include <static_and.hh>
```

13.108.1 Detailed Description

template<typename T, typename U> struct catsfoot::details::static_binary_and< T, U, true >

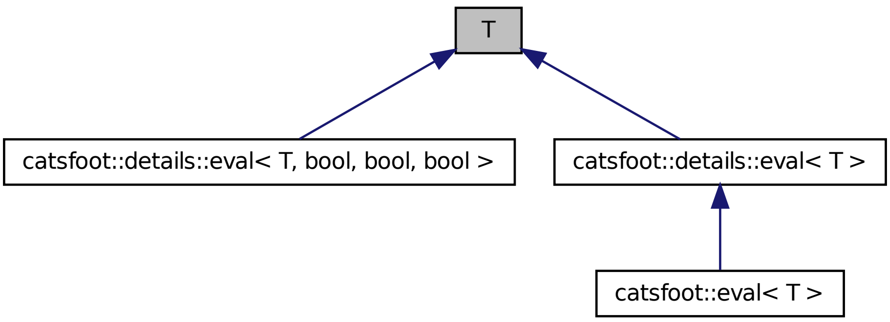
Predicate true if all predicate parameters are true.

The documentation for this struct was generated from the following file:

- concept/static_and.hh

13.109 T Class Reference

Inheritance diagram for T:



The documentation for this class was generated from the following file:

- concept/concept_tools.hh

13.110 catsfoot::term_generator_builder< Types > Struct Template Reference

Builds random term generators.

```
#include <random_term_generator.hh>
```

Classes

- struct generator

Public Member Functions

- **term_generator_builder** (size_t size=200u)
- template<typename Generator , typename... Functions>
  generator< Generator, typename wrapped< Functions >::type...> operator() (Generator &g, Functions &&...functions) const

  Build a random term generator.

13.110.1 Detailed Description

template<typename... Types> struct catsfoot::term_generator_builder< Types >

Builds random term generators.

Template Parameters

Types	The list of types it can generate

13.110.2 Member Function Documentation

13.110.2.1 template<typename... Types> template<typename Generator , typename... Functions> generator<Generator, typename wrapped<Functions>::type...> catsfoot::term_generator_builder< Types >::operator() (Generator & *g*, Functions &&... *functions*) const [inline]

Build a random term generator.

Parameters

g	A random generator engine.
functions	A list of functions.

The documentation for this struct was generated from the following file:

- dataset/random_term_generator.hh

13.111 catsfoot::details::test_all< T, bool, bool > Struct Template Reference

Test axioms of a predicate (always true)

`#include <test_all_driver.hh>`

Public Member Functions

- template<typename Generator , typename Stream = decltype(std::cerr)>
  bool **operator()** (Generator &, Stream &=std::cerr)

13.111.1 Detailed Description

template<typename T, bool = is_concept<T>::value, bool = has_get_axiom<T>::value> struct catsfoot::details::test_all< T, bool, bool >

Test axioms of a predicate (always true)

The documentation for this struct was generated from the following file:

- drivers/test_all_driver.hh

13.112 catsfoot::details::test_all< concept_list< T, U...>, false, B > Struct Template Reference

Test axioms of a list of requirements.

`#include <test_all_driver.hh>`

Public Member Functions

- template<typename Generator , typename Stream = decltype(std::cerr)>
  bool **operator()** (Generator &g, Stream &s=std::cerr)

13.112.1 Detailed Description

template<typename T, typename... U, bool B> struct catsfoot::details::test_all< concept_list< T, U...>, false, B >

Test axioms of a list of requirements.

The documentation for this struct was generated from the following file:

- drivers/test_all_driver.hh

13.113 catsfoot::details::test_all< T, true, false > Struct Template Reference

Test axioms of a concept with no local axioms.

```
#include <test_all_driver.hh>
```

Public Member Functions

- template<typename Generator , typename Stream = decltype(std::cerr)>
  bool **operator()** (Generator &g, Stream &s=std::cerr)

13.113.1 Detailed Description

template<typename T> struct catsfoot::details::test_all< T, true, false >

Test axioms of a concept with no local axioms.

The documentation for this struct was generated from the following file:

- drivers/test_all_driver.hh

13.114 catsfoot::details::test_all< T, true, true > Struct Template Reference

Test axioms of a concept with local axioms.

```
#include <test_all_driver.hh>
```

Public Member Functions

- template<typename Generator , typename... Axioms, typename Stream , typename Index = std::integral_-constant<size_t, 0>>
  bool test (Generator &g, const std::tuple< Axioms...> &axioms, Stream &s, Index=Index())

  Test axiom number "Index".

- template<typename Generator , typename... Axioms, typename Stream >
  bool test (Generator &, const std::tuple< Axioms...> &, Stream &, std::integral_-constant< size_t, sizeof...(Axioms)>)

  All axioms were tested.

- template<typename Generator , typename Stream = decltype(std::cerr)>
  bool **operator()** (Generator &g, Stream &s=std::cerr)

13.114.1 Detailed Description

template<typename T> struct catsfoot::details::test_all< T, true, true >

Test axioms of a concept with local axioms.

The documentation for this struct was generated from the following file:

- drivers/test_all_driver.hh

13.115 catsfoot::details::tester< T, U...> Struct Template Reference

Static Public Member Functions

- template<typename Generator , typename Fun , typename... Params, typename Stream >
  static bool **call_gen** (Stream &s, Generator &g, Fun f, Params &&...values)

template<typename T, typename... U> struct catsfoot::details::tester< T, U...>

The documentation for this struct was generated from the following file:

- drivers/test_driver.hh

13.116 catsfoot::details::tester<> Struct Template Reference

Static Public Member Functions

- template<typename Generator , typename Fun , typename... Params, typename Stream >
  static bool **call_gen_final** (Stream &s, Generator &, Fun f, Params &&...values)
- template<typename Generator , typename Fun , typename... Params, typename Stream >
  static bool **call_gen** (Stream &s, Generator &g, Fun f, Params &&...values)

template<> struct catsfoot::details::tester<>

The documentation for this struct was generated from the following file:

- drivers/test_driver.hh

13.117 catsfoot::details::try_all_compare< T, std::function< Ret(Args...)> > Struct Template Reference

Static Public Member Functions

- template<typename Generator , typename... OtherArgs>
  static bool **doit** (Generator &g, const selector< const T & > &, const std::function< Ret(Args...)> &f, const T &a, const T &b, const std::tuple< OtherArgs, OtherArgs > &...args...)
- template<typename Generator , typename U , typename... OtherArgs>
  static bool **doit** (Generator &g, const selector< U > &, const std::function< Ret(Args...)> &f, const T &a, const T &b, const std::tuple< OtherArgs, OtherArgs > &...args...)
- template<typename Generator , typename... OtherArgs>
  static bool **doit** (Generator &g, const std::function< Ret(Args...)> &f, const T &a, const T &b, const std::tuple< OtherArgs, OtherArgs > &...args...)
- template<typename Generator >
  static bool doit (Generator &, const std::function< Ret(Args...)> &f, const T &, const T &, const std::tuple< Args, Args > &...args...)

template<typename T, typename Ret, typename... Args> struct catsfoot::details::try_all_compare< T, std::function< Ret(Args...)> >

13.117.1 Member Function Documentation

13.117.1.1 template<typename T , typename Ret , typename... Args> template<typename Generator > static bool catsfoot::details::try_all_compare< T, std::function< Ret(Args...)> >::doit (Generator & , const std::function< Ret(Args...)> & *f*, const T & , const T & , const std::tuple< Args, Args > &... *args...*) `[inline, static]`

Todo

If == does not exist?

The documentation for this struct was generated from the following file:

- utils/black_box_equal.hh

13.118 catsfoot::details::try_first Struct Reference

Tag for prioritizing some overloaded functions.

```
#include <try_first.hh>
```

13.118.1 Detailed Description

Tag for prioritizing some overloaded functions.

The documentation for this struct was generated from the following file:

- type_traits/try_first.hh

13.119 catsfoot::details::try_second Struct Reference

Tag for prioritizing some overloaded functions.

```
#include <try_first.hh>
```

Public Member Functions

- **try_second** (const try_first &)

13.119.1 Detailed Description

Tag for prioritizing some overloaded functions.

The documentation for this struct was generated from the following file:

- type_traits/try_first.hh

13.120 catsfoot::details::tuple_generator< Generator > Struct Template Reference

Generates tuple from generator.

```
#include <tuple_generator.hh>
```

Public Member Functions

- **tuple_generator** (Generator &&g)
- **tuple_generator** (const Generator &g)
- **tuple_generator** (const tuple_generator &other)
- **tuple_generator** (tuple_generator &&other)
- template<typename U >
  decltype (tuple_generator_tool< U >()(std::declval< const Generator & >()))
  get(selector< U >)

13.120.1 Detailed Description

template<typename Generator> struct catsfoot::details::tuple_generator< Generator >

Generates tuple from generator.

The documentation for this struct was generated from the following file:

- dataset/tuple_generator.hh

13.121 catsfoot::details::tuple_generator_tool< U > Struct Template Reference

template<typename U> struct catsfoot::details::tuple_generator_tool< U >

The documentation for this struct was generated from the following file:

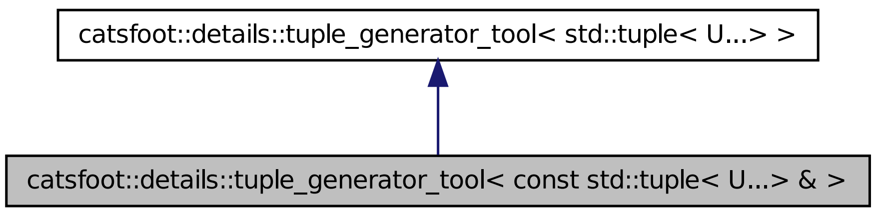
- dataset/tuple_generator.hh

13.122 catsfoot::details::tuple_generator_tool< const std::tuple< U...> & > Struct Template Reference

Generates containers of tuples std::tuple<U...>

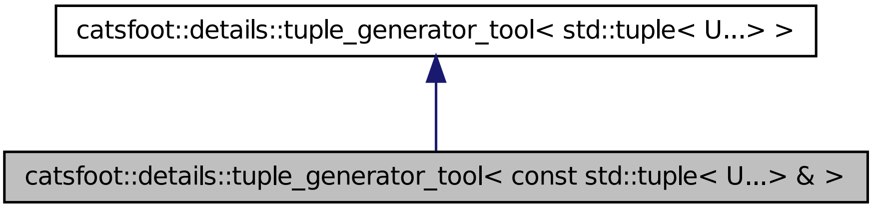
`#include <tuple_generator.hh>`

Inheritance diagram for catsfoot::details::tuple_generator_tool< const std::tuple< U...> & >:



Collaboration diagram for catsfoot::details::tuple_generator_tool< const std::tuple<

U...> & >:



13.122.1 Detailed Description

template<typename... U> struct catsfoot::details::tuple_generator_tool< const std::tuple< U...> & >

Generates containers of tuples std::tuple<U...>

The documentation for this struct was generated from the following file:

- dataset/tuple_generator.hh

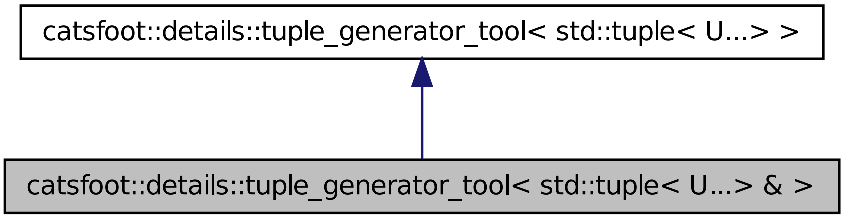
13.123 catsfoot::details::tuple_generator_tool< std::tuple< U...> & > Struct Template Reference

Generates containers of tuples std::tuple<U...>

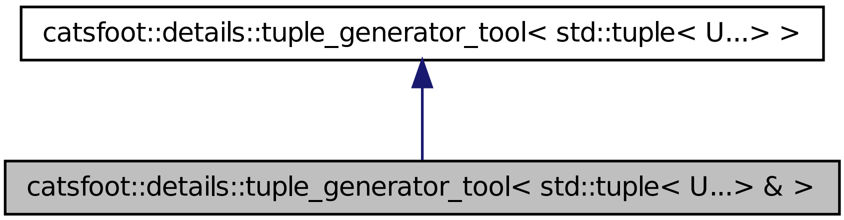
`#include <tuple_generator.hh>`

Inheritance diagram for catsfoot::details::tuple_generator_tool< std::tuple< U...> &

>:



Collaboration diagram for catsfoot::details::tuple_generator_tool< std::tuple< U...> & >:



13.123.1 Detailed Description

template<typename... U> struct catsfoot::details::tuple_generator_tool< std::tuple< U...> & >

Generates containers of tuples std::tuple<U...>

The documentation for this struct was generated from the following file:

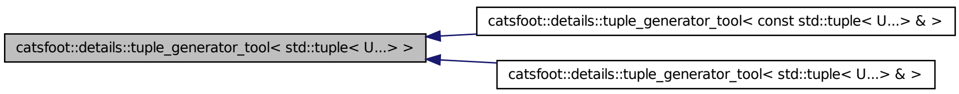
- dataset/tuple_generator.hh

13.124 catsfoot::details::tuple_generator_tool< std::tuple< U...> > Struct Template Reference

Generates containers of tuples std::tuple<U...>

```
#include <tuple_generator.hh>
```

Inheritance diagram for catsfoot::details::tuple_generator_tool< std::tuple< U...> >:



Public Member Functions

- template<typename... V, typename... Values, typename = void, typename = typename std::enable_if <(sizeof...(V) == sizeof...(Values))>::type>
  std::list< std::tuple< U...> > **make_list** (std::tuple< V...> &, Values...values...) const
- template<typename... V, typename... Values, typename = typename std::enable_if<(sizeof...(V) > sizeof...(Values)>
  ::type std::list< std::tuple< U...> > **make_list** (std::tuple< V...> &containers, Values...values) const
- template<typename Generator >
  std::list< std::tuple< U...> > **operator()** (Generator &g) const

13.124.1 Detailed Description

template<typename... U> struct catsfoot::details::tuple_generator_tool< std::tuple< U...> >

Generates containers of tuples std::tuple<U...>

The documentation for this struct was generated from the following file:

- dataset/tuple_generator.hh

13.125 catsfoot::undefined_member_type Struct Reference

Type used return by has_member_... in case member does not exist.

```
#include <type_member.hh>
```

13.125.1 Detailed Description

Type used return by has_member_... in case member does not exist.

The documentation for this struct was generated from the following file:

- type_traits/type_member.hh

13.126 catsfoot::undefined_return< T > Struct Template Reference

Return type used in case of error for is_callable.

```
#include <is_callable.hh>
```

13.126.1 Detailed Description

template< typename T > struct catsfoot::undefined_return< T >

Return type used in case of error for is_callable.

The documentation for this struct was generated from the following file:

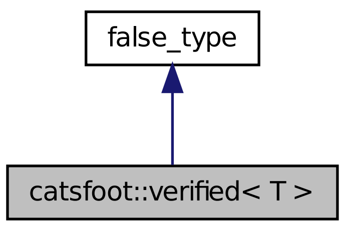
- type_traits/is_callable.hh

13.127 catsfoot::verified< T > Struct Template Reference

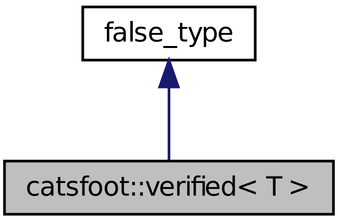
User type traits for validating models.

```
#include <concept_tools.hh>
```

Inheritance diagram for catsfoot::verified< T >:



Collaboration diagram for catsfoot::verified< T >:



13.127.1 Detailed Description

template<typename T> struct catsfoot::verified< T >

User type traits for validating models.

The documentation for this struct was generated from the following file:

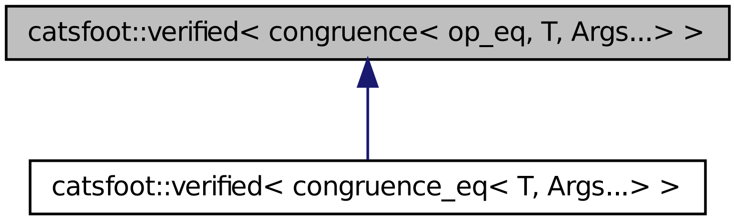
- concept/concept_tools.hh

13.128 catsfoot::verified< congruence< op_eq, T, Args...> > Struct Template Reference

When T is a congruence_eq, then T is a congruence for ==.

`#include <congruence.hh>`

Inheritance diagram for catsfoot::verified< congruence< op_eq, T, Args...> >:



13.128.1 Detailed Description

template<typename T, typename... Args> struct catsfoot::verified< congruence< op_eq, T, Args...> >

When T is a congruence_eq, then T is a congruence for ==.

The documentation for this struct was generated from the following file:

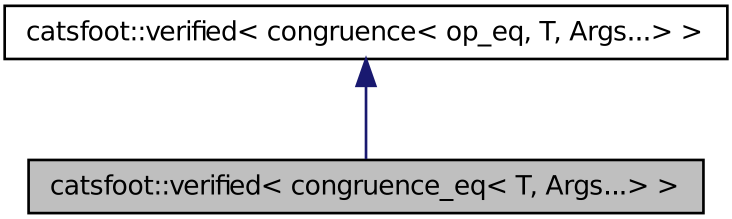
- concept/congruence.hh

13.129 catsfoot::verified< congruence_eq< T, Args...> > Struct Template Reference

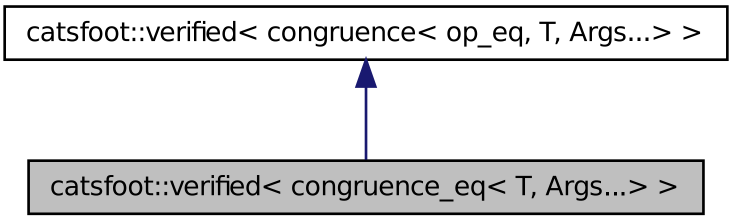
When T is a congruence for ==, then T is a congruence_eq.

```
#include <congruence.hh>
```

Inheritance diagram for catsfoot::verified< congruence_eq< T, Args...> >:



Collaboration diagram for catsfoot::verified< congruence_eq< T, Args...> >:



13.129.1 Detailed Description

template< typename T, typename... Args> struct catsfoot::verified< congruence_eq< T, Args...> >

When T is a congruence for ==, then T is a congruence_eq.

The documentation for this struct was generated from the following file:

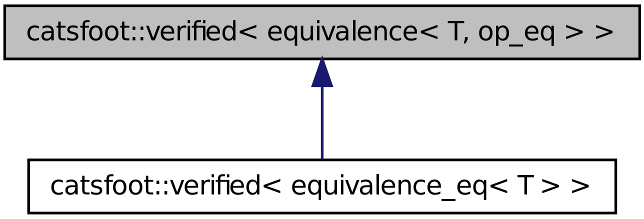
- concept/congruence.hh

13.130 catsfoot::verified< equivalence< T, op_eq > > Struct Template Reference

If T is equivalence_eq, then == is an equivalence relation to T.

```
#include <congruence.hh>
```

Inheritance diagram for catsfoot::verified< equivalence< T, op_eq > >:



13.130.1 Detailed Description

template<typename T> struct catsfoot::verified< equivalence< T, op_eq > >

If T is equivalence_eq, then == is an equivalence relation to T.

The documentation for this struct was generated from the following file:

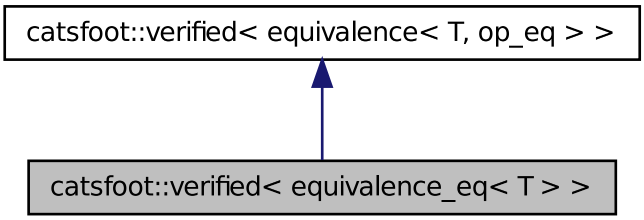
- concept/congruence.hh

13.131 catsfoot::verified< equivalence_eq< T > > Struct Template Reference

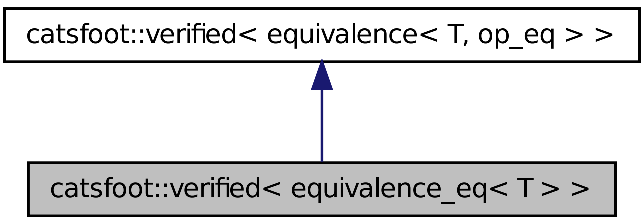
If == is an equivalence relation to T, then T is equivalence_eq.

```
#include <congruence.hh>
```

Inheritance diagram for catsfoot::verified< equivalence_eq< T > >:



Collaboration diagram for catsfoot::verified< equivalence_eq< T > >:



13.131.1 Detailed Description

template<typename T> struct catsfoot::verified< equivalence_eq< T > >

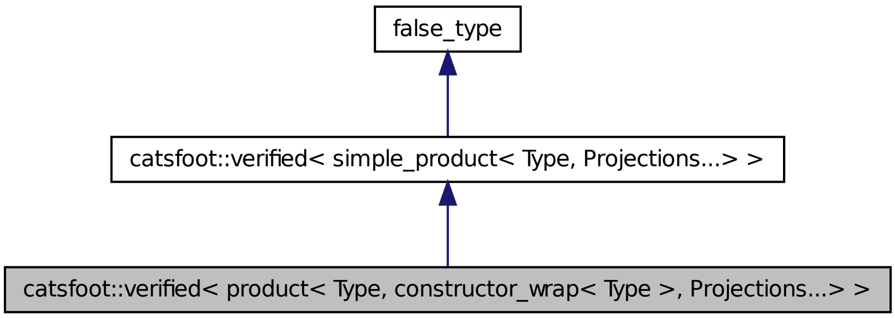
If == is an equivalence relation to T, then T is equivalence_eq.

The documentation for this struct was generated from the following file:

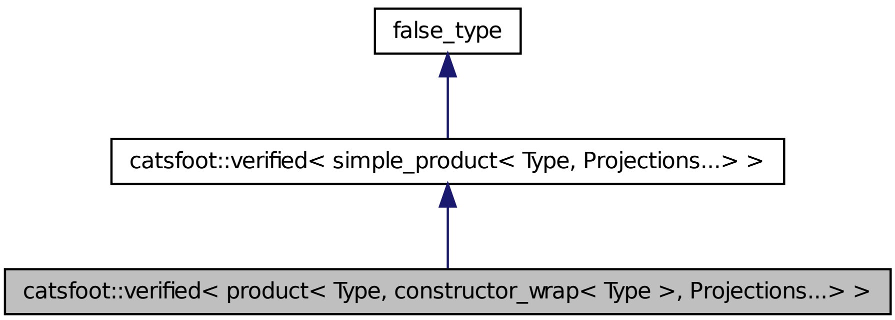
- concept/congruence.hh

13.132 catsfoot::verified< product< Type, constructor_wrap< Type >, Projections...> > Struct Template Reference

Inheritance diagram for catsfoot::verified< product< Type, constructor_wrap< Type >, Projections...> >:



Collaboration diagram for catsfoot::verified< product< Type, constructor_wrap< Type >, Projections...> >:



template<typename Type, typename... Projections> struct catsfoot::verified< product< Type, constructor_wrap< Type >, Projections...> >

The documentation for this struct was generated from the following file:

- concept/product.hh

13.133 catsfoot::wrapped< T > Struct Template Reference

Get the return type of the wrap function.

`#include <function_wrappers.hh>`

Public Member Functions

- typedef **decltype** (wrap(std::declval< T >())) type

13.133.1 Detailed Description

template<typename T> struct catsfoot::wrapped< T >

Get the return type of the wrap function.

The documentation for this struct was generated from the following file:

- wrappers/function_wrappers.hh

13.134 catsfoot::wrapped_constructor< T > Struct Template Reference

Wraps constructor T.

`#include <operators.hh>`

13.134.1 Detailed Description

template<typename T> struct catsfoot::wrapped_constructor< T >

Wraps constructor T.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.135 catsfoot::details::wrapped_constructor< T(Args...), false > Struct Template Reference

T(Args...) is not constructible.

`#include <operators.hh>`

13.135.1 Detailed Description

template<typename T, typename... Args> struct catsfoot::details::wrapped_constructor< T(Args...), false >

T(Args...) is not constructible.

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

13.136 catsfoot::details::wrapped_constructor< T(Args...), true > Struct Template Reference

Wraps constructor T(Args...)

`#include <operators.hh>`

Public Member Functions

- T **operator()** (Args...args...) const

13.136.1 Detailed Description

template<typename T, typename... Args> struct catsfoot::details::wrapped_constructor< T(Args...), true >

Wraps constructor T(Args...)

The documentation for this struct was generated from the following file:

- wrappers/operators.hh

Index