Testing

OBJECT-ORIENTED CODE

Objectives

At the end of this section, you will be able to

- Explain the difference between testing C++ constructors and methods
- Create and execute tests for C++ methods

testIDEA

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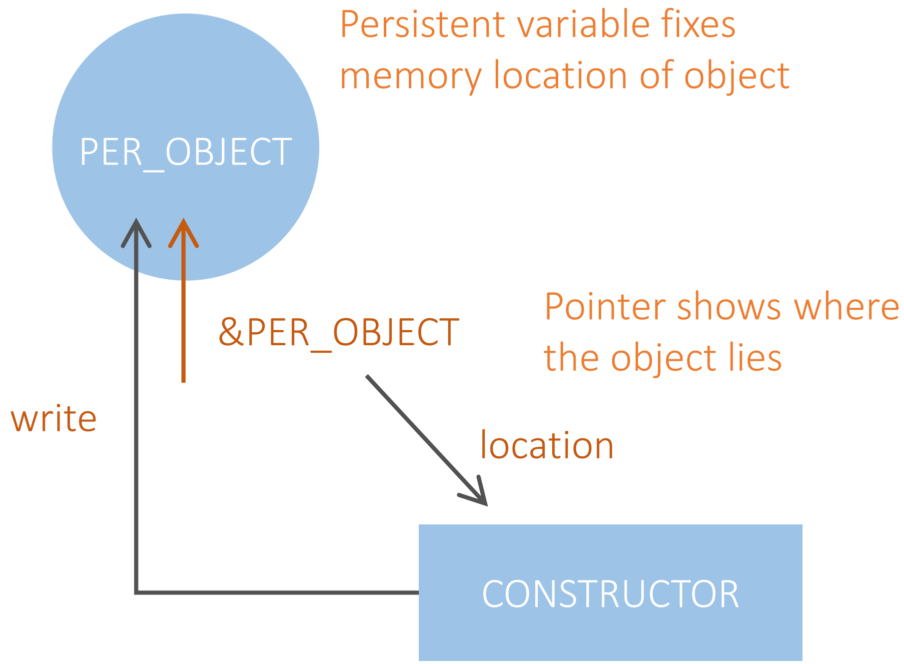
OBJECT-ORIENTED CODE

testIDEA

1 TESTING C++ CLASSES - CORE ELEMENTS

Unit testing of C++ code with testIDEA is essentially the same as C code testing with the exception that C++ objects need to be initialized prior to using their methods. These objects have to be allocated to a persistent variable in order to ensure that the constructor is called.

Persistent variables have a ***lifetime*** *that spans many test cases. They must be deleted at the end when no longer needed.*



The core difference between C and C++ testing are associated with the initialization of the objects prior to testing the class's methods.

1 TESTING C++ CLASSES - CODE

This unit uses for its examples a small demonstration application which includes the C++ Class *Temperature*.

Its purpose is to maintain a temperature value in three different units, Celsius, Fahrenheit and Kelvin (stored as 3 private values).

The class also has various public methods which allow us to operate and work on this data, including three different constructors.

```
class Temperature {
    private:
        float _tCelcius;
        float _tFahrenheit;
        float _tKelvin;
        float convCtoF(float temperature);
        float convCtoK(float temperature);
        float convFtoC(float temperature);
        float convFtoK(float temperature);
        float convKtoC(float temperature);
        float convKtoF(float temperature);

    public:
        float getTemperature();
        float getTemperature(tTypes type);
        void setTemperature(float temperature);
        void setTemperature(float temperature, tTypes
type);
        Temperature();
        Temperature(float temperature);
        Temperature(float temperature, tTypes type);
};
```

1 TESTING C++ CLASSES - CODE

The first constructor creates an object where Celsius is set to zero and Fahrenheit and Kelvin units are calculated appropriately.

The second constructor uses the value passed for *temperature* and assumes that value to be in Celsius. It then calculates Fahrenheit and Kelvin respectively.

The third constructor allows us to pass the temperature in a chosen unit that is defined by the second parameter.

```
Temperature::Temperature(void) {
    _tCelcius = 0.0;
    _tFahrenheit = convCtoF(_tCelcius);
    _tKelvin = convCtoK(_tCelcius);         }

Temperature::Temperature(float temperature) {
    _tCelcius = temperature;
    _tFahrenheit = convCtoF(temperature);
    _tKelvin = convCtoK(temperature);       }

Temperature::Temperature(float temperature, tTypes
type) {
    if (type == tTypes::tC) {
        Temperature(_tCelcius);
    } else if (type == tTypes::tF) {
        _tFahrenheit = temperature;
        _tCelcius = convFtoC(_tFahrenheit);
        _tKelvin = convFtoK(_tFahrenheit);
    } else {
        /* Assume Kelvin value */
        _tKelvin = temperature;
        _tCelcius = convKtoC(_tKelvin);
        _tFahrenheit = convKtoF(_tKelvin); }}
```

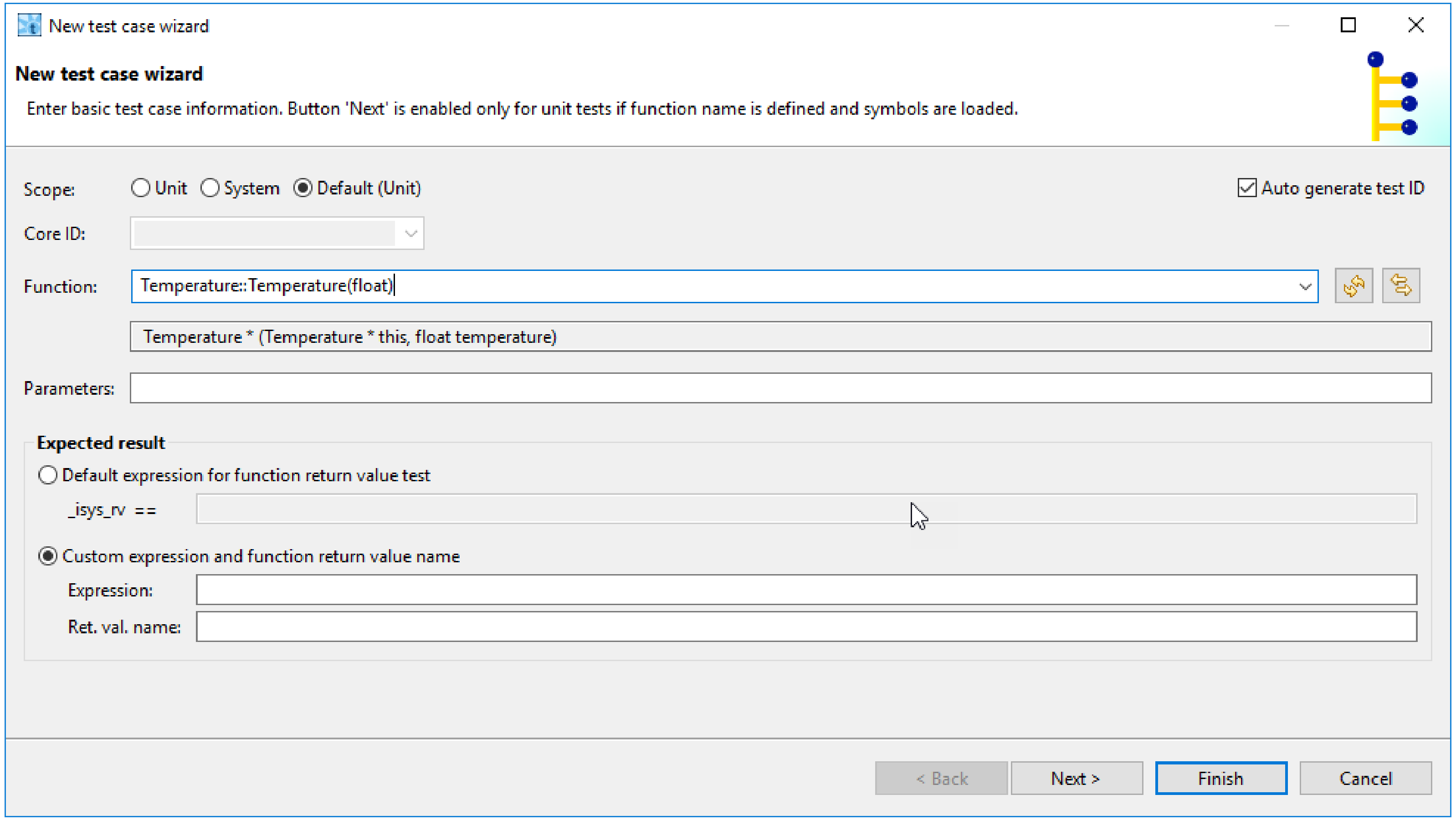
1 TESTING C++ CONSTRUCTORS - CREATE BASE TEST

Creating a base test for the constructor *Temperature (float)*

Having chosen the constructor we wish to test from the *Function* drop-down list, we see it actually has two parameters; the *temperature* we wish to pass into the constructor, and another parameter named *this*.

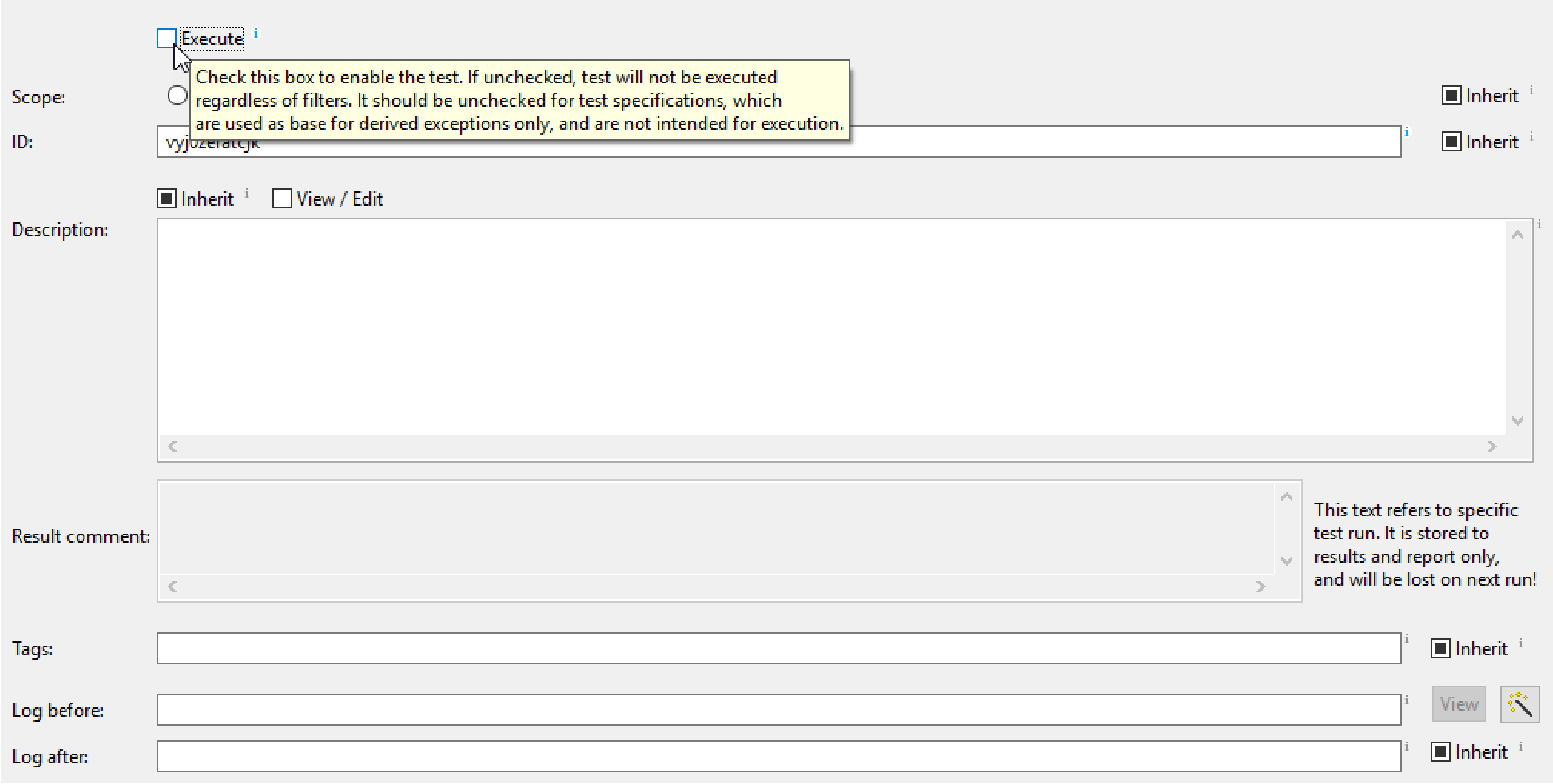
this is simply a pointer to the object in memory where all the data associated with the object (e.g. the private variables) are to be stored.

As we have not yet created an object for the constructor or other methods to use, we do not add any further information here in the wizard, instead finishing by clicking *Finish*.



1 TESTING C++ CONSTRUCTORS - CREATE BASE TEST

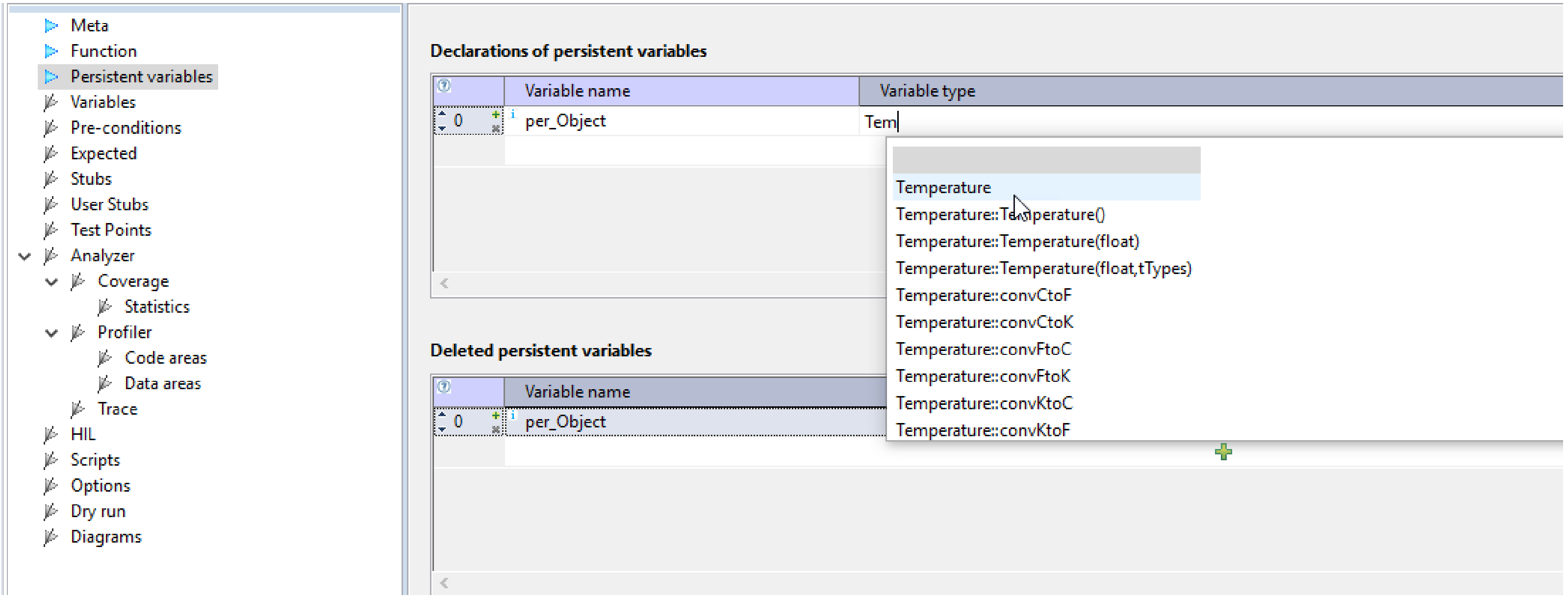
As we are creating a base test we will clear the *Execute* box in meta data form as we previously did for C unit tests.



1 TESTING C++ CONSTRUCTORS - PERSISTENT VARIABLE

We add a persistent variable to the base test. We declare the variable within the base test and delete it immediately afterwards.

This will provide us with a *per_Object* in each derived test which will be deleted upon test completion.



1 TESTING C++ CONSTRUCTORS - CREATE DERIVED TEST

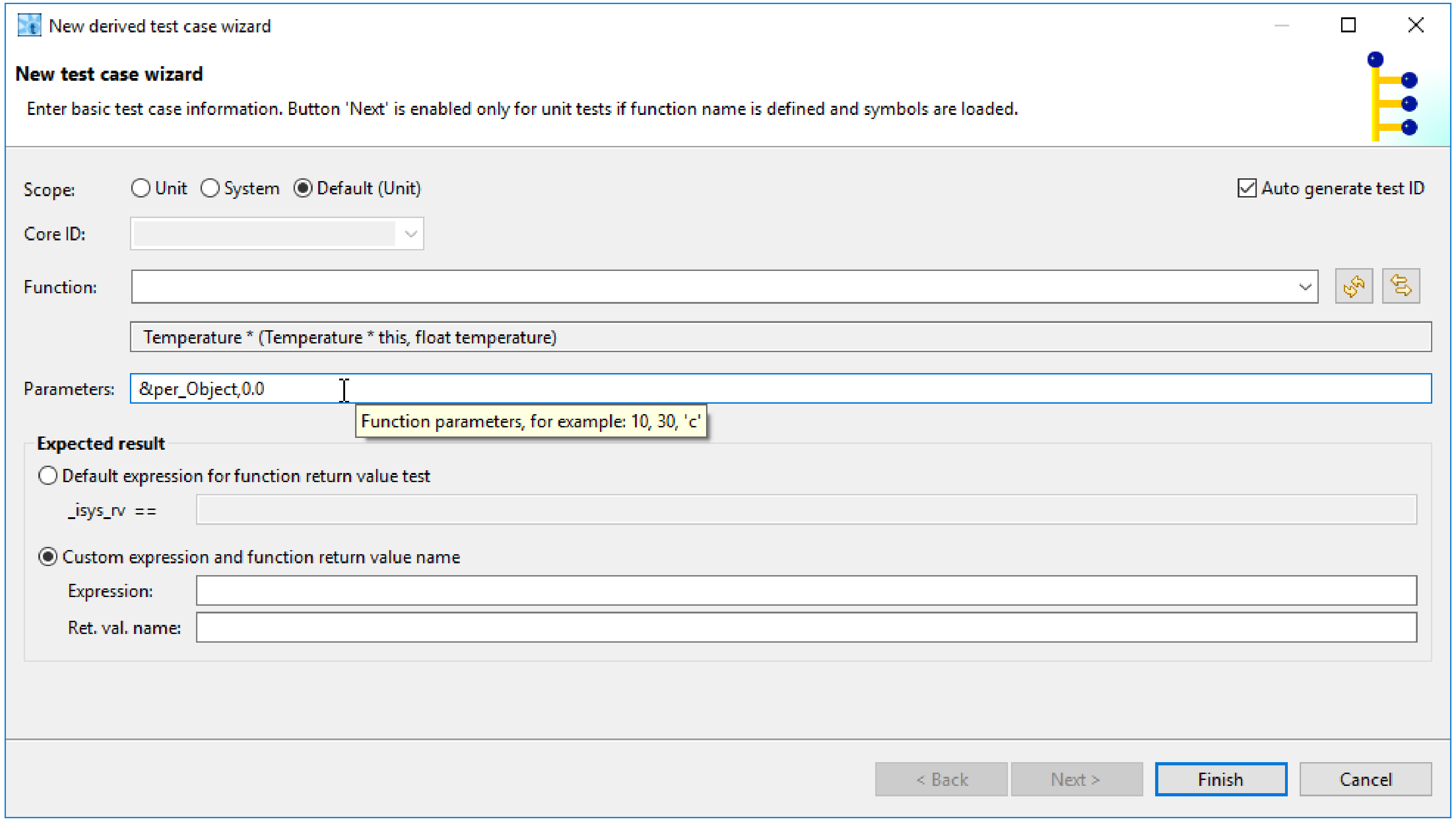
Create a derived test

We have to use the *Test* option of the main menu bar once again and select *New derived test*.

The function name is inherited, so we don't have to fill this field.

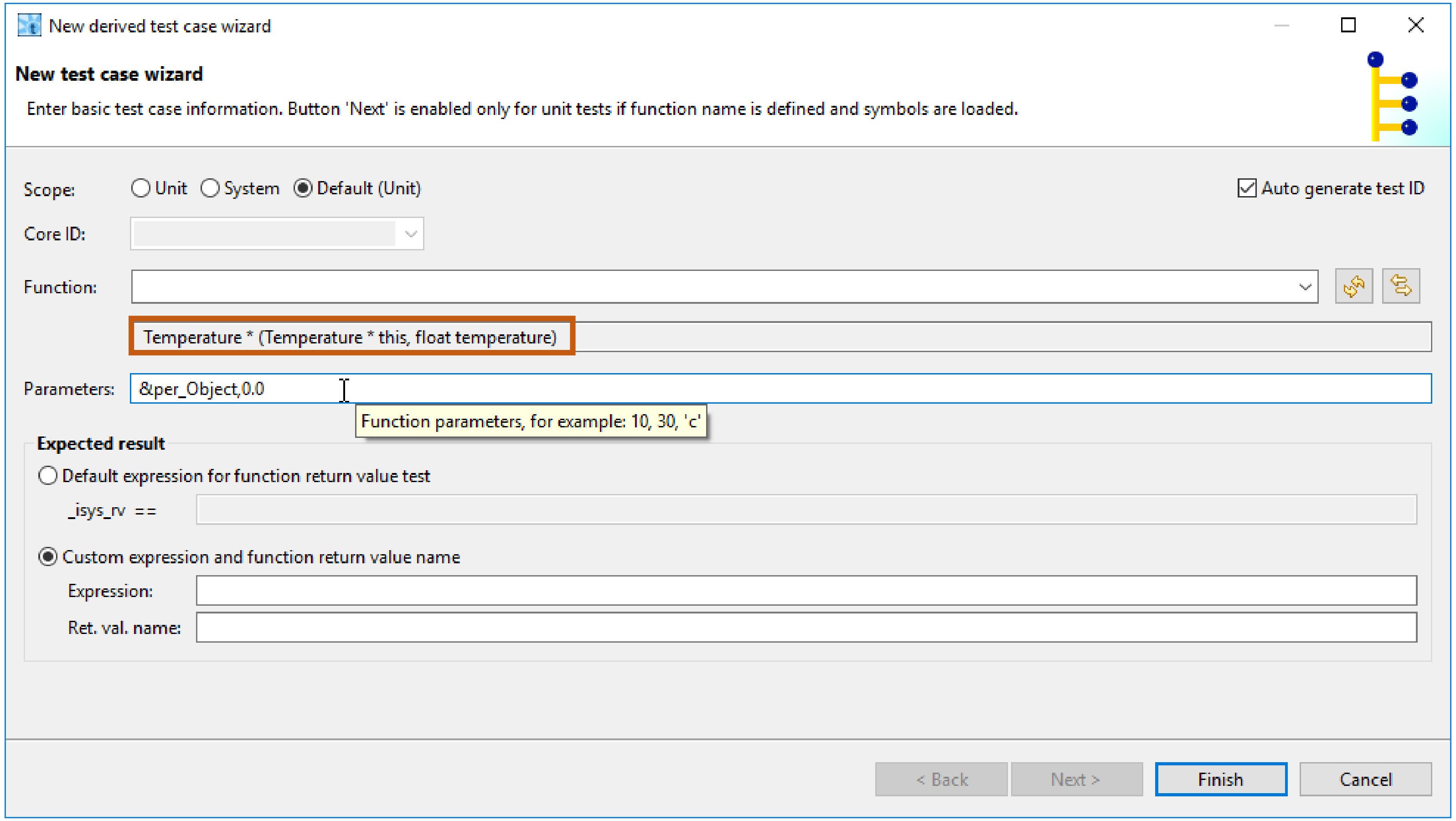
Now we have to add the parameters: Obviously, we need a parameter for the temperature we want to pass (e.g. 0.0°C), but we also have to have a pointer to the temperature object to store this information.

Here we insert the pointer to the object, so that the parameter list is: *&per_Object, 0.0*



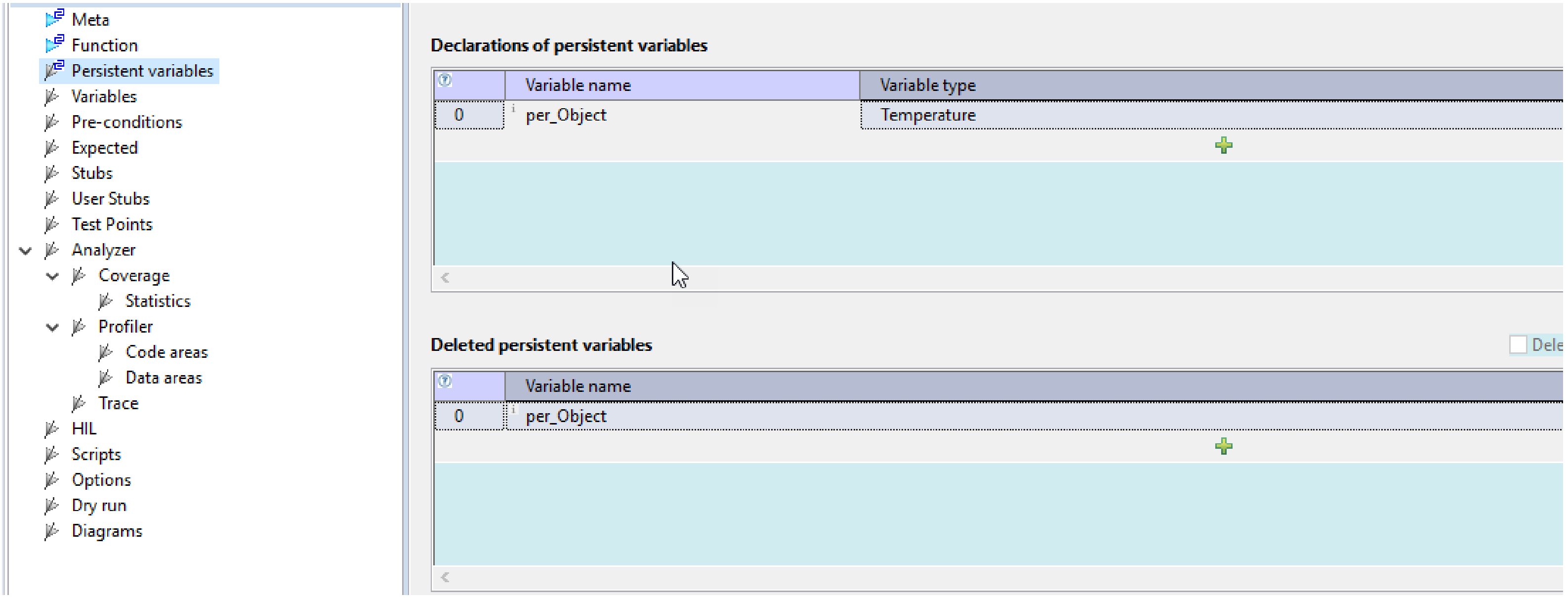
1 TESTING C++ CONSTRUCTORS - CREATE DERIVED TEST

It is possible to displays the list and datatypes of the parameters once again in this dialogue by selecting and then immediately deleting the function to be testing from the field *Function*.



1 TESTING C++ CONSTRUCTORS - CREATE DERIVED TEST

It is recommended to check the persistent variables once again after creating the derived test to ensure that the data has been inherited correctly.



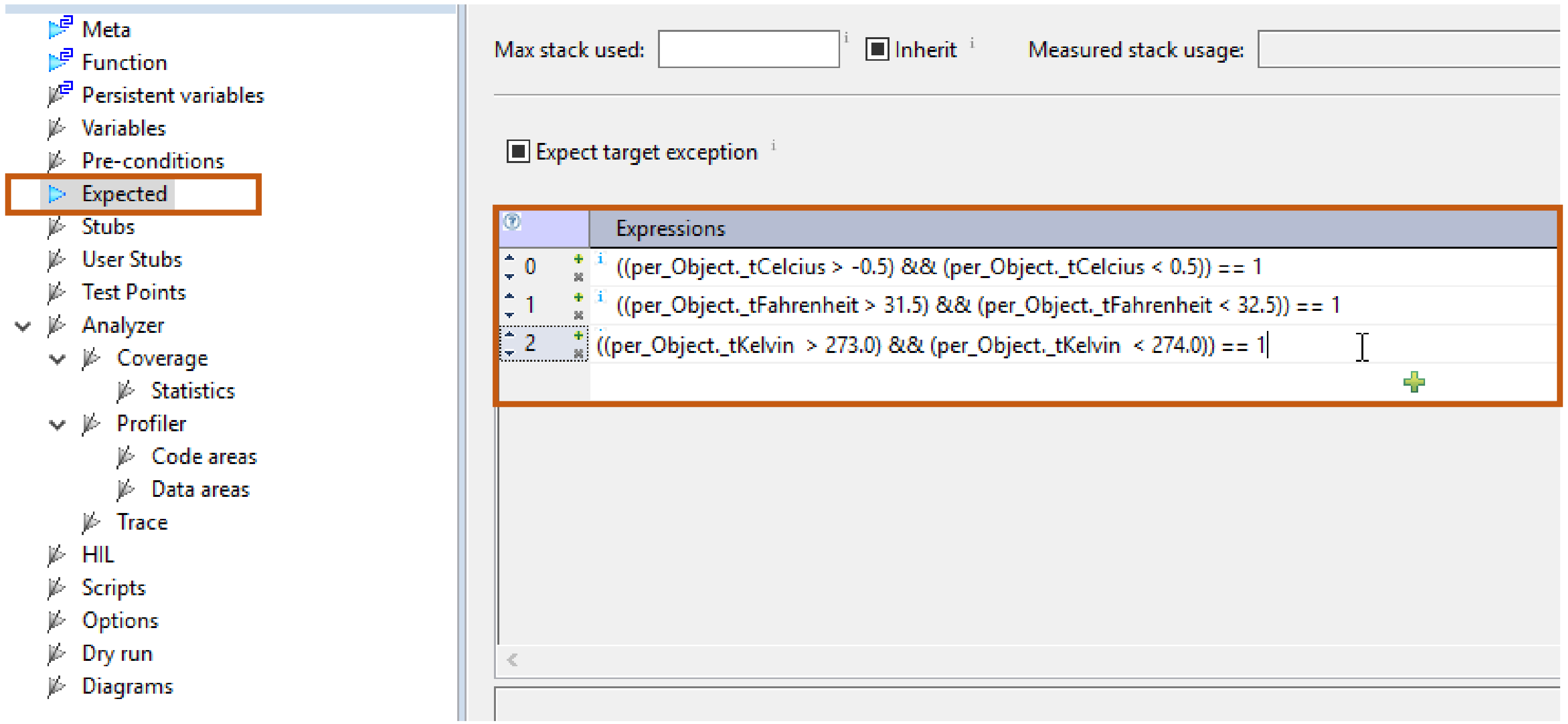
1 TESTING C++ CONSTRUCTORS - CREATE DERIVED TEST

We now have a structure for our test cases but we don't have any expected values to define the pass/fail criteria.

As the constructor does not return a result we instead need to check that the object (specifically its private variables) were correctly initialized. In the *Expected* field (as shown here) we have defined ranges for the expected results that we consider acceptable for a pass result.

Expressions for the *Expected* form can take any valid C/C++ form.

The private variables of the class can be accessed using dot-notation, i.e. *per_Object._tCelcius*.

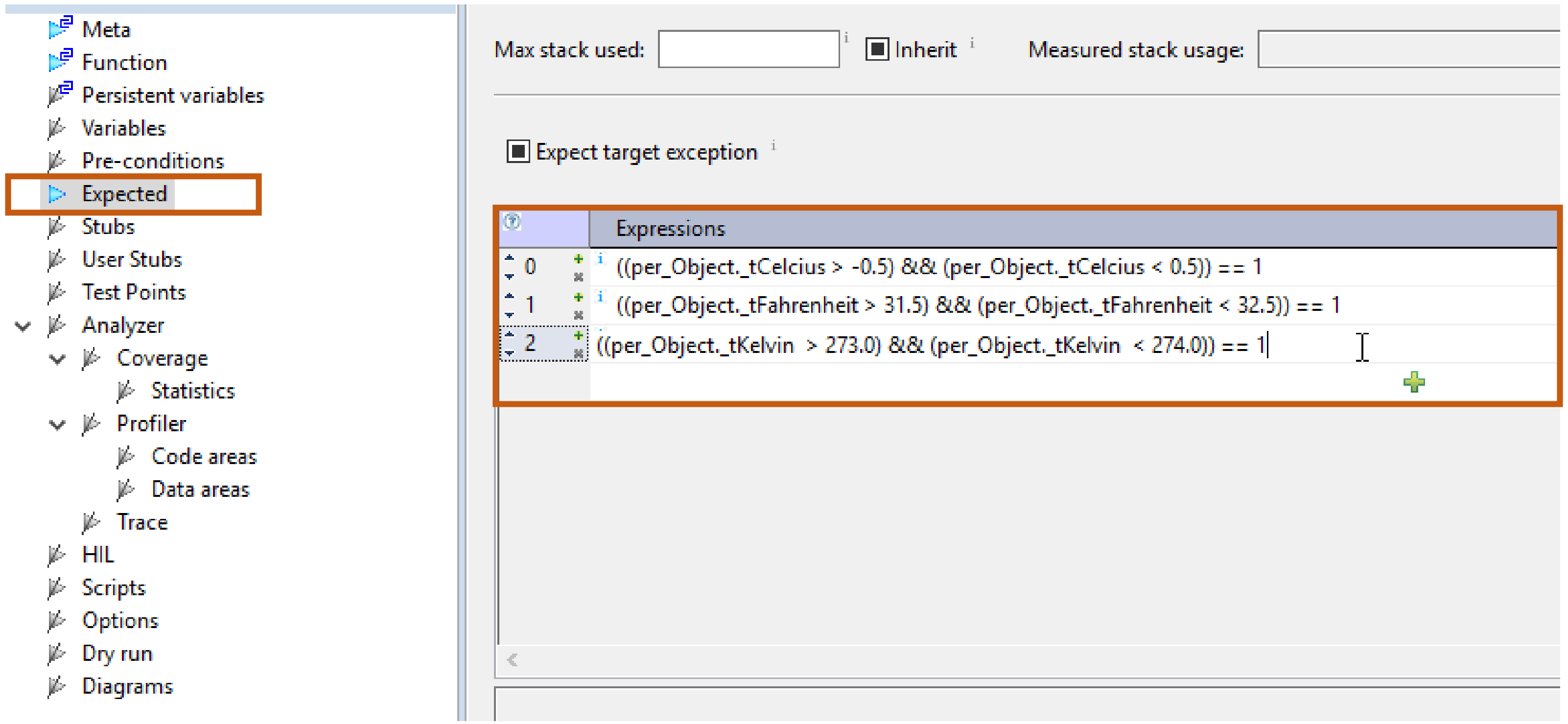


Normally, private members of a class are not accessible. However, via testIDEA, we have full access to the inner workings of classes. This is what enables us to test such code.

1 TESTING C++ CONSTRUCTORS - CREATE DERIVED TEST

Working with float values

For the purposes of testing, float values shouldn't be compared for strict equality.
Here we have chosen to test for a ± 0.5°C range around the desired float value allows for small errors caused by the datatype's representation limitations to be ignored.



1 TESTING C++ CONSTRUCTORS - CREATE A FEW MORE TESTS

Further tests are created with ease by using the *Table* view mode.

The easiest way to add further test vectors is to copy the parameters and the expected values of existing tests, changing the input parameters and expected results manually.

There is now a suite of tests that can be used to check the functionality of one of the class's constructors.

Tests for the remaining constructors can be created in a similar manner.

	func						
	func	params		retVal			
		0	1				0
0	Temperature::Temperature(float)						
1	Temperature::Temperature(float)	&per_Object	0.0				((per_Object._tCelcius > -0.5) && (per_Object._tCelcius < 0.5)) == 1
2	Temperature::Temperature(float)	&per_Object	10.8				((per_Object._tCelcius > 10.0) && (per_Object._tCelcius < 11.0)) == 1
3	Temperature::Temperature(float)	&per_Object	95.0				((per_Object._tCelcius > 94.5) && (per_Object._tCelcius < 95.5)) == 1
4	Temperature::Temperature(float)	&per_Object	-1.0				((per_Object._tCelcius > -1.5) && (per_Object._tCelcius < -0.5)) == 1
5	Temperature::Temperature(float)	&per_Object	-50.3				((per_Object._tCelcius > -51.0) && (per_Object._tCelcius < -50.0)) == 1
6	Temperature::Temperature(float)	&per_Object	-270.0				((per_Object._tCelcius > -270.5) && (per_Object._tCelcius < 269.5)) == 1

2 TESTING A C++ METHOD

In the previous test we only tested whether the constructor is constructing the object properly and if the private variables have been initialized correctly.

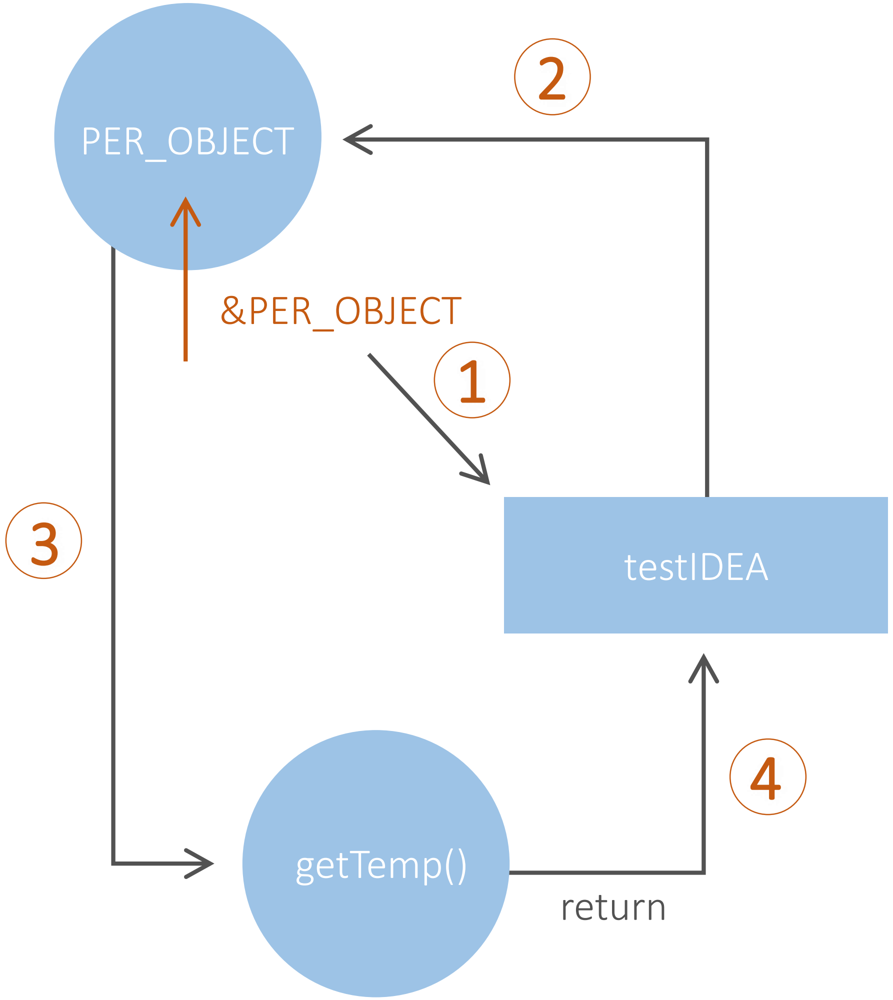
Now we want to test the class's *getTemperature()* method.

```
float Temperature::getTemperature() {
    return _tCelcius;
}

float Temperature::getTemperature(tTypes type) {
    float returnValue = 0.0;

    if (type == tTypes::tC) {
        returnValue = _tCelcius;
    } else if (type == tTypes::tF) {
        returnValue = _tFahrenheit;
    } else {
        /* Assume Kelvin value */
        returnValue = _tKelvin;
    }
    return returnValue;
}
```

2 TESTING A C++ METHOD - PROCESS

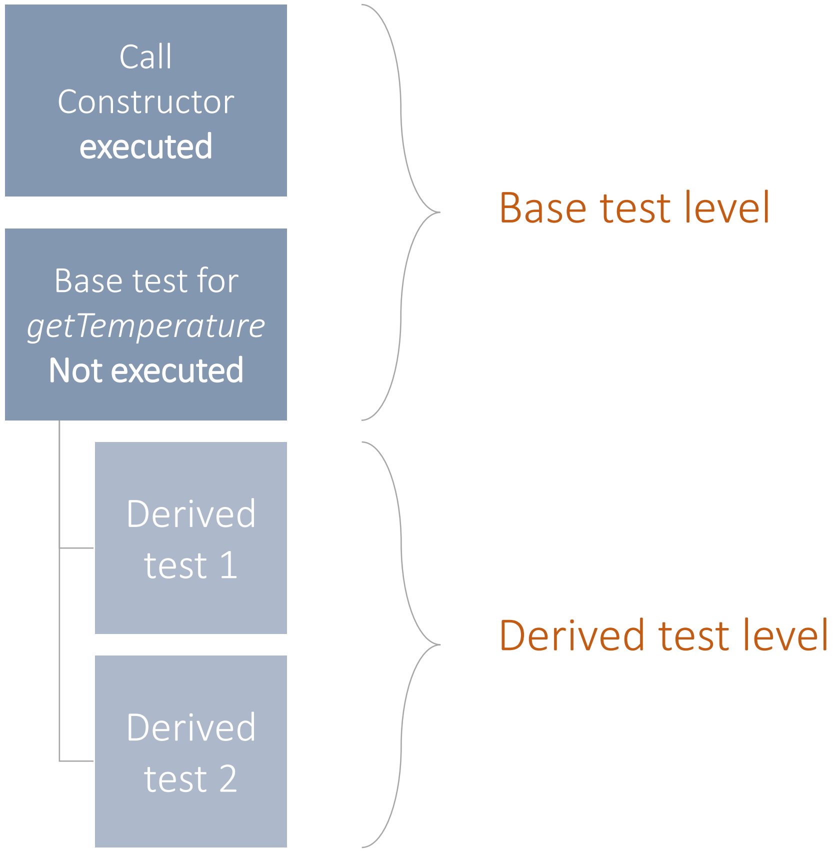
The process is very similar to that used to develop tests for C code but with the additional of a single extra step – the constructor needs to have been called before we can test any class methods.

The function *getTemperature()* simply returns the current temperature. Thus the test case can simply compare the returned value from the method with the value expected. The value expected, however, will depend on the current state of the internal private variables of the class – this will likely depend on the state they were left in after the previous test.



2 TESTING A C++ METHOD - TESTING CONCEPT

To test a C++ method it is recommended to work with the displayed structure of base and derived tests.

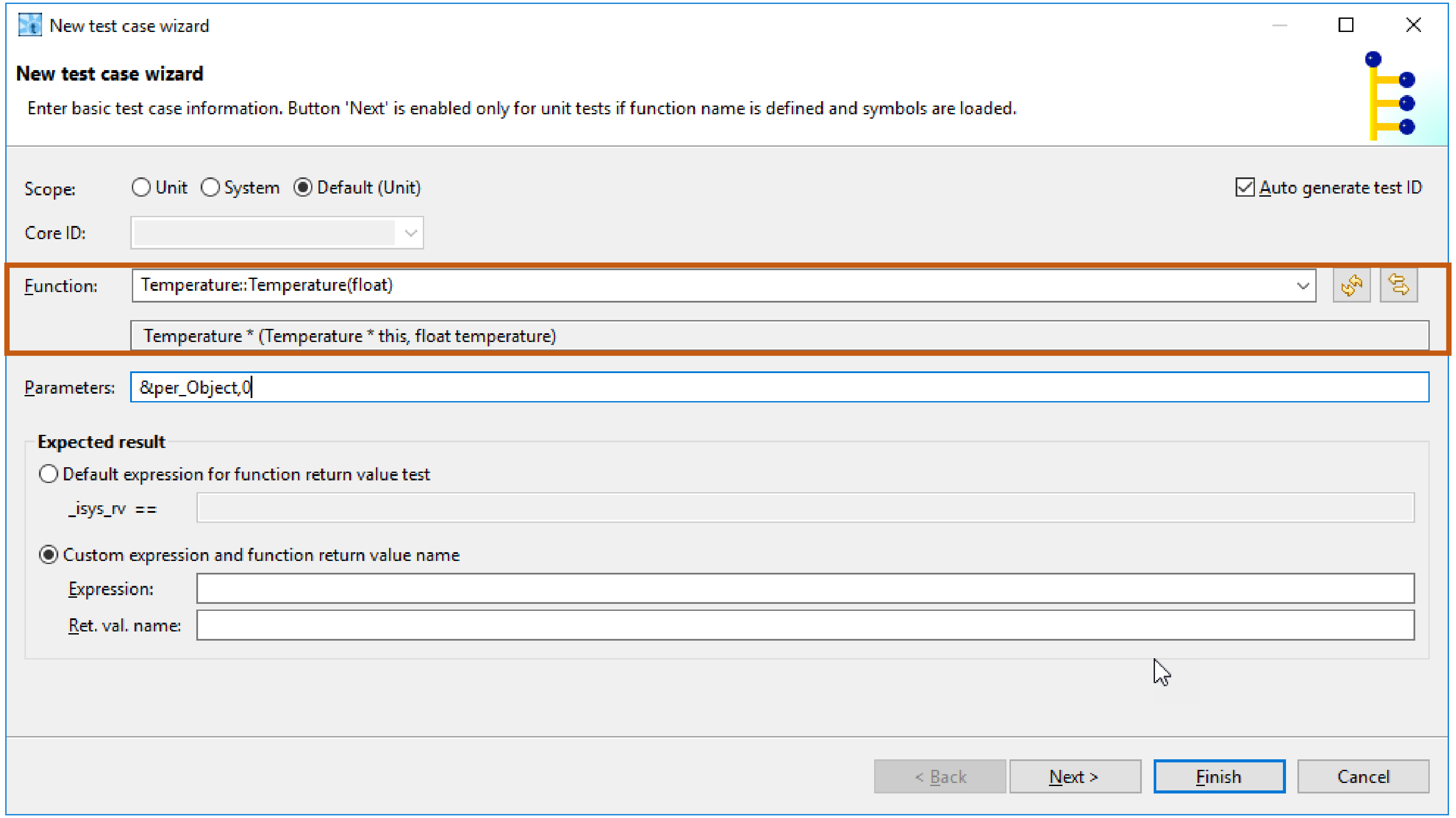


2 TESTING A C++ METHOD - CALL CONSTRUCTOR

For the **first test** we have to **call the C++ constructor** for the class. This is performed at base test level.

In this case we will use the constructor *Temperature::Temperature(float)*.

*This test case is not a base test but a regular test vector at base test level. So the **Execute** box in the meta data has to be left **Enabled**.*



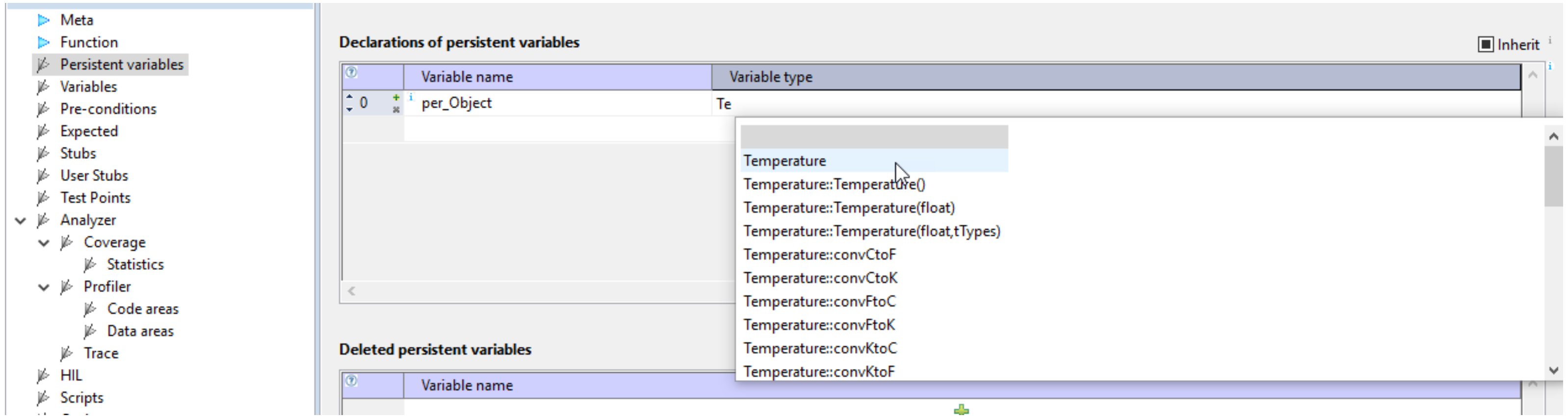
2 TESTING A C++ METHOD - CREATE & DELETE PERSISTENT VARIABLE

When testing a **C++ method** we again need to ensure there is a persistent variable *per_Object* created for use over the duration of testing. In the **first test that is to be executed** (in this case, the class constructor test) we define a variable of type *Temperature*.

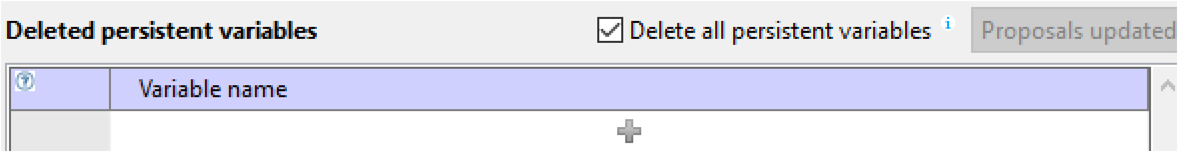
In the **very last derived test** we must **delete** the persistent variable again.

In this way we create a class object which will exist for the entire time of testing. The object's state is retained between tests and modified corresponding to the tests executed.

First executed test vector (call of class constructor):



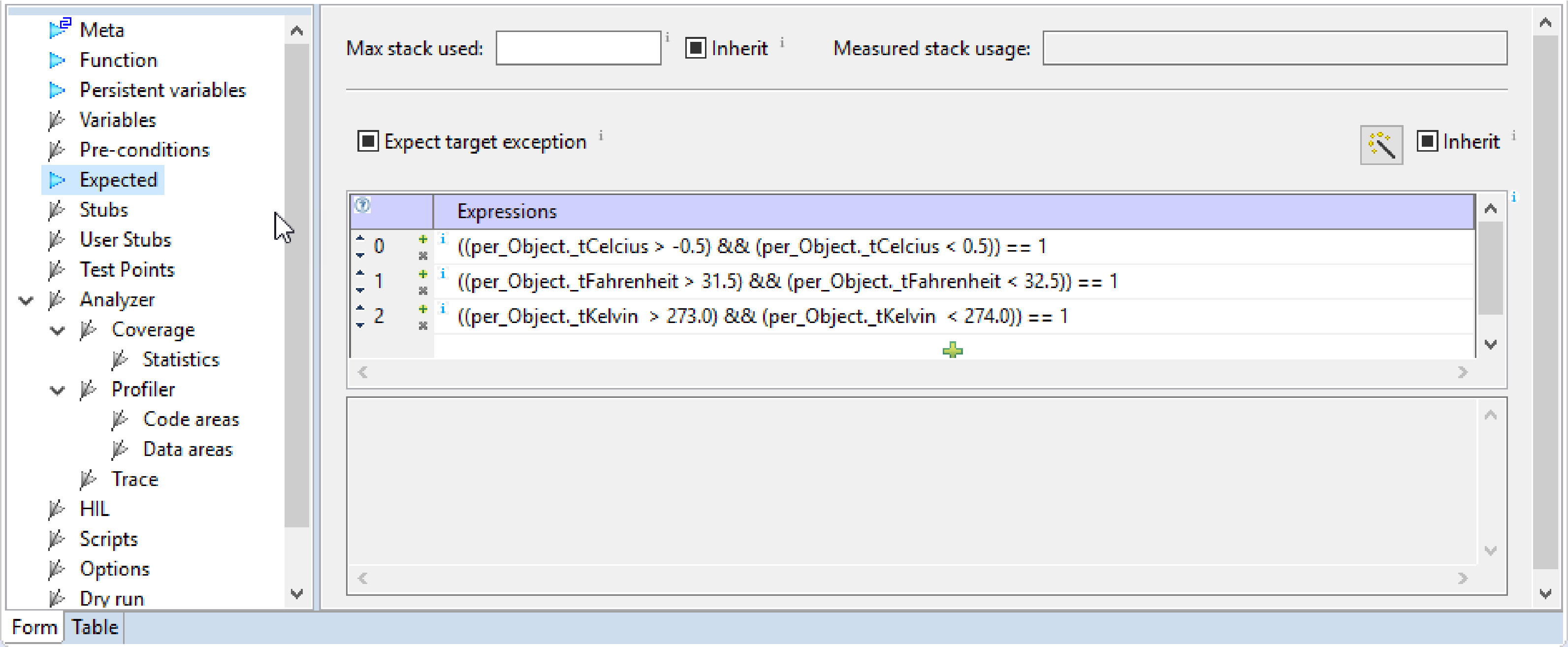
Very last test vector (last derived test for *getTemperature()*):



2 TESTING A C++ METHOD - TEST CONSTRUCTOR (OPTIONAL)

Optional: You may wish to test that the constructor initialized the object correctly by making sure that the internal values of the object correspond to 0.0°C.

If you have already tested the constructor elsewhere, this is not absolutely necessary. However, if you wish to include this pass/fail criteria again, it can be added as shown here.



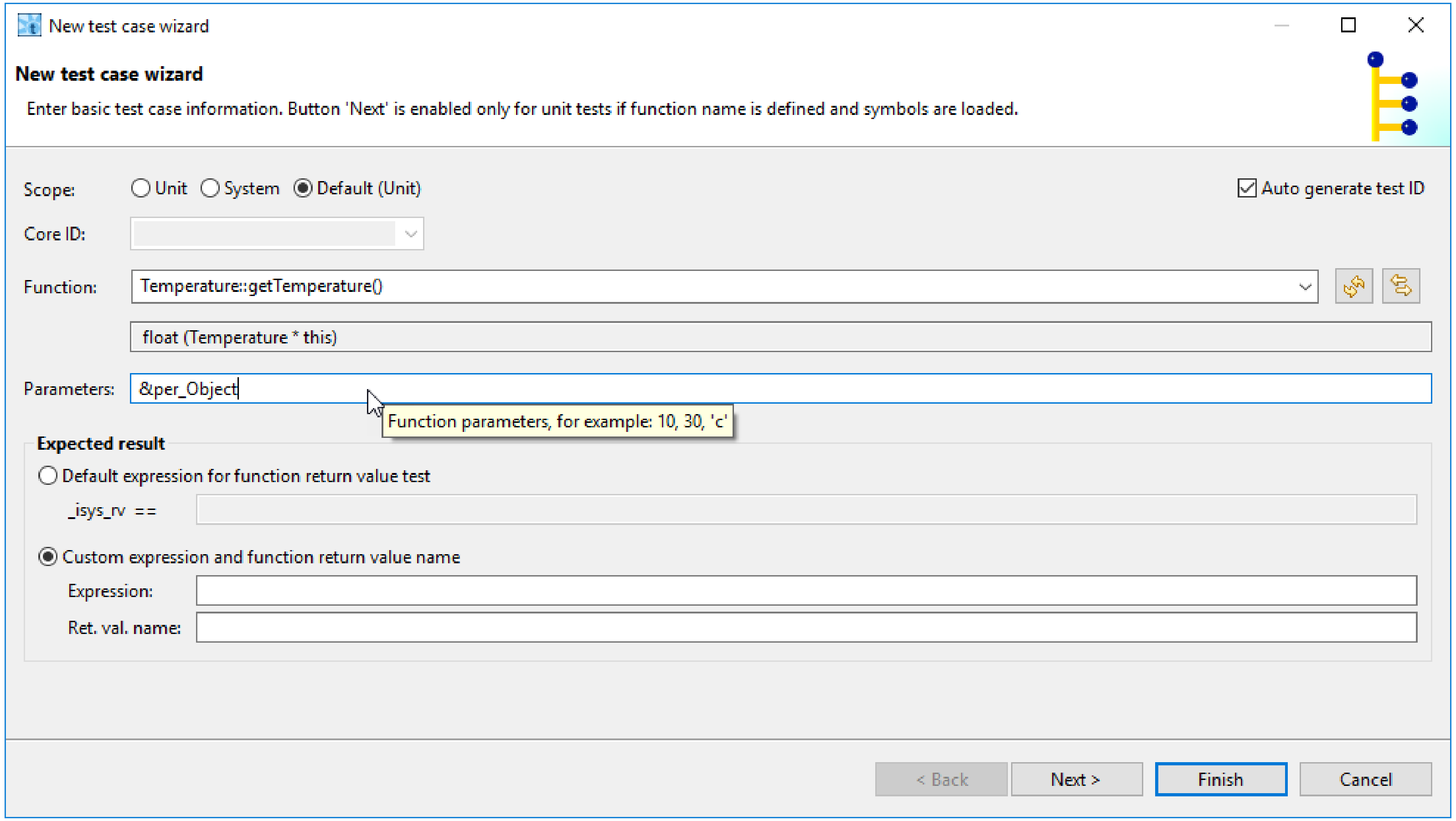
2 TESTING A C++ METHOD - CREATE A BASE TEST FOR THE METHOD

Next we will configure the base test for the *getTemperature()* method using the *New test case wizard*.

In the base test the parameter *&per_Object* is entered.

This reference to the parameter *&per_Object* is entered in the base test to enable inheritance of this parameter into all of the derived tests.

Once this base test is created (after clicking *Finish*), remember to clear the check box for the *Execute* option.

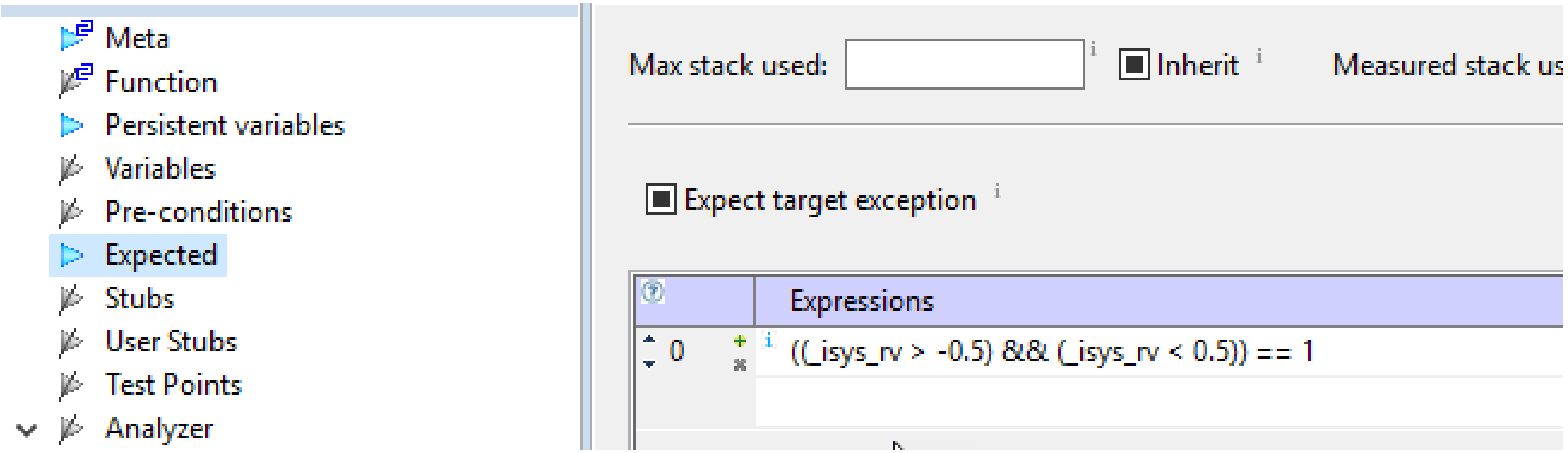


2 TESTING A C++ METHOD - CREATE A DERIVED TEST

The next step requires the creation of an executable derived test from the base test. Rather than enter information into the wizard, we have chosen here to enter the pass/fail criteria directly into the form fields.

After the initialization of the object with the default constructor, we expect 0.0°C as our return value for this first test.

In the *Expected* form we will again define a small acceptable range as our pass/fail criteria.



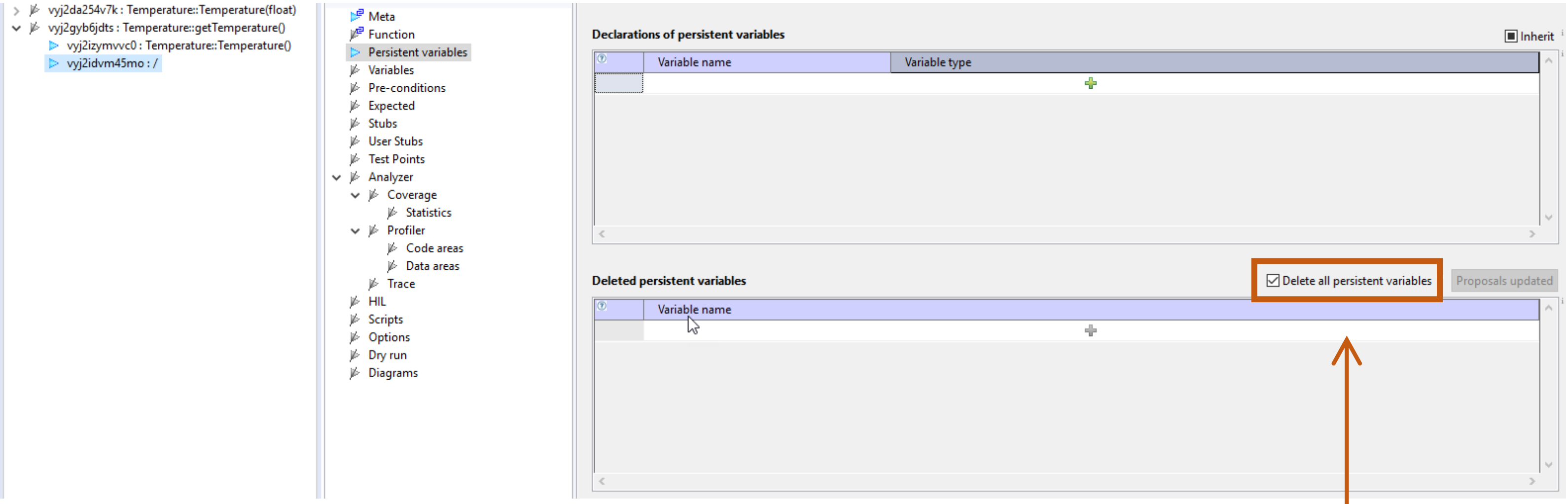
2 TESTING A C++ METHOD - DELETE PERSISTENT VARIABLE

Remember:

Ensure that the persistent variable is **deleted** at the end of the final derived test. To do this, select the last test in the group and configure it to delete all persistent variables at the end of testing.

This is really the key difference between testing C++ and C:

A class object must be created as a persistent variable that exists across several different tests, and variable needs to be deleted again upon completion of testing.



Now we are ready to execute our tests!

07

SUMMARY

testIDEA

3 SUMMARY

C++ constructors and methods - differences in testing

C++ CONSTRUCTOR	C++ METHOD
Define and delete persistent variable in each test	Define persistent variable in first executed test (constructor call)
	Delete persistent variable in final executed derived test