

Tang

0.1

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# Chapter 1

## Tang: A Template Language

### 1.1 Quick Description

**Tang** is a C++ Template Language. It takes the form of a library which may be included in other projects. It is under active development, and you can follow its progress here:

- [YouTube playlist](#)
- [GitHub repository](#)

### 1.2 Features

The following features are planned:

- Native support for Unicode/Utf-8 strings.
- Change from template to script mode using escape tags like PHP.
- Loosely typed, with Python-like indexing and slicing of containers.
- Syntax similar to C/C++/PHP.
- Code compiles to a custom Bytecode and is executed by the Tang VM.
- Fast and thread-safe.

### 1.3 License

MIT License

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## Chapter 2

# Hierarchical Index

### 2.1 Class Hierarchy

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## Chapter 3

# Class Index

### 3.1 Class List

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

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| <a href="#">Tang::AstNodeAdd</a>                     | An <a href="#">AstNode</a> that represents a "+" expression . . . . .   | 12 |
| <a href="#">Tang::AstNodeFloat</a>                   | An <a href="#">AstNode</a> that represents an float literal . . . . .   | 15 |
| <a href="#">Tang::AstNodeInteger</a>                 | An <a href="#">AstNode</a> that represents an integer literal . . . . .   | 18 |
| <a href="#">Tang::ComputedExpression</a>             | Represents the result of a computation that has been executed . . . . .   | 21 |
| <a href="#">Tang::ComputedExpressionError</a>        | Represents a Runtime <a href="#">Error</a> . . . . .  | 23 |
| <a href="#">Tang::ComputedExpressionFloat</a>        | Represents a Float that is the result of a computation . . . . .  | 27 |
| <a href="#">Tang::ComputedExpressionInteger</a>      | Represents an Integer that is the result of a computation . . . . .   | 31 |
| <a href="#">Tang::Error</a>                          | Used to report any error of the system, whether a syntax (parsing) error or a runtime (execution) error . . . . . | 34 |
| <a href="#">Tang::GarbageCollected</a>               | A container that acts as a resource-counting garbage collector for the specified type . . . . .                   | 36 |
| <a href="#">Tang::location</a>                       | Two points in a source file . . . . .   | 43 |
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## Chapter 4

# File Index

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## Chapter 5

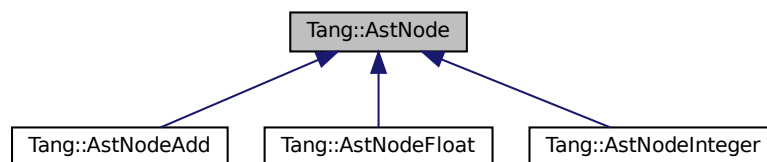
# Class Documentation

### 5.1 Tang::AstNode Class Reference

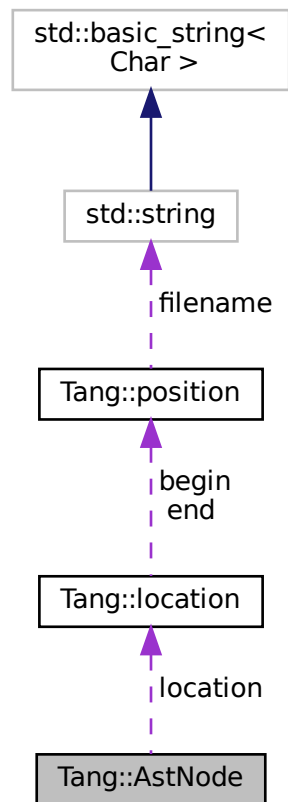
Base class for representing nodes of an Abstract Syntax Tree (AST).

```
#include <astNode.hpp>
```

Inheritance diagram for Tang::AstNode:



Collaboration diagram for Tang::AstNode:



## Public Member Functions

- virtual `~AstNode` ()  
*The object destructor.*
- virtual `std::string dump` (`std::string indent=""`) const  
*Return a string that describes the contents of the node.*
- virtual void `compile` (`Tang::Program &program`) const  
*Compile the ast of the provided `Tang::Program`.*
- virtual `AstNode * makeCopy` () const  
*Provide a copy of the `AstNode` (recursively, if appropriate).*

## Protected Member Functions

- `AstNode` (`Tang::location loc`)  
*The generic constructor.*

## Protected Attributes

- [Tang::location location](#)

*The location associated with this node.*

### 5.1.1 Detailed Description

Base class for representing nodes of an Abstract Syntax Tree (AST).

There will be *many* derived classes, each one conveying the syntactic meaning of the code that it represents.

### 5.1.2 Constructor & Destructor Documentation

#### 5.1.2.1 AstNode()

```
Tang::AstNode::AstNode (
    Tang::location loc ) [inline], [protected]
```

The generic constructor.

It should never be called on its own.

##### Parameters

|            |   |
|------------|---|
| <i>loc</i> | The location associated with this node. |
|------------|---|

### 5.1.3 Member Function Documentation

#### 5.1.3.1 makeCopy()

```
AstNode * AstNode::makeCopy ( ) const [virtual]
```

Provide a copy of the [AstNode](#) (recursively, if appropriate).

##### Returns

A pointer to a new [AstNode](#) that is a copy of the current [AstNode](#).

Reimplemented in [Tang::AstNodeInteger](#), [Tang::AstNodeFloat](#), and [Tang::AstNodeAdd](#).

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

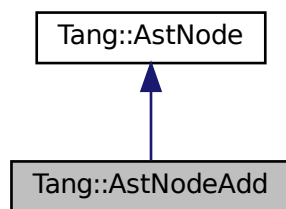
- include/[astNode.hpp](#)
- src/[astNode.cpp](#)

## 5.2 Tang::AstNodeAdd Class Reference

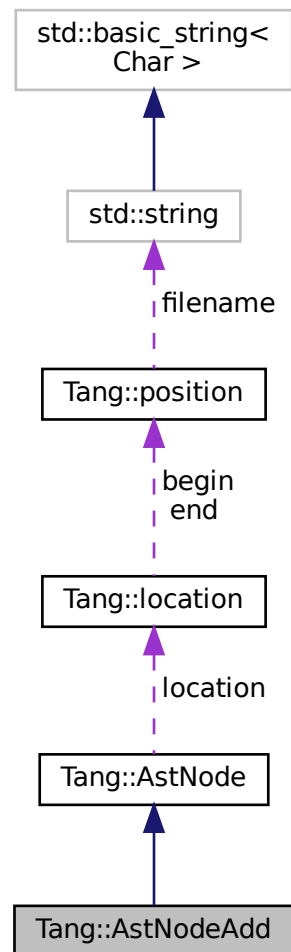
An [AstNode](#) that represents a "+" expression.

```
#include <astNodeAdd.hpp>
```

Inheritance diagram for Tang::AstNodeAdd:



Collaboration diagram for Tang::AstNodeAdd:



## Public Member Functions

- `AstNodeAdd` (`AstNode` \*lhs, `AstNode` \*rhs, `Tang::location` loc)  
*The constructor.*
- virtual `std::string` `dump` (`std::string` indent="") const override  
*Return a string that describes the contents of the node.*
- virtual void `compile` (`Tang::Program` &program) const override  
*Compile the ast of the provided `Tang::Program`.*
- virtual `AstNode` \* `makeCopy` () const override  
*Provide a copy of the `AstNode` (recursively, if appropriate).*

## Protected Attributes

- `Tang::location` `location`  
*The location associated with this node.*

## 5.2.1 Detailed Description

An [AstNode](#) that represents a "+" expression.

## 5.2.2 Constructor & Destructor Documentation

### 5.2.2.1 AstNodeAdd()

```
Tang::AstNodeAdd::AstNodeAdd (
    AstNode * lhs,
    AstNode * rhs,
    Tang::location loc ) [inline]
```

The constructor.

#### Parameters

|            |  |
|------------|--|
| <i>lhs</i> | The left hand side expression.   |
| <i>rhs</i> | The right hand side expression.  |
| <i>loc</i> | The location associated with the expression. @location The location associated with this node. |

## 5.2.3 Member Function Documentation

### 5.2.3.1 makeCopy()

```
AstNode * AstNodeAdd::makeCopy ( ) const [override], [virtual]
```

Provide a copy of the [AstNode](#) (recursively, if appropriate).

#### Returns

A pointer to a new [AstNode](#) that is a copy of the current [AstNode](#).

Reimplemented from [Tang::AstNode](#).

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

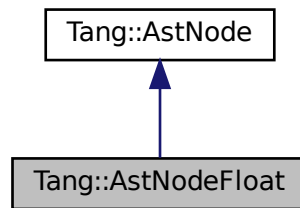
- include/[astNodeAdd.hpp](#)
- src/[astNodeAdd.cpp](#)

## 5.3 Tang::AstNodeFloat Class Reference

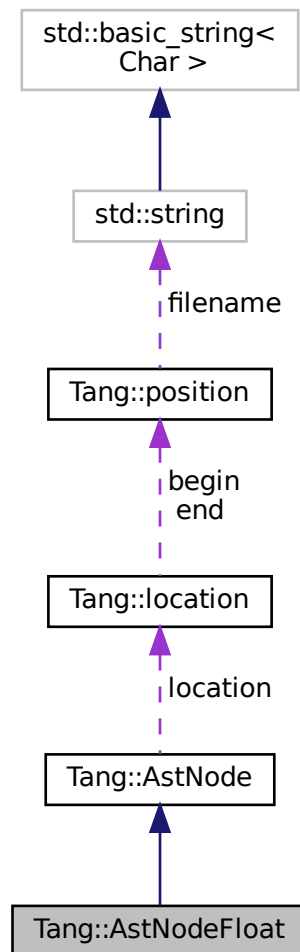
An [AstNode](#) that represents an float literal.

```
#include <astNodeFloat.hpp>
```

Inheritance diagram for Tang::AstNodeFloat:



Collaboration diagram for Tang::AstNodeFloat:



## Public Member Functions

- `AstNodeFloat` (double number, `Tang::location` loc)  
*The constructor.*
- virtual `std::string dump` (`std::string indent=""`) const override  
*Return a string that describes the contents of the node.*
- virtual void `compile` (`Tang::Program &program`) const override  
*Compile the ast of the provided `Tang::Program`.*
- virtual `AstNode * makeCopy` () const override  
*Provide a copy of the `AstNode` (recursively, if appropriate).*

## Protected Attributes

- `Tang::location location`  
*The location associated with this node.*



### 5.3.1 Detailed Description

An [AstNode](#) that represents an float literal.

Integers are represented by the `long double` type, and so are limited in range by that of the underlying type.

### 5.3.2 Constructor & Destructor Documentation

#### 5.3.2.1 AstNodeFloat()

```
Tang::AstNodeFloat::AstNodeFloat (
    double number,
    Tang::location loc ) [inline]
```

The constructor.

##### Parameters

|               |  |
|---------------|--|
| <i>number</i> | The number to represent.   |
| <i>loc</i>    | The location associated with the expression. @location The location associated with this node. |

### 5.3.3 Member Function Documentation

#### 5.3.3.1 makeCopy()

```
AstNode * AstNodeFloat::makeCopy ( ) const [override], [virtual]
```

Provide a copy of the [AstNode](#) (recursively, if appropriate).

##### Returns

A pointer to a new [AstNode](#) that is a copy of the current [AstNode](#).

Reimplemented from [Tang::AstNode](#).

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

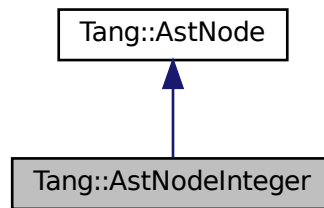
- include/[astNodeFloat.hpp](#)
- src/[astNodeFloat.cpp](#)

## 5.4 Tang::AstNodeInteger Class Reference

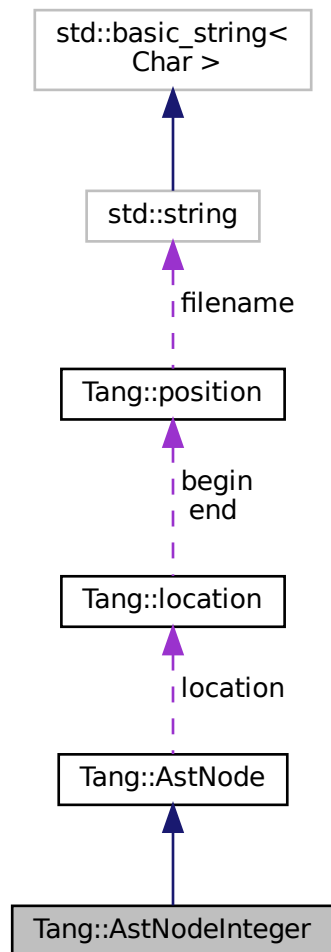
An [AstNode](#) that represents an integer literal.

```
#include <astNodeInteger.hpp>
```

Inheritance diagram for Tang::AstNodeInteger:



Collaboration diagram for Tang::AstNodeInteger:



## Public Member Functions

- [AstNodeInteger](#) (int64\_t number, [Tang::location](#) loc)  
*The constructor.*
- virtual std::string [dump](#) (std::string indent="") const override  
*Return a string that describes the contents of the node.*
- virtual void [compile](#) ([Tang::Program](#) &program) const override  
*Compile the ast of the provided [Tang::Program](#).*
- virtual [AstNode](#) \* [makeCopy](#) () const override  
*Provide a copy of the [AstNode](#) (recursively, if appropriate).*

## Protected Attributes

- [Tang::location](#) location  
*The location associated with this node.*

### 5.4.1 Detailed Description

An [AstNode](#) that represents an integer literal.

Integers are represented by the `int64_t` type, and so are limited in range by that of the underlying type.

### 5.4.2 Constructor & Destructor Documentation

#### 5.4.2.1 AstNodeInteger()

```
Tang::AstNodeInteger::AstNodeInteger (
    int64_t number,
    Tang::location loc ) [inline]
```

The constructor.

##### Parameters

|               |  |
|---------------|--|
| <i>number</i> | The number to represent.   |
| <i>loc</i>    | The location associated with the expression. @location The location associated with this node. |

### 5.4.3 Member Function Documentation

#### 5.4.3.1 makeCopy()

```
AstNode * AstNodeInteger::makeCopy ( ) const [override], [virtual]
```

Provide a copy of the [AstNode](#) (recursively, if appropriate).

##### Returns

A pointer to a new [AstNode](#) that is a copy of the current [AstNode](#).

Reimplemented from [Tang::AstNode](#).

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

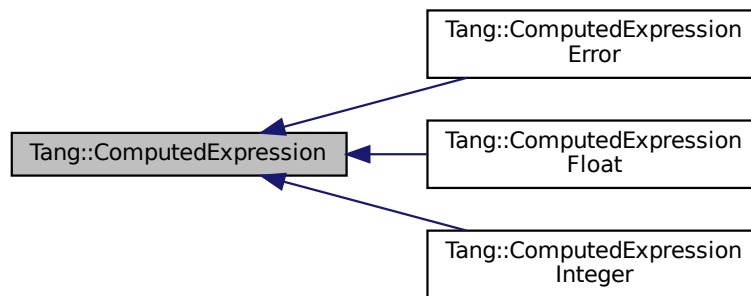
- include/[astNodeInteger.hpp](#)
- src/[astNodeInteger.cpp](#)

## 5.5 Tang::ComputedExpression Class Reference

Represents the result of a computation that has been executed.

```
#include <computedExpression.hpp>
```

Inheritance diagram for Tang::ComputedExpression:



### Public Member Functions

- virtual `~ComputedExpression ()`  
*The object destructor.*
- virtual `std::string dump () const`  
*Output the contents of the `ComputedExpression` as a string.*
- virtual `ComputedExpression * makeCopy () const`  
*Make a copy of the `ComputedExpression` (recursively, if appropriate).*
- virtual `bool is_equal (const int &val) const`  
*Check whether or not the computed expression is equal to another value.*
- virtual `bool is_equal (const double &val) const`  
*Check whether or not the computed expression is equal to another value.*
- virtual `GarbageCollected __add (const GarbageCollected &rhs) const`  
*Compute the result of adding this value and the supplied value.*

### 5.5.1 Detailed Description

Represents the result of a computation that has been executed.

### 5.5.2 Member Function Documentation

#### 5.5.2.1 \_\_add()

```
GarbageCollected ComputedExpression::__add (
    const GarbageCollected & rhs ) const [virtual]
```

Compute the result of adding this value and the supplied value.

#### Parameters

|            |  |
|------------|--|
| <i>rhs</i> | The <a href="#">GarbageCollected</a> value to add to this. |
|------------|--|

#### Returns

The result of the operation.

Reimplemented in [Tang::ComputedExpressionInteger](#), and [Tang::ComputedExpressionFloat](#).

#### 5.5.2.2 dump()

```
string ComputedExpression::dump ( ) const [virtual]
```

Output the contents of the [ComputedExpression](#) as a string.

#### Returns

A string representation of the computed expression.

Reimplemented in [Tang::ComputedExpressionInteger](#), [Tang::ComputedExpressionFloat](#), and [Tang::ComputedExpressionError](#).

#### 5.5.2.3 is\_equal() [1/2]

```
virtual bool Tang::ComputedExpression::is_equal (
    const double & val ) const [virtual]
```

Check whether or not the computed expression is equal to another value.

#### Parameters

|            |                               |
|------------|-------------------------------|
| <i>val</i> | The value to compare against. |
|------------|-------------------------------|

#### Returns

True if equal, false if not.

Reimplemented in [Tang::ComputedExpressionInteger](#), and [Tang::ComputedExpressionFloat](#).

#### 5.5.2.4 is\_equal() [2/2]

```
virtual bool Tang::ComputedExpression::is_equal (
    const int & val ) const [virtual]
```

Check whether or not the computed expression is equal to another value.

## Parameters

|            |                               |
|------------|-------------------------------|
| <i>val</i> | The value to compare against. |
|------------|-------------------------------|

## Returns

True if equal, false if not.

Reimplemented in [Tang::ComputedExpressionInteger](#), and [Tang::ComputedExpressionFloat](#).

### 5.5.2.5 makeCopy()

```
ComputedExpression * ComputedExpression::makeCopy ( ) const [virtual]
```

Make a copy of the [ComputedExpression](#) (recursively, if appropriate).

## Returns

A pointer to the new [ComputedExpression](#).

Reimplemented in [Tang::ComputedExpressionInteger](#), [Tang::ComputedExpressionFloat](#), and [Tang::ComputedExpressionError](#).

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

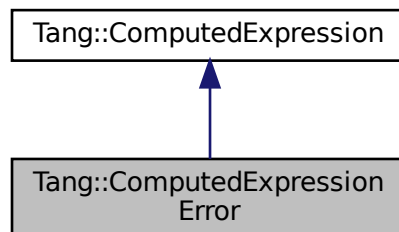
- [include/computedExpression.hpp](#)
- [src/computedExpression.cpp](#)

## 5.6 Tang::ComputedExpressionError Class Reference

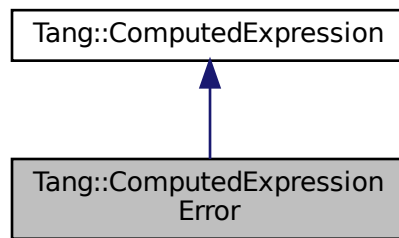
Represents a Runtime [Error](#).

```
#include <computedExpressionError.hpp>
```

Inheritance diagram for Tang::ComputedExpressionError:



Collaboration diagram for Tang::ComputedExpressionError:



## Public Member Functions

- [ComputedExpressionError](#) ([Tang::Error](#) error)  
*Construct a Runtime [Error](#).*
- virtual std::string [dump](#) () const override  
*Output the contents of the [ComputedExpression](#) as a string.*
- [ComputedExpression](#) \* [makeCopy](#) () const override  
*Make a copy of the [ComputedExpression](#) (recursively, if appropriate).*
- virtual bool [is\\_equal](#) (const int &val) const  
*Check whether or not the computed expression is equal to another value.*
- virtual bool [is\\_equal](#) (const double &val) const  
*Check whether or not the computed expression is equal to another value.*
- virtual [GarbageCollected](#) [\\_\\_add](#) (const [GarbageCollected](#) &rhs) const  
*Compute the result of adding this value and the supplied value.*

### 5.6.1 Detailed Description

Represents a Runtime [Error](#).

### 5.6.2 Constructor & Destructor Documentation

#### 5.6.2.1 ComputedExpressionError()

```
ComputedExpressionError::ComputedExpressionError (
    Tang::Error error )
```

Construct a Runtime [Error](#).



## Parameters

|              |   |
|--------------|---|
| <i>error</i> | The <a href="#">Tang::Error</a> object. |
|--------------|---|

### 5.6.3 Member Function Documentation

#### 5.6.3.1 \_\_add()

```
GarbageCollected ComputedExpression::__add (
    const GarbageCollected & rhs ) const [virtual], [inherited]
```

Compute the result of adding this value and the supplied value.

## Parameters

|            |  |
|------------|--|
| <i>rhs</i> | The <a href="#">GarbageCollected</a> value to add to this. |
|------------|--|

## Returns

The result of the operation.

Reimplemented in [Tang::ComputedExpressionInteger](#), and [Tang::ComputedExpressionFloat](#).

#### 5.6.3.2 dump()

```
std::string ComputedExpressionError::dump ( ) const [override], [virtual]
```

Output the contents of the [ComputedExpression](#) as a string.

## Returns

A string representation of the computed expression.

Reimplemented from [Tang::ComputedExpression](#).

#### 5.6.3.3 is\_equal() [1/2]

```
virtual bool Tang::ComputedExpression::is_equal (
    const double & val ) const [virtual], [inherited]
```

Check whether or not the computed expression is equal to another value.

**Parameters**

|            |                               |
|------------|-------------------------------|
| <i>val</i> | The value to compare against. |
|------------|-------------------------------|

**Returns**

True if equal, false if not.

Reimplemented in [Tang::ComputedExpressionInteger](#), and [Tang::ComputedExpressionFloat](#).

**5.6.3.4 is\_equal() [2/2]**

```
virtual bool Tang::ComputedExpression::is_equal (
    const int & val ) const [virtual], [inherited]
```

Check whether or not the computed expression is equal to another value.

**Parameters**

|            |                               |
|------------|-------------------------------|
| <i>val</i> | The value to compare against. |
|------------|-------------------------------|

**Returns**

True if equal, false if not.

Reimplemented in [Tang::ComputedExpressionInteger](#), and [Tang::ComputedExpressionFloat](#).

**5.6.3.5 makeCopy()**

```
ComputedExpression * ComputedExpressionError::makeCopy ( ) const [override], [virtual]
```

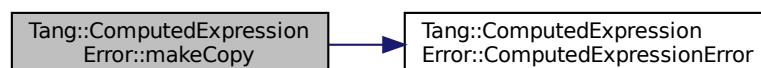
Make a copy of the [ComputedExpression](#) (recursively, if appropriate).

**Returns**

A pointer to the new [ComputedExpression](#).

Reimplemented from [Tang::ComputedExpression](#).

Here is the call graph for this function:



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

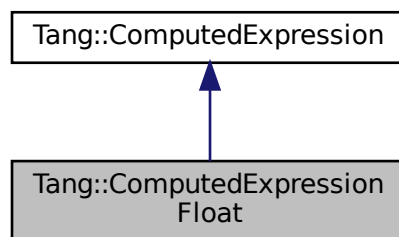
- [include/computedExpressionError.hpp](#)
- [src/computedExpressionError.cpp](#)

## 5.7 Tang::ComputedExpressionFloat Class Reference

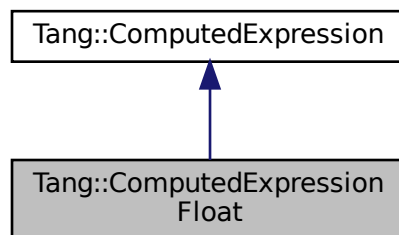
Represents a Float that is the result of a computation.

```
#include <computedExpressionFloat.hpp>
```

Inheritance diagram for Tang::ComputedExpressionFloat:



Collaboration diagram for Tang::ComputedExpressionFloat:



### Public Member Functions

- [ComputedExpressionFloat](#) (double val)  
*Construct a Float result.*
- virtual std::string [dump](#) () const override  
*Output the contents of the [ComputedExpression](#) as a string.*
- [ComputedExpression](#) \* [makeCopy](#) () const override  
*Make a copy of the [ComputedExpression](#) (recursively, if appropriate).*

- virtual bool `is_equal` (const int &val) const override  
*Check whether or not the computed expression is equal to another value.*
- virtual bool `is_equal` (const double &val) const override  
*Check whether or not the computed expression is equal to another value.*
- virtual `GarbageCollected __add` (const `GarbageCollected` &rhs) const override  
*Compute the result of adding this value and the supplied value.*

## Friends

- class `ComputedExpressionInteger`

### 5.7.1 Detailed Description

Represents a Float that is the result of a computation.

### 5.7.2 Constructor & Destructor Documentation

#### 5.7.2.1 ComputedExpressionFloat()

```
ComputedExpressionFloat::ComputedExpressionFloat (
    double val )
```

Construct a Float result.

#### Parameters

|            |                  |
|------------|------------------|
| <i>val</i> | The float value. |
|------------|------------------|

### 5.7.3 Member Function Documentation

#### 5.7.3.1 \_\_add()

```
GarbageCollected ComputedExpressionFloat::__add (
    const GarbageCollected & rhs ) const [override], [virtual]
```

Compute the result of adding this value and the supplied value.

#### Parameters

|            |   |
|------------|---|
| <i>rhs</i> | The <code>GarbageCollected</code> value to add to this. |
|------------|---|

**Returns**

The result of the operation.

Reimplemented from [Tang::ComputedExpression](#).

**5.7.3.2 dump()**

```
string ComputedExpressionFloat::dump ( ) const [override], [virtual]
```

Output the contents of the [ComputedExpression](#) as a string.

**Returns**

A string representation of the computed expression.

Reimplemented from [Tang::ComputedExpression](#).

**5.7.3.3 is\_equal() [1/2]**

```
bool ComputedExpressionFloat::is_equal (
    const double & val ) const [override], [virtual]
```

Check whether or not the computed expression is equal to another value.

**Parameters**

|            |                               |
|------------|-------------------------------|
| <i>val</i> | The value to compare against. |
|------------|-------------------------------|

**Returns**

True if equal, false if not.

Reimplemented from [Tang::ComputedExpression](#).

**5.7.3.4 is\_equal() [2/2]**

```
bool ComputedExpressionFloat::is_equal (
    const int & val ) const [override], [virtual]
```

Check whether or not the computed expression is equal to another value.

**Parameters**

|            |                               |
|------------|-------------------------------|
| <i>val</i> | The value to compare against. |
|------------|-------------------------------|

**Returns**

True if equal, false if not.

Reimplemented from [Tang::ComputedExpression](#).

**5.7.3.5 makeCopy()**

```
ComputedExpression * ComputedExpressionFloat::makeCopy ( ) const [override], [virtual]
```

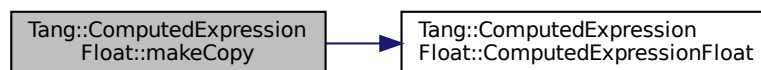
Make a copy of the [ComputedExpression](#) (recursively, if appropriate).

**Returns**

A pointer to the new [ComputedExpression](#).

Reimplemented from [Tang::ComputedExpression](#).

Here is the call graph for this function:



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

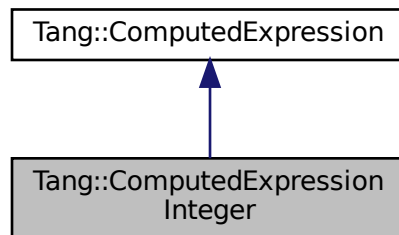
- [include/computedExpressionFloat.hpp](#)
- [src/computedExpressionFloat.cpp](#)

## 5.8 Tang::ComputedExpressionInteger Class Reference

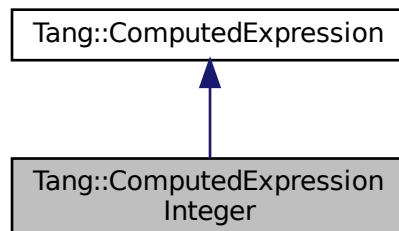
Represents an Integer that is the result of a computation.

```
#include <computedExpressionInteger.hpp>
```

Inheritance diagram for Tang::ComputedExpressionInteger:



Collaboration diagram for Tang::ComputedExpressionInteger:



### Public Member Functions

- [ComputedExpressionInteger](#) (int64\_t val)  
*Construct an Integer result.*
- virtual std::string [dump](#) () const override  
*Output the contents of the [ComputedExpression](#) as a string.*
- [ComputedExpression](#) \* [makeCopy](#) () const override  
*Make a copy of the [ComputedExpression](#) (recursively, if appropriate).*
- virtual bool [is\\_equal](#) (const int &val) const override  
*Check whether or not the computed expression is equal to another value.*
- virtual bool [is\\_equal](#) (const double &val) const override  
*Check whether or not the computed expression is equal to another value.*
- virtual [GarbageCollected](#) [\\_\\_add](#) (const [GarbageCollected](#) &rhs) const override  
*Compute the result of adding this value and the supplied value.*

## Friends

- class **ComputedExpressionFloat**

### 5.8.1 Detailed Description

Represents an Integer that is the result of a computation.

### 5.8.2 Constructor & Destructor Documentation

#### 5.8.2.1 ComputedExpressionInteger()

```
ComputedExpressionInteger::ComputedExpressionInteger (
    int64_t val )
```

Construct an Integer result.

##### Parameters

|            |                    |
|------------|--------------------|
| <i>val</i> | The integer value. |
|------------|--------------------|

### 5.8.3 Member Function Documentation

#### 5.8.3.1 \_\_add()

```
GarbageCollected ComputedExpressionInteger::__add (
    const GarbageCollected & rhs ) const [override], [virtual]
```

Compute the result of adding this value and the supplied value.

##### Parameters

|            |  |
|------------|--|
| <i>rhs</i> | The <a href="#">GarbageCollected</a> value to add to this. |
|------------|--|

##### Returns

The result of the operation.

Reimplemented from [Tang::ComputedExpression](#).



### 5.8.3.2 dump()

```
string ComputedExpressionInteger::dump ( ) const [override], [virtual]
```

Output the contents of the [ComputedExpression](#) as a string.

#### Returns

A string representation of the computed expression.

Reimplemented from [Tang::ComputedExpression](#).

### 5.8.3.3 is\_equal() [1/2]

```
bool ComputedExpressionInteger::is_equal (
    const double & val ) const [override], [virtual]
```

Check whether or not the computed expression is equal to another value.

#### Parameters

|            |                               |
|------------|-------------------------------|
| <i>val</i> | The value to compare against. |
|------------|-------------------------------|

#### Returns

True if equal, false if not.

Reimplemented from [Tang::ComputedExpression](#).

### 5.8.3.4 is\_equal() [2/2]

```
bool ComputedExpressionInteger::is_equal (
    const int & val ) const [override], [virtual]
```

Check whether or not the computed expression is equal to another value.

#### Parameters

|            |                               |
|------------|-------------------------------|
| <i>val</i> | The value to compare against. |
|------------|-------------------------------|

#### Returns

True if equal, false if not.

Reimplemented from [Tang::ComputedExpression](#).

### 5.8.3.5 makeCopy()

```
ComputedExpression * ComputedExpressionInteger::makeCopy ( ) const [override], [virtual]
```

Make a copy of the [ComputedExpression](#) (recursively, if appropriate).

#### Returns

A pointer to the new [ComputedExpression](#).

Reimplemented from [Tang::ComputedExpression](#).

Here is the call graph for this function:



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

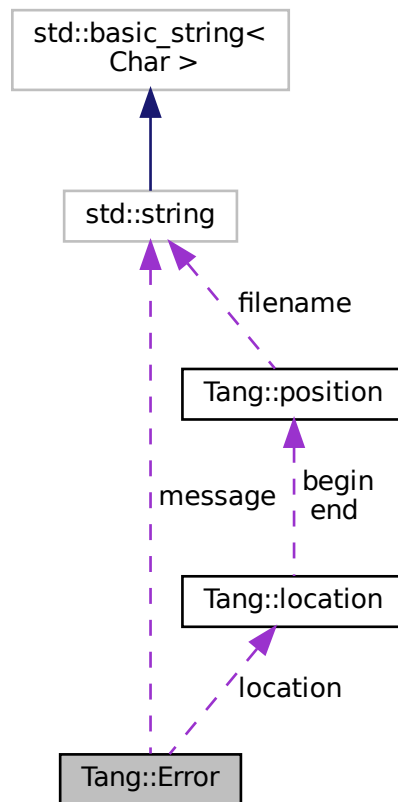
- [include/computedExpressionInteger.hpp](#)
- [src/computedExpressionInteger.cpp](#)

## 5.9 Tang::Error Class Reference

The [Error](#) class is used to report any error of the system, whether a syntax (parsing) error or a runtime (execution) error.

```
#include <error.hpp>
```

Collaboration diagram for Tang::Error:



## Public Member Functions

- [Error](#) ()  
*Creates an empty error message.*
- [Error](#) (std::string [message](#))  
*Creates an error message using the supplied error string and location.*
- [Error](#) (std::string [message](#), [Tang::location](#) [location](#))  
*Creates an error message using the supplied error string and location.*

## Public Attributes

- std::string [message](#)  
*The error message as a string.*
- [Tang::location](#) [location](#)  
*The location of the error.*

### 5.9.1 Detailed Description

The [Error](#) class is used to report any error of the system, whether a syntax (parsing) error or a runtime (execution) error.

### 5.9.2 Constructor & Destructor Documentation

#### 5.9.2.1 Error() [1/2]

```
Tang::Error::Error (
    std::string message ) [inline]
```

Creates an error message using the supplied error string and location.

##### Parameters

|                |                                |
|----------------|--------------------------------|
| <i>message</i> | The error message as a string. |
|----------------|--------------------------------|

#### 5.9.2.2 Error() [2/2]

```
Tang::Error::Error (
    std::string message,
    Tang::location location ) [inline]
```

Creates an error message using the supplied error string and location.

##### Parameters

|                 |                                |
|-----------------|--------------------------------|
| <i>message</i>  | The error message as a string. |
| <i>location</i> | The location of the error.     |

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

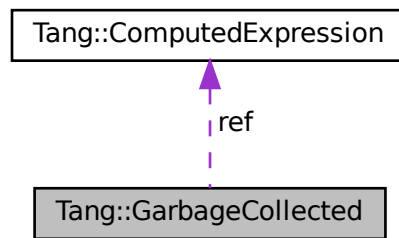
- [include/error.hpp](#)
- [src/error.cpp](#)

## 5.10 Tang::GarbageCollected Class Reference

A container that acts as a resource-counting garbage collector for the specified type.

```
#include <garbageCollected.hpp>
```

Collaboration diagram for Tang::GarbageCollected:



## Public Member Functions

- [GarbageCollected](#) (const [GarbageCollected](#) &other)  
*Copy Constructor.*
- [GarbageCollected](#) ([GarbageCollected](#) &&other)  
*Move Constructor.*
- [GarbageCollected](#) & [operator=](#) (const [GarbageCollected](#) &other)  
*Copy Assignment.*
- [GarbageCollected](#) & [operator=](#) ([GarbageCollected](#) &&other)  
*Move Assignment.*
- [~GarbageCollected](#) ()  
*Destructor.*
- [ComputedExpression](#) \* [operator->](#) () const  
*Access the tracked object as a pointer.*
- [ComputedExpression](#) & [operator\\*](#) () const  
*Access the tracked object.*
- bool [operator==](#) (const int &val) const  
*Compare the [GarbageCollected](#) tracked object with a supplied value.*
- bool [operator==](#) (const double &val) const  
*Compare the [GarbageCollected](#) tracked object with a supplied value.*
- [GarbageCollected](#) [operator+](#) (const [GarbageCollected](#) &lhs) const

## Static Public Member Functions

- template<class T , typename... Args>  
static [GarbageCollected](#) [make](#) (Args... args)  
*Creates a garbage-collected object of the specified type.*

## Protected Member Functions

- [GarbageCollected](#) ()  
*Constructs a garbage-collected object of the specified type.*

## Protected Attributes

- `size_t * count`  
*The count of references to the tracked object.*
- `ComputedExpression * ref`  
*A reference to the tracked object.*
- `std::function< void(void)> recycle`  
*A cleanup function to recycle the object.*

## Friends

- `std::ostream & operator<< (std::ostream &out, const GarbageCollected &gc)`  
*Add friendly output.*

### 5.10.1 Detailed Description

A container that acts as a resource-counting garbage collector for the specified type.

Uses the [SingletonObjectPool](#) to created and recycle object memory. The container is not thread-safe.

### 5.10.2 Constructor & Destructor Documentation

#### 5.10.2.1 GarbageCollected() [1/3]

```
Tang::GarbageCollected::GarbageCollected (
    const GarbageCollected & other ) [inline]
```

Copy Constructor.

##### Parameters

|            |  |
|------------|--|
| <i>The</i> | other <a href="#">GarbageCollected</a> object to copy. |
|------------|--|

#### 5.10.2.2 GarbageCollected() [2/3]

```
Tang::GarbageCollected::GarbageCollected (
    GarbageCollected && other ) [inline]
```

Move Constructor.

## Parameters

|            |  |
|------------|--|
| <i>The</i> | other <a href="#">GarbageCollected</a> object to move. |
|------------|--|

**5.10.2.3 ~GarbageCollected()**

```
Tang::GarbageCollected::~~GarbageCollected ( ) [inline]
```

Destructor.

Clean up the tracked object, if appropriate.

**5.10.2.4 GarbageCollected() [3/3]**

```
Tang::GarbageCollected::GarbageCollected ( ) [inline], [protected]
```

Constructs a garbage-collected object of the specified type.

It is private so that a [GarbageCollected](#) object can only be created using the [GarbageCollected::make\(\)](#) function.

## Parameters

|                 |   |
|-----------------|---|
| <i>variable</i> | The arguments to pass to the constructor of the specified type. |
|-----------------|---|

**5.10.3 Member Function Documentation****5.10.3.1 make()**

```
template<class T , typename... Args>
static GarbageCollected Tang::GarbageCollected::make (
    Args... args ) [inline], [static]
```

Creates a garbage-collected object of the specified type.

## Parameters

|                 |   |
|-----------------|---|
| <i>variable</i> | The arguments to pass to the constructor of the specified type. |
|-----------------|---|

## Returns

A [GarbageCollected](#) object.

Here is the call graph for this function:



### 5.10.3.2 operator\*()

```
ComputedExpression& Tang::GarbageCollected::operator* ( ) const [inline]
```

Access the tracked object.

#### Returns

A reference to the tracked object.

### 5.10.3.3 operator->()

```
ComputedExpression* Tang::GarbageCollected::operator-> ( ) const [inline]
```

Access the tracked object as a pointer.

#### Returns

A pointer to the tracked object.

### 5.10.3.4 operator=() [1/2]

```
GarbageCollected& Tang::GarbageCollected::operator= (
    const GarbageCollected & other ) [inline]
```

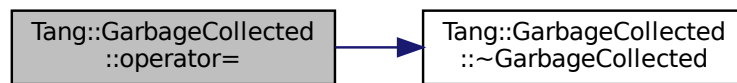
Copy Assignment.

#### Parameters

|            |   |
|------------|---|
| <i>The</i> | other <code>GarbageCollected</code> object. |
|------------|---|



Here is the call graph for this function:



#### 5.10.3.5 operator=() [2/2]

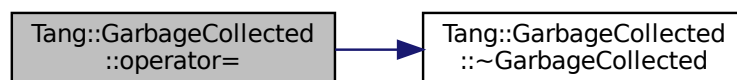
```
GarbageCollected& Tang::GarbageCollected::operator= (
    GarbageCollected && other ) [inline]
```

Move Assignment.

##### Parameters

|            |  |
|------------|--|
| <i>The</i> | other <a href="#">GarbageCollected</a> object. |
|------------|--|

Here is the call graph for this function:



#### 5.10.3.6 operator==( ) [1/2]

```
bool GarbageCollected::operator==(
    const double & val ) const
```

Compare the [GarbageCollected](#) tracked object with a supplied value.

##### Parameters

|            |  |
|------------|--|
| <i>val</i> | The value to compare the tracked object against. |
|------------|--|

**Returns**

True if they are equal, false otherwise.

**5.10.3.7 operator==( ) [2/2]**

```
bool GarbageCollected::operator== (
    const int & val ) const
```

Compare the [GarbageCollected](#) tracked object with a supplied value.

**Parameters**

|            |  |
|------------|--|
| <i>val</i> | The value to compare the tracked object against. |
|------------|--|

**Returns**

True if they are equal, false otherwise.

**5.10.4 Friends And Related Function Documentation****5.10.4.1 operator<<**

```
std::ostream& operator<< (
    std::ostream & out,
    const GarbageCollected & gc ) [friend]
```

Add friendly output.

**Parameters**

|            |   |
|------------|---|
| <i>out</i> | The output stream.                          |
| <i>gc</i>  | The <a href="#">GarbageCollected</a> value. |

**Returns**

The output stream.

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

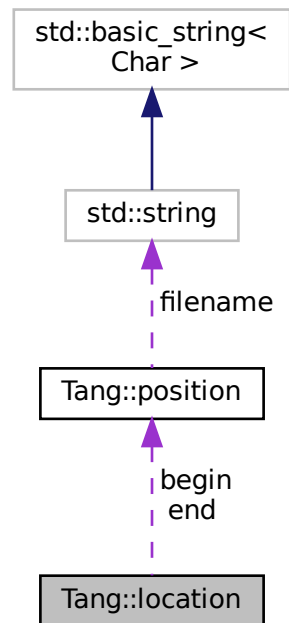
- [include/garbageCollected.hpp](#)
- [src/garbageCollected.cpp](#)

## 5.11 Tang::location Class Reference

Two points in a source file.

```
#include <location.hh>
```

Collaboration diagram for Tang::location:



### Public Types

- typedef `position::filename_type filename_type`  
*Type for file name.*
- typedef `position::counter_type counter_type`  
*Type for line and column numbers.*

### Public Member Functions

- `location` (const `position` &b, const `position` &e)  
*Construct a location from b to e.*
- `location` (const `position` &p=`position`())  
*Construct a 0-width location in p.*
- `location` (`filename_type` \*f, `counter_type` l=1, `counter_type` c=1)  
*Construct a 0-width location in f, l, c.*
- void `initialize` (`filename_type` \*f=((void \*) 0), `counter_type` l=1, `counter_type` c=1)  
*Initialization.*

### Line and Column related manipulators

- void `step` ()  
*Reset initial location to final location.*
- void `columns` (`counter_type` count=1)  
*Extend the current location to the COUNT next columns.*
- void `lines` (`counter_type` count=1)  
*Extend the current location to the COUNT next lines.*

### Public Attributes

- `position begin`  
*Beginning of the located region.*
- `position end`  
*End of the located region.*

#### 5.11.1 Detailed Description

Two points in a source file.

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

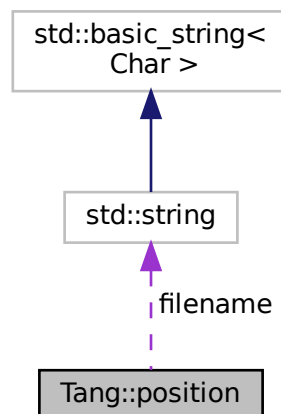
- build/generated/[location.hh](#)

## 5.12 Tang::position Class Reference

A point in a source file.

```
#include <location.hh>
```

Collaboration diagram for Tang::position:



## Public Types

- typedef const std::string [filename\\_type](#)  
*Type for file name.*
- typedef int [counter\\_type](#)  
*Type for line and column numbers.*

## Public Member Functions

- [position](#) ([filename\\_type](#) \*f=((void \*) 0), [counter\\_type](#) l=1, [counter\\_type](#) c=1)  
*Construct a position.*
- void [initialize](#) ([filename\\_type](#) \*fn=((void \*) 0), [counter\\_type](#) l=1, [counter\\_type](#) c=1)  
*Initialization.*

### Line and Column related manipulators

- void [lines](#) ([counter\\_type](#) count=1)  
*(line related) Advance to the COUNT next lines.*
- void [columns](#) ([counter\\_type](#) count=1)  
*(column related) Advance to the COUNT next columns.*

## Public Attributes

- [filename\\_type](#) \* [filename](#)  
*File name to which this position refers.*
- [counter\\_type](#) [line](#)  
*Current line number.*
- [counter\\_type](#) [column](#)  
*Current column number.*

### 5.12.1 Detailed Description

A point in a source file.

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

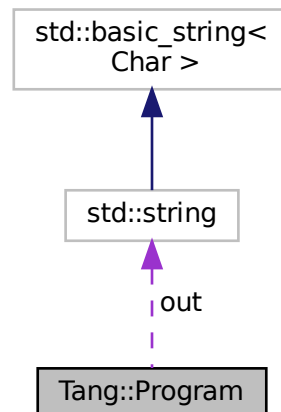
- build/generated/[location.hh](#)

## 5.13 Tang::Program Class Reference

Represents a compiled script or template that may be executed.

```
#include <program.hpp>
```

Collaboration diagram for Tang::Program:



### Public Types

- enum [CodeType](#) { [Script](#) , [Template](#) }  
Indicate the type of code that was supplied to the [Program](#).

### Public Member Functions

- [Program](#) (std::string code, [CodeType](#) codeType)  
Create a compiled program using the provided code.
- [~Program](#) ()  
The [Program](#) Destructor.
- [Program](#) (const [Program](#) &program)  
The Copy Constructor.
- [Program](#) & [operator=](#) (const [Program](#) &program)  
The Copy Assignment operator.
- [Program](#) ([Program](#) &&program)  
The Move Constructor.
- [Program](#) & [operator=](#) ([Program](#) &&program)  
The Move Assignment operator.
- std::string [getCode](#) () const  
Get the code that was provided when the [Program](#) was created.
- std::optional< const [AstNode](#) \* > [getAst](#) () const  
Get the AST that was generated by the parser.

- `std::string dumpBytecode () const`  
*Get the Opcodes of the compiled program, formatted like Assembly.*
- `std::optional< const GarbageCollected > getResult () const`  
*Get the result of the [Program](#) execution, if it exists.*
- `void addBytecode (uint64_t)`  
*Add a `uint64_t` to the Bytecode.*
- `Program & execute ()`  
*Execute the program's Bytecode, and return the current [Program](#) object.*

## Public Attributes

- `std::string out`  
*The output of the program, resulting from the program execution.*

### 5.13.1 Detailed Description

Represents a compiled script or template that may be executed.

### 5.13.2 Member Enumeration Documentation

#### 5.13.2.1 CodeType

```
enum Tang::Program::CodeType
```

Indicate the type of code that was supplied to the [Program](#).

Enumerator

|          |   |
|----------|---|
| Script   | The code is pure Tang script, without any templating. |
| Template | The code is a template.                               |

### 5.13.3 Constructor & Destructor Documentation

#### 5.13.3.1 Program()

```
Program::Program (
    std::string code,
    Program::CodeType codeType )
```

Create a compiled program using the provided code.

## Parameters

|                 |  |
|-----------------|--|
| <i>code</i>     | The code to be compiled.                                 |
| <i>codeType</i> | Whether the code is a <i>Script</i> or <i>Template</i> . |

## 5.13.4 Member Function Documentation

### 5.13.4.1 addBytecode()

```
void Program::addBytecode (
    uint64_t op )
```

Add a `uint64_t` to the Bytecode.

## Parameters

|           |                                   |
|-----------|-----------------------------------|
| <i>op</i> | The value to add to the Bytecode. |
|-----------|-----------------------------------|

### 5.13.4.2 dumpBytecode()

```
string Program::dumpBytecode ( ) const
```

Get the Opcodes of the compiled program, formatted like Assembly.

## Returns

A string containing the Opcode representation.

### 5.13.4.3 execute()

```
Program & Program::execute ( )
```

Execute the program's Bytecode, and return the current [Program](#) object.

## Returns

The current [Program](#) object.



#### 5.13.4.4 getAst()

```
optional< const AstNode * > Program::getAst ( ) const
```

Get the AST that was generated by the parser.

The parser may have failed, so the return is an `optional<>` type. If the compilation failed, check `Program::error`.

##### Returns

A pointer to the AST, if it exists.

#### 5.13.4.5 getCode()

```
string Program::getCode ( ) const
```

Get the code that was provided when the `Program` was created.

##### Returns

The source code from which the `Program` was created.

#### 5.13.4.6 getResult()

```
optional< const GarbageCollected > Program::getResult ( ) const
```

Get the result of the `Program` execution, if it exists.

##### Returns

The result of the `Program` execution, if it exists.

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

- `include/program.hpp`
- `src/program.cpp`

## 5.14 Tang::SingletonObjectPool< T > Class Template Reference

### Public Member Functions

- `T * get ( )`  
*Request an uninitialized memory location from the pool for an object T.*
- `void recycle ( T *obj)`  
*Recycle a memory location for an object T.*
- `~SingletonObjectPool ( )`  
*Destructor.*

## Static Public Member Functions

- static `SingletonObjectPool< T > & getInstance ()`  
*Get the singleton instance of the object pool.*

### 5.14.1 Member Function Documentation

#### 5.14.1.1 get()

```
template<class T >
T* Tang::SingletonObjectPool< T >::get ( ) [inline]
```

Request an uninitialized memory location from the pool for an object T.

##### Returns

An uninitialized memory location for an object T.

#### 5.14.1.2 getInstance()

```
template<class T >
static SingletonObjectPool<T>& Tang::SingletonObjectPool< T >::getInstance ( ) [inline],
[static]
```

Get the singleton instance of the object pool.

##### Returns

The singleton instance of the object pool.

#### 5.14.1.3 recycle()

```
template<class T >
void Tang::SingletonObjectPool< T >::recycle (
    T * obj ) [inline]
```

Recycle a memory location for an object T.

##### Parameters

|            |                                 |
|------------|---------------------------------|
| <i>obj</i> | The memory location to recycle. |
|------------|---------------------------------|

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

- [include/singletonObjectPool.hpp](#)

## 5.15 Tang::TangBase Class Reference

The base class for the Tang programming language.

```
#include <tangBase.hpp>
```

### Public Member Functions

- [TangBase](#) ()  
*The constructor.*
- [Program compileScript](#) (std::string script)  
*Compile the provided source code as a script and return a [Program](#).*

### 5.15.1 Detailed Description

The base class for the Tang programming language.

This class is the fundamental starting point to compile and execute a Tang program. It may be considered in three parts:

1. It acts as an extendable interface through which additional "library" functions can be added to the language. It is intentionally designed that each instance of [TangBase](#) will have its own library functions.
2. It provides methods to compile scripts and templates, resulting in a [Program](#) object.
3. The [Program](#) object may then be executed, providing instance-specific context information (*i.e.*, state).

### 5.15.2 Constructor & Destructor Documentation

#### 5.15.2.1 TangBase()

```
TangBase::TangBase ( )
```

The constructor.

Isn't it glorious.

### 5.15.3 Member Function Documentation

#### 5.15.3.1 compileScript()

```
Program TangBase::compileScript (
    std::string script )
```

Compile the provided source code as a script and return a [Program](#).

**Parameters**

|               |                                 |
|---------------|---------------------------------|
| <i>script</i> | The Tang script to be compiled. |
|---------------|---------------------------------|

**Returns**

The [Program](#) object representing the compiled script.

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

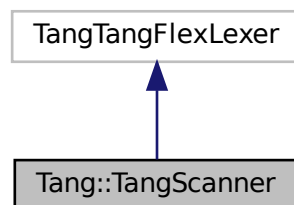
- [include/tangBase.hpp](#)
- [src/tangBase.cpp](#)

## 5.16 Tang::TangScanner Class Reference

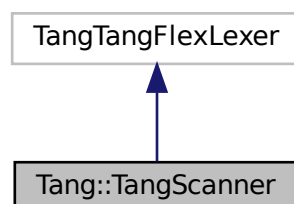
The Flex lexer class for the main Tang language.

```
#include <tangScanner.hpp>
```

Inheritance diagram for Tang::TangScanner:



Collaboration diagram for Tang::TangScanner:



## Public Member Functions

- [TangScanner](#) (std::istream &arg\_yyin, std::ostream &arg\_yyout)  
*The constructor for the Scanner.*
- virtual Tang::TangParser::symbol\_type [get\\_next\\_token](#) ()  
*A pass-through function that we supply so that we can provide a Bison 3 token return type instead of the `int` that is returned by the default class configuration.*

### 5.16.1 Detailed Description

The Flex lexer class for the main Tang language.

Flex requires that our lexer class inherit from `yyFlexLexer`, an "intermediate" class whose real name is "TangTangFlexLexer". We are subclassing it so that we can override the return type of [get\\_next\\_token\(\)](#), for compatibility with Bison 3 tokens.

### 5.16.2 Constructor & Destructor Documentation

#### 5.16.2.1 TangScanner()

```
Tang::TangScanner::TangScanner (
    std::istream & arg_yyin,
    std::ostream & arg_yyout ) [inline]
```

The constructor for the Scanner.

The design of the Flex lexer is to tokenize the contents of an input stream, and to write any error messages to an output stream. In our implementation, however, errors are returned differently, so the output stream is never used. It's presence is retained, however, in case it is needed in the future.

For now, the general approach should be to supply the input as a string stream, and to use `std::cout` as the output.

#### Parameters

|                  |  |
|------------------|--|
| <i>arg_yyin</i>  | The input stream to be tokenized       |
| <i>arg_yyout</i> | The output stream (not currently used) |

### 5.16.3 Member Function Documentation

#### 5.16.3.1 get\_next\_token()

```
virtual Tang::TangParser::symbol_type Tang::TangScanner::get_next_token ( ) [virtual]
```

A pass-through function that we supply so that we can provide a Bison 3 token return type instead of the `int` that is returned by the default class configuration.

**Returns**

A Bison 3 token representing the lexeme that was recognized.

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

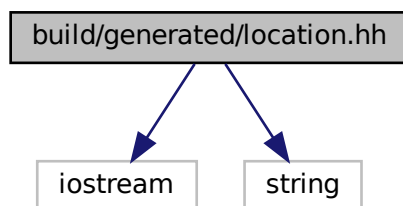
- include/[tangScanner.hpp](#)

## File Documentation

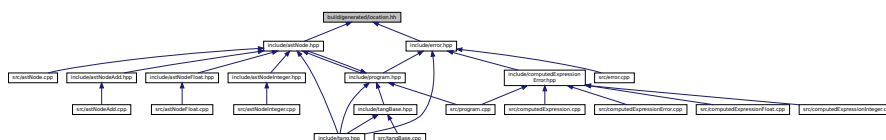
Define the Tang ::location class.

```
#include <string>
```

Include dependency graph for location.hh:



This graph shows which files directly or indirectly include this file:



- class `Tang::position`  
*A point in a source file.*
- class `Tang::location`  
*Two points in a source file.*

## Macros

- `#define YY_NULLPTR ((void*)0)`

## Functions

- `position & Tang::operator+= (position &res, position::counter_type width)`  
*Add width columns, in place.*
- `position Tang::operator+ (position res, position::counter_type width)`  
*Add width columns.*
- `position & Tang::operator-= (position &res, position::counter_type width)`  
*Subtract width columns, in place.*
- `position Tang::operator- (position res, position::counter_type width)`  
*Subtract width columns.*
- `template<typename YYChar >  
std::basic_ostream< YYChar > & Tang::operator<< (std::basic_ostream< YYChar > &ostr, const position &pos)`  
*Intercept output stream redirection.*
- `location & Tang::operator+= (location &res, const location &end)`  
*Join two locations, in place.*
- `location Tang::operator+ (location res, const location &end)`  
*Join two locations.*
- `location & Tang::operator+= (location &res, location::counter_type width)`  
*Add width columns to the end position, in place.*
- `location Tang::operator+ (location res, location::counter_type width)`  
*Add width columns to the end position.*
- `location & Tang::operator-= (location &res, location::counter_type width)`  
*Subtract width columns to the end position, in place.*
- `location Tang::operator- (location res, location::counter_type width)`  
*Subtract width columns to the end position.*
- `template<typename YYChar >  
std::basic_ostream< YYChar > & Tang::operator<< (std::basic_ostream< YYChar > &ostr, const location &loc)`  
*Intercept output stream redirection.*

### 6.1.1 Detailed Description

Define the Tang ::location class.

### 6.1.2 Function Documentation

#### 6.1.2.1 operator<<() [1/2]

```
template<typename YYChar >
std::basic_ostream<YYChar>& Tang::operator<< (
    std::basic_ostream< YYChar > & ostr,
    const location & loc )
```

Intercept output stream redirection.



## Parameters

|             |   |
|-------------|---|
| <i>ostr</i> | the destination output stream           |
| <i>loc</i>  | a reference to the location to redirect |

Avoid duplicate information.

## 6.1.2.2 operator&lt;&lt;() [2/2]

```
template<typename YYChar >
std::basic_ostream<YYChar>& Tang::operator<< (
    std::basic_ostream< YYChar > & ostr,
    const position & pos )
```

Intercept output stream redirection.

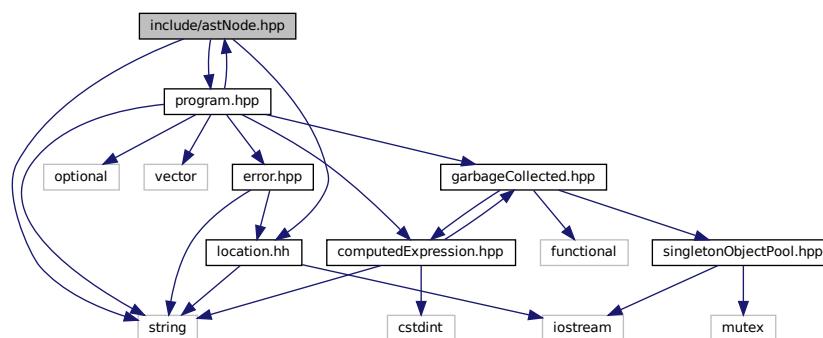
## Parameters

|             |   |
|-------------|---|
| <i>ostr</i> | the destination output stream           |
| <i>pos</i>  | a reference to the position to redirect |

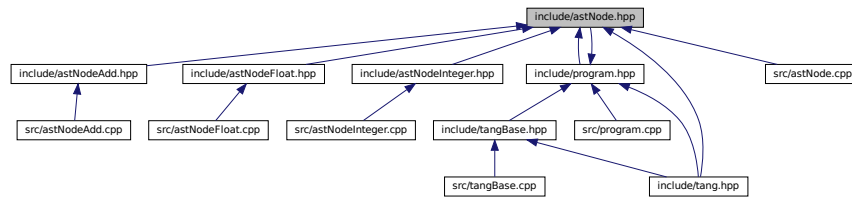
## 6.2 include/astNode.hpp File Reference

Define the [Tang::AstNode](#) and its associated/derivative classes.

```
#include <string>
#include "location.hh"
#include "program.hpp"
Include dependency graph for astNode.hpp:
```



This graph shows which files directly or indirectly include this file:



## Classes

- class [Tang::AstNode](#)  
Base class for representing nodes of an Abstract Syntax Tree (AST).

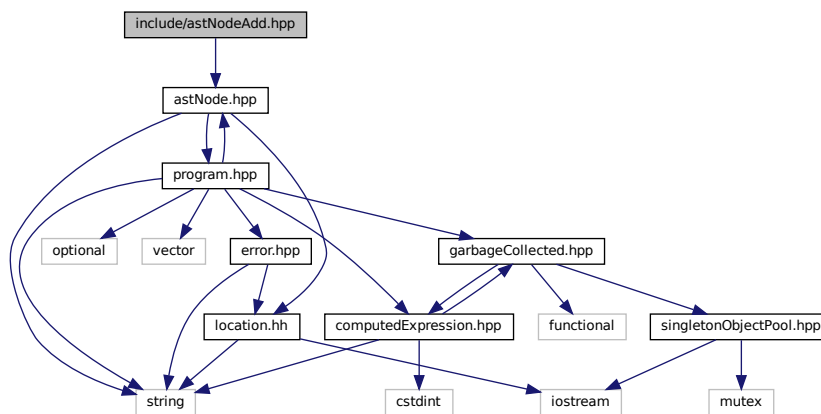
### 6.2.1 Detailed Description

Define the [Tang::AstNode](#) and its associated/derivative classes.

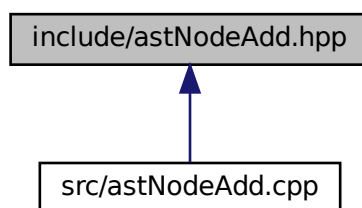
## 6.3 include/astNodeAdd.hpp File Reference

```
#include "astNode.hpp"
```

Include dependency graph for astNodeAdd.hpp:



This graph shows which files directly or indirectly include this file:



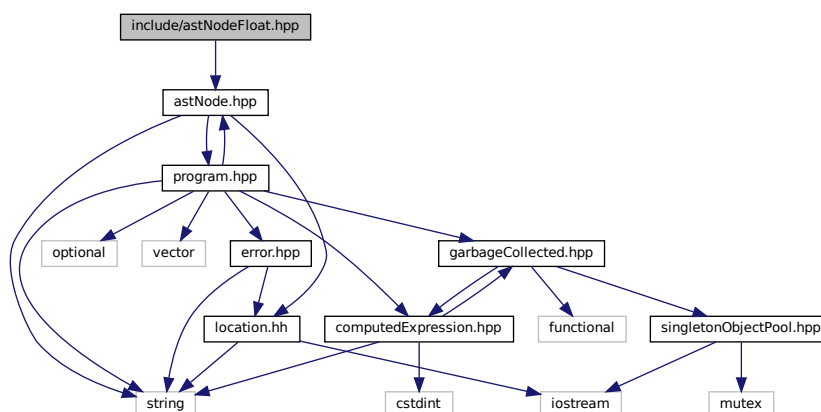
## Classes

- class [Tang::AstNodeAdd](#)  
*An [AstNode](#) that represents a "+" expression.*

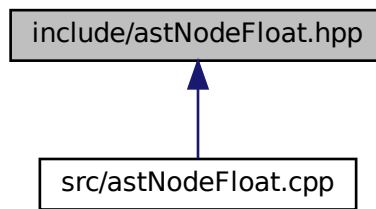
## 6.4 include/astNodeFloat.hpp File Reference

```
#include "astNode.hpp"
```

Include dependency graph for astNodeFloat.hpp:



This graph shows which files directly or indirectly include this file:



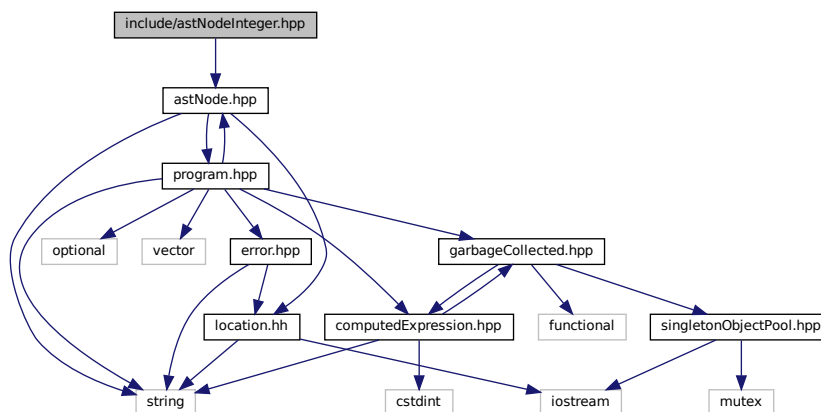
## Classes

- class [Tang::AstNodeFloat](#)  
An [AstNode](#) that represents an float literal.

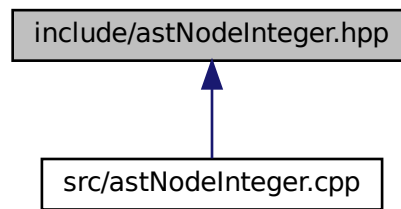
## 6.5 include/astNodeInteger.hpp File Reference

```
#include "astNode.hpp"
```

Include dependency graph for astNodeInteger.hpp:



This graph shows which files directly or indirectly include this file:



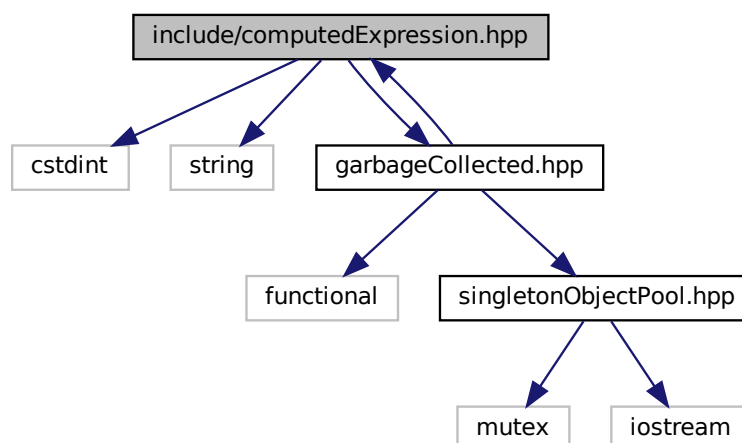
## Classes

- class [Tang::AstNodeInteger](#)  
*An [AstNode](#) that represents an integer literal.*

## 6.6 include/computedExpression.hpp File Reference

```
#include <cstdlib>
#include <string>
#include "garbageCollected.hpp"
```

Include dependency graph for computedExpression.hpp:



```

graph TD
    subgraph src
        srcCE[src/computedExpression.cpp]
        srcCEErr[src/computedExpressionError.cpp]
        srcCEInt[src/computedExpressionInteger.cpp]
        srcCEFloat[src/computedExpressionFloat.cpp]
        srcCEIntFloat[src/computedExpressionIntegerFloat.cpp]
        srcProg[src/program.cpp]
        srcASTAdd[src/astNodeAdd.cpp]
        srcASTFloat[src/astNodeFloat.cpp]
        srcASTInt[src/astNodeInteger.cpp]
        srcASTIntFloat[src/astNodeIntegerFloat.cpp]
        srcASTBase[src/astBase.cpp]
        srcASTBaseInt[src/astBaseInteger.cpp]
    end

    subgraph include
        incCE[include/computedExpression.hpp]
        incCEErr[include/computedExpressionError.hpp]
        incCEInt[include/computedExpressionInteger.hpp]
        incCEFloat[include/computedExpressionFloat.hpp]
        incCEIntFloat[include/computedExpressionIntegerFloat.hpp]
        incProg[include/program.hpp]
        incASTAdd[include/astNodeAdd.hpp]
        incASTFloat[include/astNodeFloat.hpp]
        incASTInt[include/astNodeInteger.hpp]
        incASTIntFloat[include/astNodeIntegerFloat.hpp]
        incASTBase[include/astBase.hpp]
        incASTBaseInt[include/astBaseInteger.hpp]
        incGarb[include/garbageCollected.hpp]
    end

    srcCE --> incCE
    srcCE --> incCEErr
    srcCE --> incCEInt
    srcCE --> incCEFloat
    srcCE --> incCEIntFloat
    srcCE --> incProg
    srcCE --> incASTAdd
    srcCE --> incASTFloat
    srcCE --> incASTInt
    srcCE --> incASTIntFloat
    srcCE --> incASTBase
    srcCE --> incASTBaseInt
    srcCE --> incGarb

    srcCEErr --> incCE
    srcCEErr --> incCEErr
    srcCEErr --> incCEInt
    srcCEErr --> incCEFloat
    srcCEErr --> incCEIntFloat
    srcCEErr --> incProg
    srcCEErr --> incASTAdd
    srcCEErr --> incASTFloat
    srcCEErr --> incASTInt
    srcCEErr --> incASTIntFloat
    srcCEErr --> incASTBase
    srcCEErr --> incASTBaseInt
    srcCEErr --> incGarb

    srcCEInt --> incCE
    srcCEInt --> incCEErr
    srcCEInt --> incCEInt
    srcCEInt --> incCEFloat
    srcCEInt --> incCEIntFloat
    srcCEInt --> incProg
    srcCEInt --> incASTAdd
    srcCEInt --> incASTFloat
    srcCEInt --> incASTInt
    srcCEInt --> incASTIntFloat
    srcCEInt --> incASTBase
    srcCEInt --> incASTBaseInt
    srcCEInt --> incGarb

    srcCEFloat --> incCE
    srcCEFloat --> incCEErr
    srcCEFloat --> incCEInt
    srcCEFloat --> incCEFloat
    srcCEFloat --> incCEIntFloat
    srcCEFloat --> incProg
    srcCEFloat --> incASTAdd
    srcCEFloat --> incASTFloat
    srcCEFloat --> incASTInt
    srcCEFloat --> incASTIntFloat
    srcCEFloat --> incASTBase
    srcCEFloat --> incASTBaseInt
    srcCEFloat --> incGarb

    srcCEIntFloat --> incCE
    srcCEIntFloat --> incCEErr
    srcCEIntFloat --> incCEInt
    srcCEIntFloat --> incCEFloat
    srcCEIntFloat --> incCEIntFloat
    srcCEIntFloat --> incProg
    srcCEIntFloat --> incASTAdd
    srcCEIntFloat --> incASTFloat
    srcCEIntFloat --> incASTInt
    srcCEIntFloat --> incASTIntFloat
    srcCEIntFloat --> incASTBase
    srcCEIntFloat --> incASTBaseInt
    srcCEIntFloat --> incGarb

    srcProg --> incCE
    srcProg --> incCEErr
    srcProg --> incCEInt
    srcProg --> incCEFloat
    srcProg --> incCEIntFloat
    srcProg --> incProg
    srcProg --> incASTAdd
    srcProg --> incASTFloat
    srcProg --> incASTInt
    srcProg --> incASTIntFloat
    srcProg --> incASTBase
    srcProg --> incASTBaseInt
    srcProg --> incGarb

    srcASTAdd --> incCE
    srcASTAdd --> incCEErr
    srcASTAdd --> incCEInt
    srcASTAdd --> incCEFloat
    srcASTAdd --> incCEIntFloat
    srcASTAdd --> incProg
    srcASTAdd --> incASTAdd
    srcASTAdd --> incASTFloat
    srcASTAdd --> incASTInt
    srcASTAdd --> incASTIntFloat
    srcASTAdd --> incASTBase
    srcASTAdd --> incASTBaseInt
    srcASTAdd --> incGarb

    srcASTFloat --> incCE
    srcASTFloat --> incCEErr
    srcASTFloat --> incCEInt
    srcASTFloat --> incCEFloat
    srcASTFloat --> incCEIntFloat
    srcASTFloat --> incProg
    srcASTFloat --> incASTAdd
    srcASTFloat --> incASTFloat
    srcASTFloat --> incASTInt
    srcASTFloat --> incASTIntFloat
    srcASTFloat --> incASTBase
    srcASTFloat --> incASTBaseInt
    srcASTFloat --> incGarb

    srcASTInt --> incCE
    srcASTInt --> incCEErr
    srcASTInt --> incCEInt
    srcASTInt --> incCEFloat
    srcASTInt --> incCEIntFloat
    srcASTInt --> incProg
    srcASTInt --> incASTAdd
    srcASTInt --> incASTFloat
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    srcASTInt --> incASTIntFloat
    srcASTInt --> incASTBase
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    srcASTIntFloat --> incCE
    srcASTIntFloat --> incCEErr
    srcASTIntFloat --> incCEInt
    srcASTIntFloat --> incCEFloat
    srcASTIntFloat --> incCEIntFloat
    srcASTIntFloat --> incProg
    srcASTIntFloat --> incASTAdd
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    srcASTIntFloat --> incASTInt
    srcASTIntFloat --> incASTIntFloat
    srcASTIntFloat --> incASTBase
    srcASTIntFloat --> incASTBaseInt
    srcASTIntFloat --> incGarb

    srcASTBase --> incCE
    srcASTBase --> incCEErr
    srcASTBase --> incCEInt
    srcASTBase --> incCEFloat
    srcASTBase --> incCEIntFloat
    srcASTBase --> incProg
    srcASTBase --> incASTAdd
    srcASTBase --> incASTFloat
    srcASTBase --> incASTInt
    srcASTBase --> incASTIntFloat
    srcASTBase --> incASTBase
    srcASTBase --> incASTBaseInt
    srcASTBase --> incGarb

    srcASTBaseInt --> incCE
    srcASTBaseInt --> incCEErr
    srcASTBaseInt --> incCEInt
    srcASTBaseInt --> incCEFloat
    srcASTBaseInt --> incCEIntFloat
    srcASTBaseInt --> incProg
    srcASTBaseInt --> incASTAdd
    srcASTBaseInt --> incASTFloat
    srcASTBaseInt --> incASTInt
    srcASTBaseInt --> incASTIntFloat
    srcASTBaseInt --> incASTBase
    srcASTBaseInt --> incASTBaseInt
    srcASTBaseInt --> incGarb

    incCE --> incCEErr
    incCE --> incCEInt
    incCE --> incCEFloat
    incCE --> incCEIntFloat
    incCE --> incProg
    incCE --> incASTAdd
    incCE --> incASTFloat
    incCE --> incASTInt
    incCE --> incASTIntFloat
    incCE --> incASTBase
    incCE --> incASTBaseInt
    incCE --> incGarb

    incCEErr --> incCE
    incCEErr --> incCEErr
    incCEErr --> incCEInt
    incCEErr --> incCEFloat
    incCEErr --> incCEIntFloat
    incCEErr --> incProg
    incCEErr --> incASTAdd
    incCEErr --> incASTFloat
    incCEErr --> incASTInt
    incCEErr --> incASTIntFloat
    incCEErr --> incASTBase
    incCEErr --> incASTBaseInt
    incCEErr --> incGarb

    incCEInt --> incCE
    incCEInt --> incCEErr
    incCEInt --> incCEInt
    incCEInt --> incCEFloat
    incCEInt --> incCEIntFloat
    incCEInt --> incProg
    incCEInt --> incASTAdd
    incCEInt --> incASTFloat
    incCEInt --> incASTInt
    incCEInt --> incASTIntFloat
    incCEInt --> incASTBase
    incCEInt --> incASTBaseInt
    incCEInt --> incGarb

    incCEFloat --> incCE
    incCEFloat --> incCEErr
    incCEFloat --> incCEInt
    incCEFloat --> incCEFloat
    incCEFloat --> incCEIntFloat
    incCEFloat --> incProg
    incCEFloat --> incASTAdd
    incCEFloat --> incASTFloat
    incCEFloat --> incASTInt
    incCEFloat --> incASTIntFloat
    incCEFloat --> incASTBase
    incCEFloat --> incASTBaseInt
    incCEFloat --> incGarb

    incCEIntFloat --> incCE
    incCEIntFloat --> incCEErr
    incCEIntFloat --> incCEInt
    incCEIntFloat --> incCEFloat
    incCEIntFloat --> incCEIntFloat
    incCEIntFloat --> incProg
    incCEIntFloat --> incASTAdd
    incCEIntFloat --> incASTFloat
    incCEIntFloat --> incASTInt
    incCEIntFloat --> incASTIntFloat
    incCEIntFloat --> incASTBase
    incCEIntFloat --> incASTBaseInt
    incCEIntFloat --> incGarb

    incProg --> incCE
    incProg --> incCEErr
    incProg --> incCEInt
    incProg --> incCEFloat
    incProg --> incCEIntFloat
    incProg --> incProg
    incProg --> incASTAdd
    incProg --> incASTFloat
    incProg --> incASTInt
    incProg --> incASTIntFloat
    incProg --> incASTBase
    incProg --> incASTBaseInt
    incProg --> incGarb

    incASTAdd --> incCE
    incASTAdd --> incCEErr
    incASTAdd --> incCEInt
    incASTAdd --> incCEFloat
    incASTAdd --> incCEIntFloat
    incASTAdd --> incProg
    incASTAdd --> incASTAdd
    incASTAdd --> incASTFloat
    incASTAdd --> incASTInt
    incASTAdd --> incASTIntFloat
    incASTAdd --> incASTBase
    incASTAdd --> incASTBaseInt
    incASTAdd --> incGarb

    incASTFloat --> incCE
    incASTFloat --> incCEErr
    incASTFloat --> incCEInt
    incASTFloat --> incCEFloat
    incASTFloat --> incCEIntFloat
    incASTFloat --> incProg
    incASTFloat --> incASTAdd
    incASTFloat --> incASTFloat
    incASTFloat --> incASTInt
    incASTFloat --> incASTIntFloat
    incASTFloat --> incASTBase
    incASTFloat --> incASTBaseInt
    incASTFloat --> incGarb

    incASTInt --> incCE
    incASTInt --> incCEErr
    incASTInt --> incCEInt
    incASTInt --> incCEFloat
    incASTInt --> incCEIntFloat
    incASTInt --> incProg
    incASTInt --> incASTAdd
    incASTInt --> incASTFloat
    incASTInt --> incASTInt
    incASTInt --> incASTIntFloat
    incASTInt --> incASTBase
    incASTInt --> incASTBaseInt
    incASTInt --> incGarb

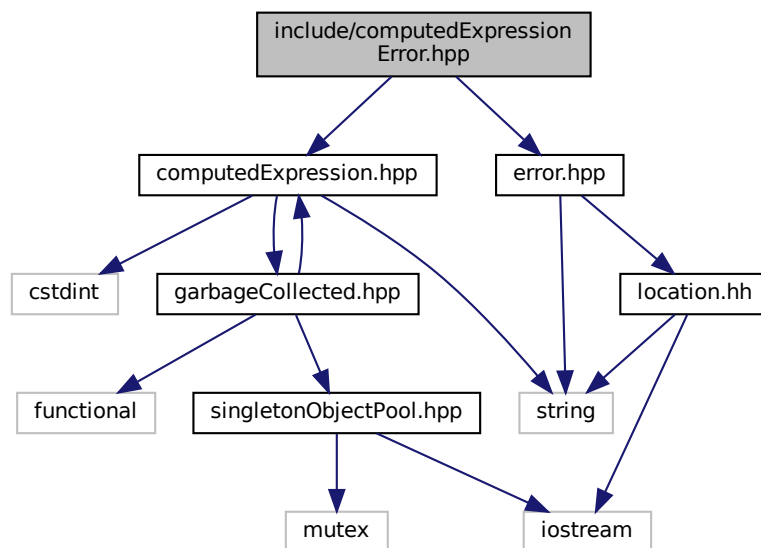
    incASTIntFloat --> incCE
    incASTIntFloat --> incCEErr
    incASTIntFloat --> incCEInt
    incASTIntFloat --> incCEFloat
    incASTIntFloat --> incCEIntFloat
    incASTIntFloat --> incProg
    incASTIntFloat --> incASTAdd
    incASTIntFloat --> incASTFloat
    incASTIntFloat --> incASTInt
    incASTIntFloat --> incASTIntFloat
    incASTIntFloat --> incASTBase
    incASTIntFloat --> incASTBaseInt
    incASTIntFloat --> incGarb

    incASTBase --> incCE
    incASTBase --> incCEErr
    incASTBase --> incCEInt
    incASTBase --> incCEFloat
    incASTBase --> incCEIntFloat
    incASTBase --> incProg
    incASTBase --> incASTAdd
    incASTBase --> incASTFloat
    incASTBase --> incASTInt
    incASTBase --> incASTIntFloat
    incASTBase --> incASTBase
    incASTBase --> incASTBaseInt
    incASTBase --> incGarb

    incASTBaseInt --> incCE
    incASTBaseInt --> incCEErr
    incASTBaseInt --> incCEInt
    incASTBaseInt --> incCEFloat
    incASTBaseInt --> incCEIntFloat
    incASTBaseInt --
```

- class `Tang::ComputedExpression`  
*Represents the result of a computation that has been executed.*

```
#include "computedExpression.hpp"
#include "error.hpp"
Include dependency graph for computedExpressionError.hpp:
```



```

graph TD
    A[include/computedExpressionError.hpp]
    B[src/computedExpression.cpp] --> A
    C[src/computedExpressionError.cpp] --> A
    D[src/computedExpressionFloat.cpp] --> A
    E[src/computedExpressionInteger.cpp] --> A
    F[src/program.cpp] --> A
  
```

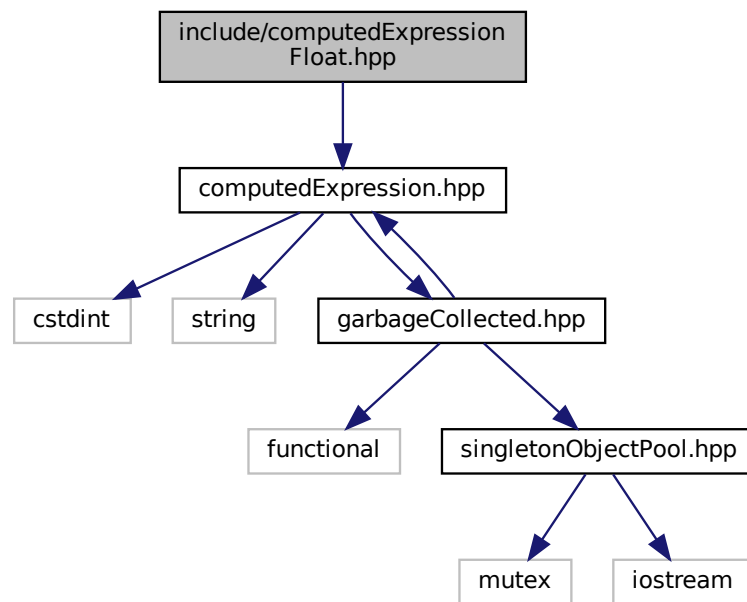
## Classes

- class [Tang::ComputedExpressionError](#)  
*Represents a Runtime [Error](#).*

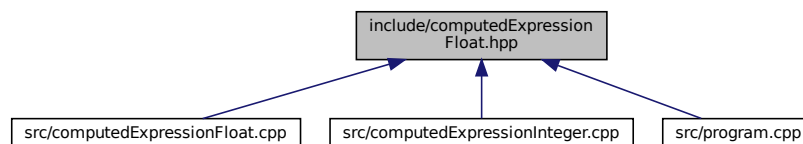
## 6.8 include/computedExpressionFloat.hpp File Reference

```
#include "computedExpression.hpp"
```

Include dependency graph for computedExpressionFloat.hpp:



This graph shows which files directly or indirectly include this file:



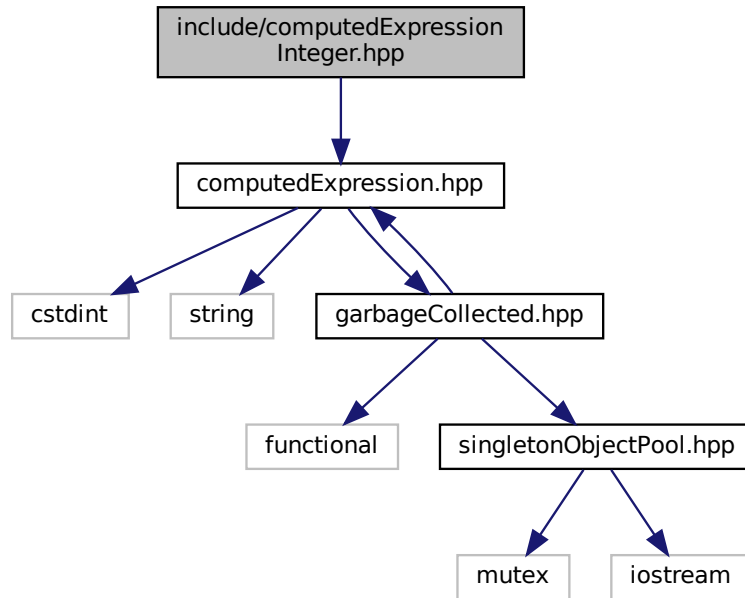
## Classes

- class [Tang::ComputedExpressionFloat](#)  
*Represents a Float that is the result of a computation.*

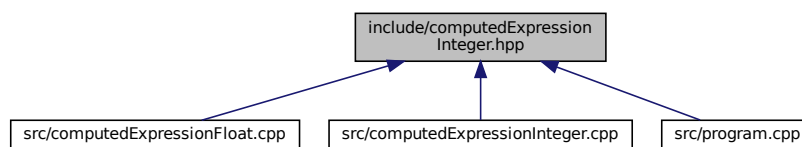
## 6.9 include/computedExpressionInteger.hpp File Reference

```
#include "computedExpression.hpp"
```

Include dependency graph for computedExpressionInteger.hpp:



This graph shows which files directly or indirectly include this file:



### Classes

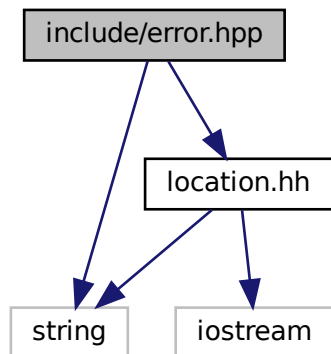
- class [Tang::ComputedExpressionInteger](#)  
*Represents an Integer that is the result of a computation.*

## 6.10 include/error.hpp File Reference

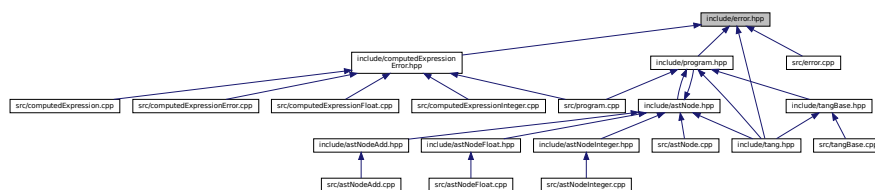
Define the [Tang::Error](#) class used to describe syntax and runtime errors.



```
#include <string>
#include "location.hh"
Include dependency graph for error.hpp:
```



This graph shows which files directly or indirectly include this file:



## Classes

- class `Tang::Error`

The `Error` class is used to report any error of the system, whether a syntax (parsing) error or a runtime (execution) error.

### 6.10.1 Detailed Description

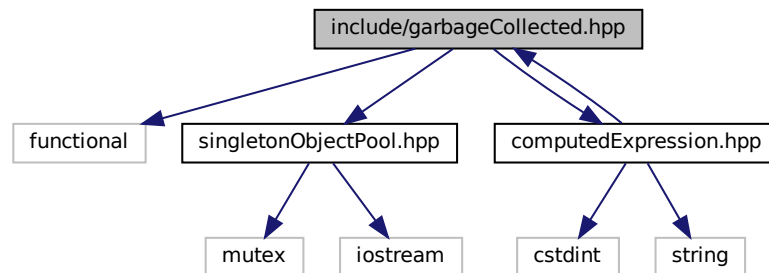
Define the `Tang::Error` class used to describe syntax and runtime errors.

## 6.11 include/garbageCollected.hpp File Reference

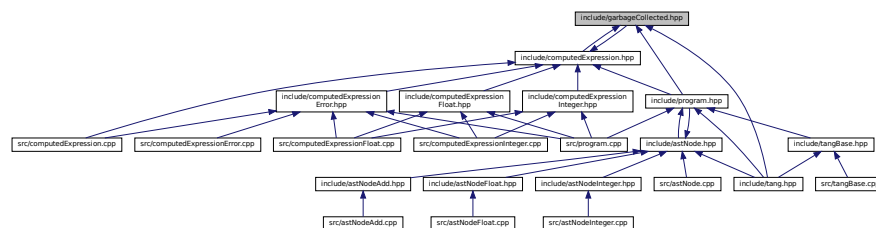
```
#include <functional>
#include "singletonObjectPool.hpp"
```

```
#include "computedExpression.hpp"
```

Include dependency graph for garbageCollected.hpp:



This graph shows which files directly or indirectly include this file:



## Classes

- class [Tang::GarbageCollected](#)

*A container that acts as a resource-counting garbage collector for the specified type.*

## 6.12 include/macros.hpp File Reference

Contains generic macros.

## Macros

- #define [TANG\\_UNUSED\(x\)](#) x

*Instruct the compiler that a function argument will not be used so that it does not generate an error.*

### 6.12.1 Detailed Description

Contains generic macros.

## 6.12.2 Macro Definition Documentation

### 6.12.2.1 TANG\_UNUSED

```
#define TANG_UNUSED(
    x ) x
```

Instruct the compiler that a function argument will not be used so that it does not generate an error.

When defining a function, use the [TANG\\_UNUSED\(\)](#) macro around any argument which is *not* used in the function, in order to squash any compiler warnings. e.g., `void foo(int TANG_UNUSED(a)) {}`

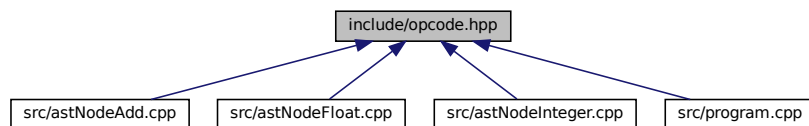
#### Parameters

|   |                             |
|---|-----------------------------|
| x | The argument to be ignored. |
|---|-----------------------------|

## 6.13 include/opcode.hpp File Reference

Declare the Opcodes used in the Bytecode representation of a program.

This graph shows which files directly or indirectly include this file:



## Enumerations

- enum class [Tang::Opcode](#) { [INTEGER](#) , [FLOAT](#) , [ADD](#) }

### 6.13.1 Detailed Description

Declare the Opcodes used in the Bytecode representation of a program.

### 6.13.2 Enumeration Type Documentation

#### 6.13.2.1 Opcode

```
enum Tang::Opcode [strong]
```

### Enumerator

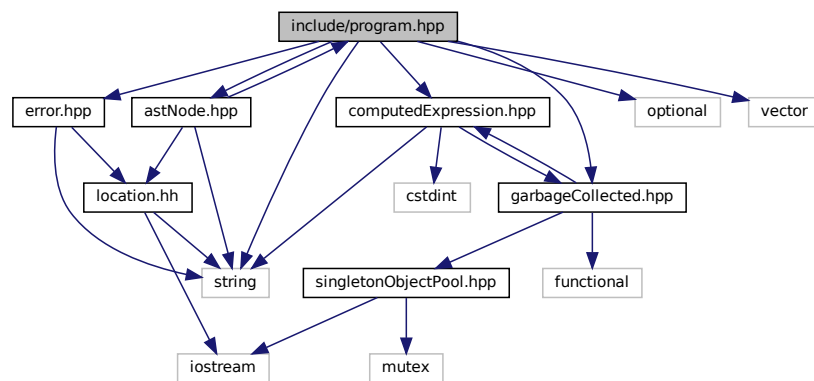
|         |  |
|---------|--|
| INTEGER | Push an integer onto the stack.              |
| FLOAT   | Push a floating point number onto the stack. |
| ADD     | Pop rhs, pop lhs, push lhs + rhs.            |

## 6.14 include/program.hpp File Reference

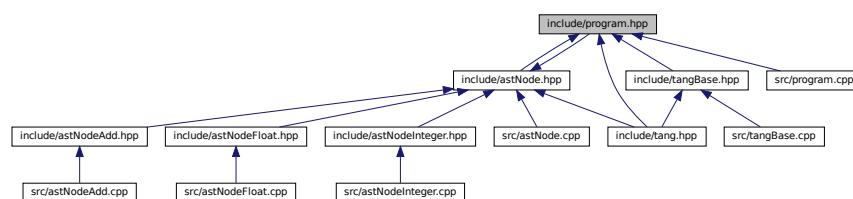
Define the [Tang::Program](#) class used to compile and execute source code.

```
#include <string>
#include <optional>
#include <vector>
#include "astNode.hpp"
#include "error.hpp"
#include "computedExpression.hpp"
#include "garbageCollected.hpp"
```

Include dependency graph for program.hpp:



This graph shows which files directly or indirectly include this file:



### Classes

- class [Tang::Program](#)  
*Represents a compiled script or template that may be executed.*

## Typedefs

- using [Tang::Bytecode](#) = std::vector< uint64\_t >  
Contains the Opcodes of a compiled program.

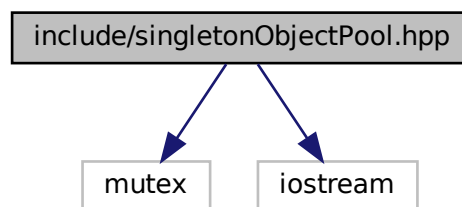
### 6.14.1 Detailed Description

Define the [Tang::Program](#) class used to compile and execute source code.

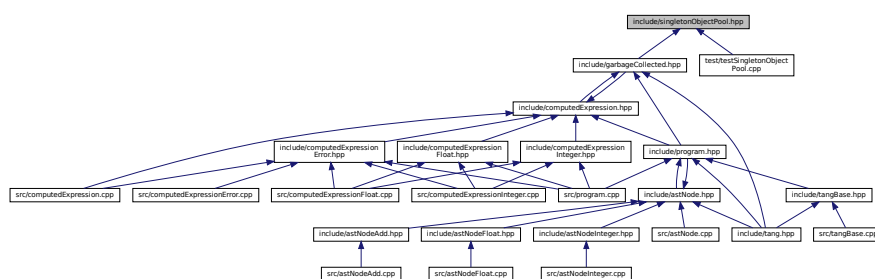
## 6.15 include/singletonObjectPool.hpp File Reference

```
#include <mutex>
#include <iostream>
```

Include dependency graph for singletonObjectPool.hpp:



This graph shows which files directly or indirectly include this file:



## Classes

- class [Tang::SingletonObjectPool< T >](#)

## Macros

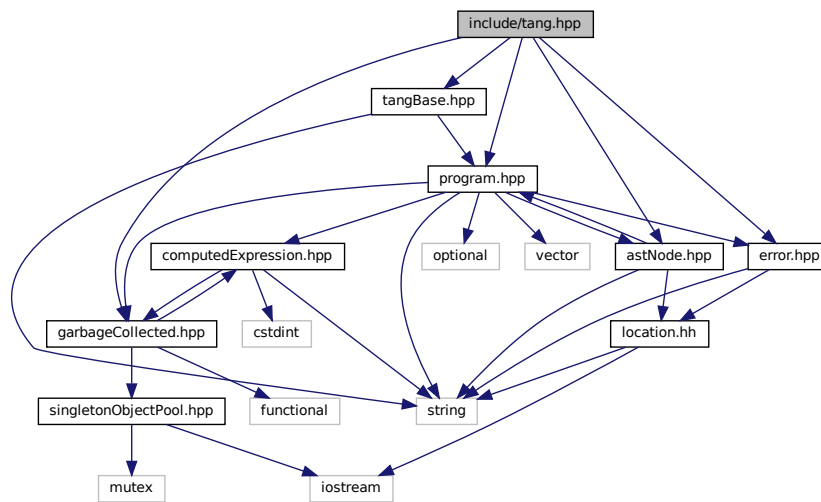
- #define [GROW](#) 1024  
The threshold size to use when allocating blocks of data, measured in the number of instances of the object type.

## 6.16 include/tang.hpp File Reference

Header file supplied for use by 3rd party code so that they can easily include all necessary headers.

```
#include "tangBase.hpp"
#include "astNode.hpp"
#include "error.hpp"
#include "garbageCollected.hpp"
#include "program.hpp"
```

Include dependency graph for tang.hpp:



### 6.16.1 Detailed Description

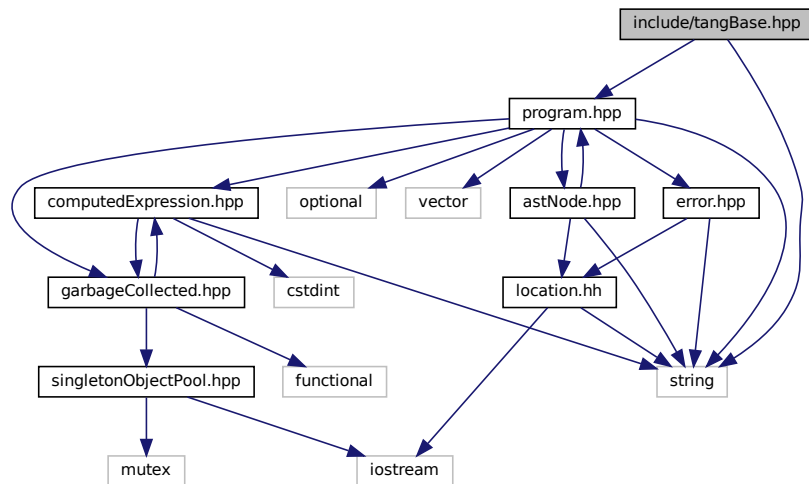
Header file supplied for use by 3rd party code so that they can easily include all necessary headers.

## 6.17 include/tangBase.hpp File Reference

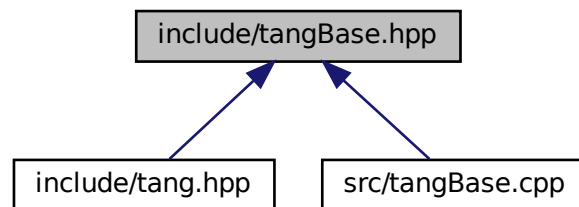
Defines the [Tang::TangBase](#) class used to interact with Tang.

```
#include <string>
#include "program.hpp"
```

Include dependency graph for tangBase.hpp:



This graph shows which files directly or indirectly include this file:



## Classes

- class [Tang::TangBase](#)

*The base class for the Tang programming language.*

### 6.17.1 Detailed Description

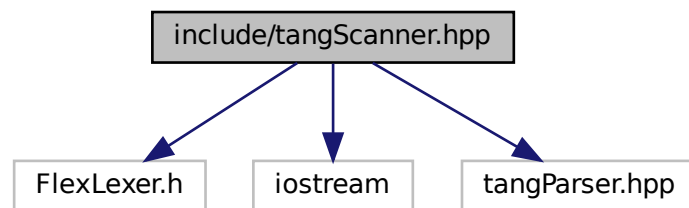
Defines the [Tang::TangBase](#) class used to interact with Tang.

## 6.18 include/tangScanner.hpp File Reference

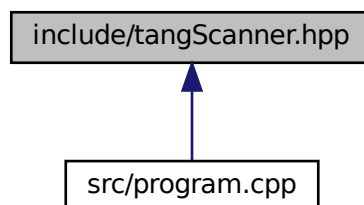
Defines the [Tang::TangScanner](#) used to tokenize a Tang script.

```
#include <FlexLexer.h>
#include <iostream>
#include "tangParser.hpp"
```

Include dependency graph for tangScanner.hpp:



This graph shows which files directly or indirectly include this file:



### Classes

- class [Tang::TangScanner](#)  
*The Flex lexer class for the main Tang language.*

### Macros

- #define **yyFlexLexer** TangTangFlexLexer
- #define **YY\_DECL** Tang::TangParser::symbol\_type [Tang::TangScanner::get\\_next\\_token\(\)](#)

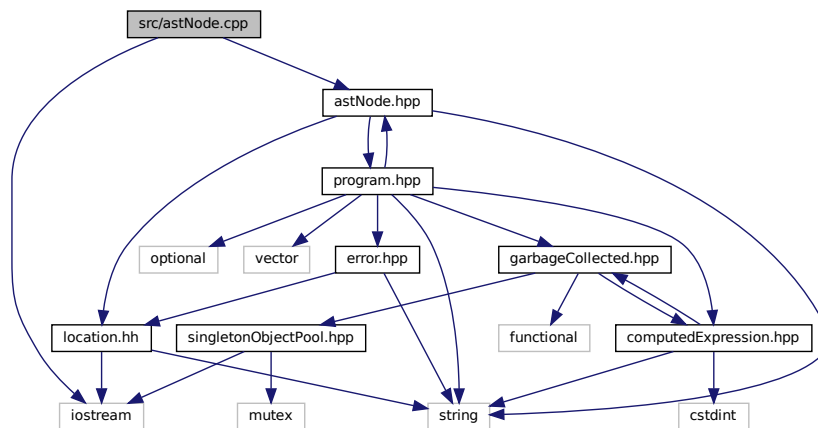


### 6.18.1 Detailed Description

Defines the [Tang::TangScanner](#) used to tokenize a Tang script.

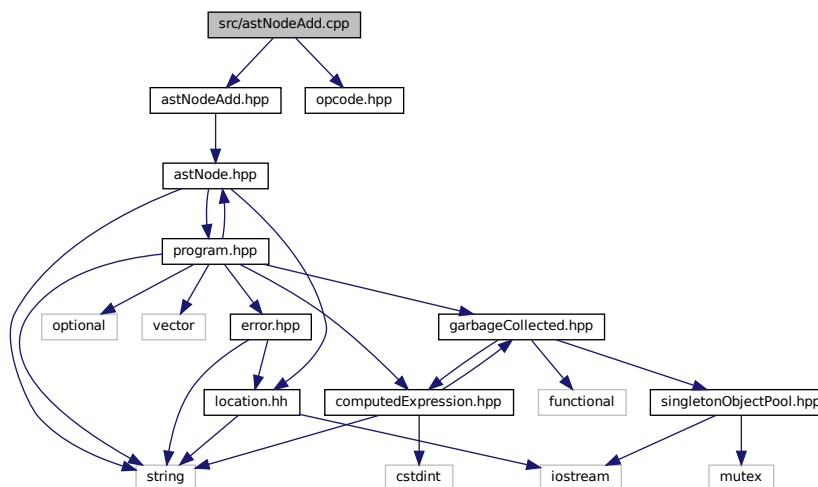
## 6.19 src/astNode.cpp File Reference

```
#include <iostream>
#include "astNode.hpp"
Include dependency graph for astNode.cpp:
```



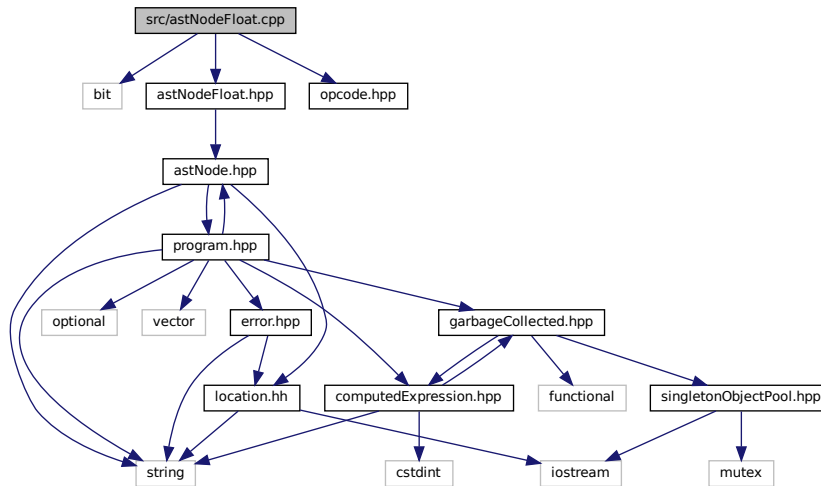
## 6.20 src/astNodeAdd.cpp File Reference

```
#include "astNodeAdd.hpp"
#include "opcode.hpp"
Include dependency graph for astNodeAdd.cpp:
```



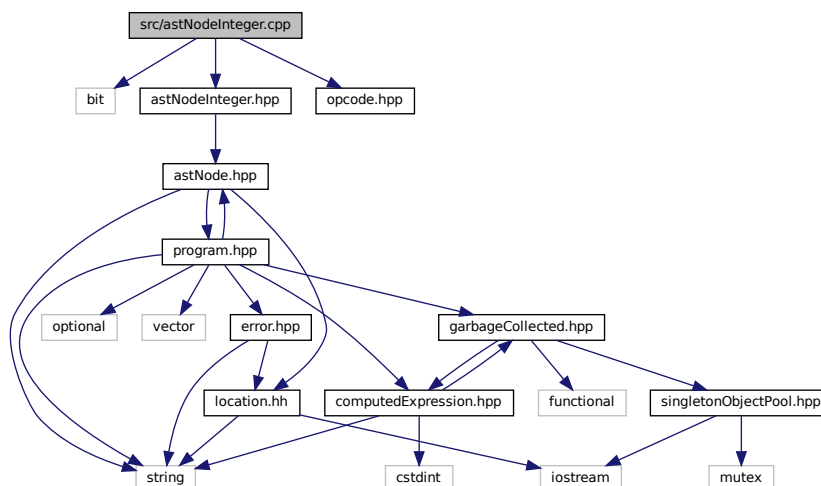
## 6.21 src/astNodeFloat.cpp File Reference

```
#include <bit>
#include "astNodeFloat.hpp"
#include "opcode.hpp"
Include dependency graph for astNodeFloat.cpp:
```



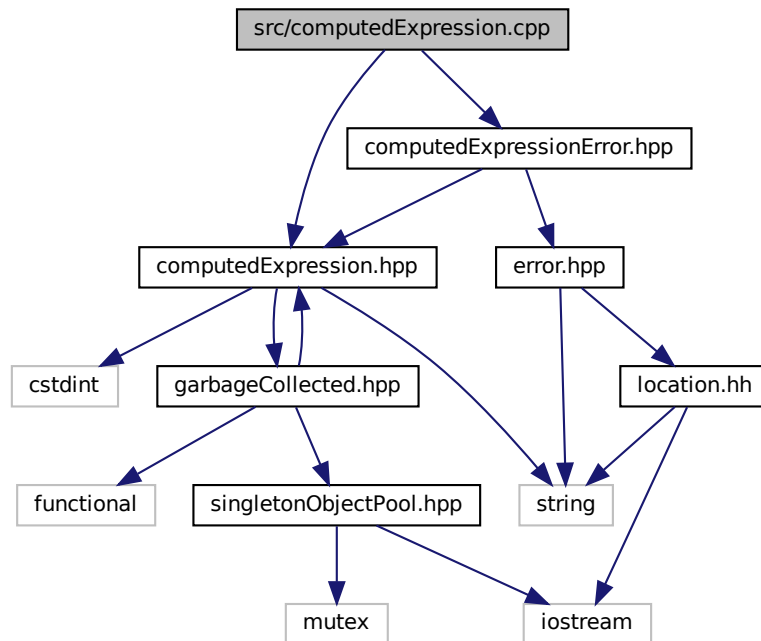
## 6.22 src/astNodeInteger.cpp File Reference

```
#include <bit>
#include "astNodeInteger.hpp"
#include "opcode.hpp"
Include dependency graph for astNodeInteger.cpp:
```



## 6.23 src/computedExpression.cpp File Reference

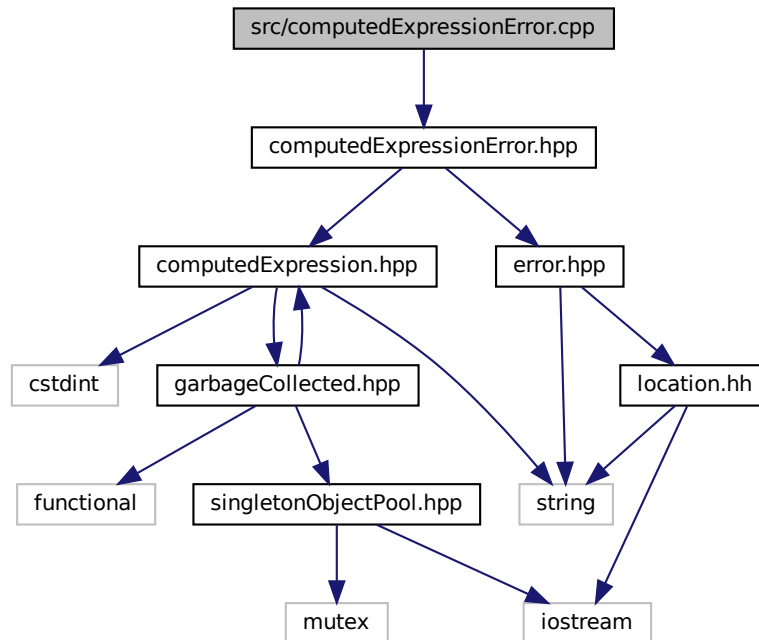
```
#include "computedExpression.hpp"  
#include "computedExpressionError.hpp"  
Include dependency graph for computedExpression.cpp:
```



## 6.24 src/computedExpressionError.cpp File Reference

```
#include "computedExpressionError.hpp"
```

Include dependency graph for computedExpressionError.cpp:



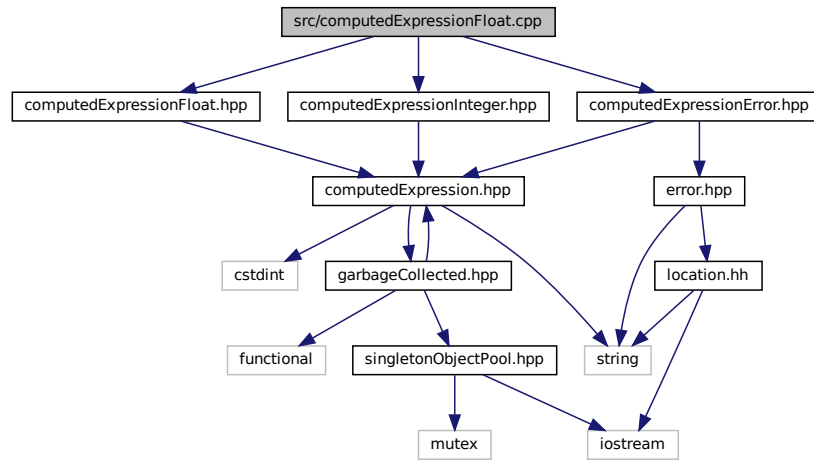
## 6.25 src/computedExpressionFloat.cpp File Reference

```
#include "computedExpressionFloat.hpp"
```

```
#include "computedExpressionInteger.hpp"
```

```
#include "computedExpressionError.hpp"
```

Include dependency graph for computedExpressionFloat.cpp:



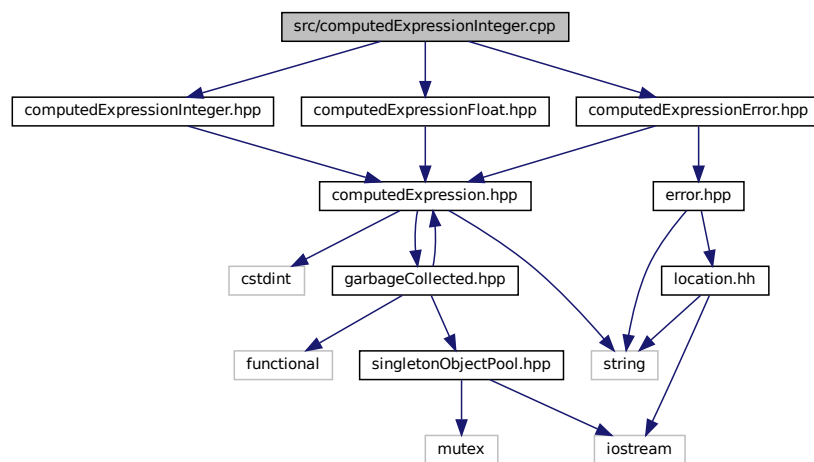
## 6.26 src/computedExpressionInteger.cpp File Reference

```

#include "computedExpressionInteger.hpp"
#include "computedExpressionFloat.hpp"
#include "computedExpressionError.hpp"

```

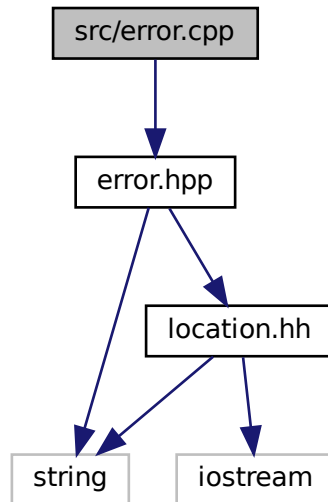
Include dependency graph for computedExpressionInteger.cpp:



## 6.27 src/error.cpp File Reference

```
#include "error.hpp"
```

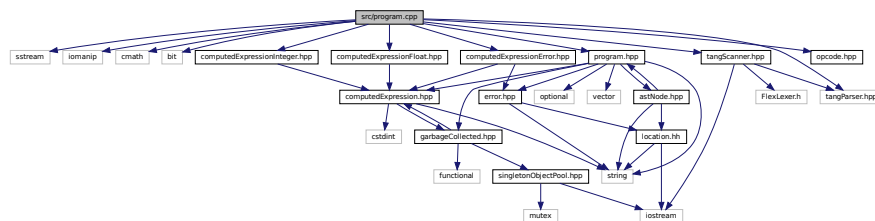
Include dependency graph for error.cpp:



## 6.28 src/program.cpp File Reference

```
#include <sstream>
#include <iomanip>
#include <cmath>
#include <bit>
#include "program.hpp"
#include "tangScanner.hpp"
#include "tangParser.hpp"
#include "opcode.hpp"
#include "computedExpressionError.hpp"
#include "computedExpressionInteger.hpp"
#include "computedExpressionFloat.hpp"
```

Include dependency graph for program.cpp:



## Macros

- `#define DUMPPROGRAMCHECK(x)`  
Verify the size of the Bytecode vector so that it may be safely accessed.
- `#define EXECUTEPROGRAMCHECK(x)`  
Verify the size of the Bytecode vector so that it may be safely accessed.
- `#define STACKCHECK(x)`  
Verify the size of the stack vector so that it may be safely accessed.

### 6.28.1 Macro Definition Documentation

#### 6.28.1.1 DUMPPROGRAMCHECK

```
#define DUMPPROGRAMCHECK(  
    x )
```

##### Value:

```
if (this->bytecode.size() < (pc + (x))) \  
    return out.str() + "Error: Opcode truncated\n"
```

Verify the size of the Bytecode vector so that it may be safely accessed.

If the vector is not large enough, an error message is appended to the output string and no further opcodes are printed.

##### Parameters

|                |  |
|----------------|--|
| <code>x</code> | The number of additional vector entries that should exist. |
|----------------|--|

#### 6.28.1.2 EXECUTEPROGRAMCHECK

```
#define EXECUTEPROGRAMCHECK(  
    x )
```

##### Value:

```
if (this->bytecode.size() < (pc + (x))) { \  
    stack.push_back(GarbageCollected::make<ComputedExpressionError>(Error{"Opcode instruction  
truncated."})); \  
    pc = this->bytecode.size(); \  
    break; \  
}
```

Verify the size of the Bytecode vector so that it may be safely accessed.

##### Parameters

|                |  |
|----------------|--|
| <code>x</code> | The number of additional vector entries that should exist. |
|----------------|--|

### 6.28.1.3 STACKCHECK

```
#define STACKCHECK(  
    x )
```

#### Value:

```
if (stack.size() < (fp + (x))) { \
    stack.push_back(GarbageCollected::make<ComputedExpressionError>(Error{"Insufficient stack depth."})); \
    pc = this->bytecode.size(); \
    break; \
}
```

Verify the size of the stack vector so that it may be safely accessed.

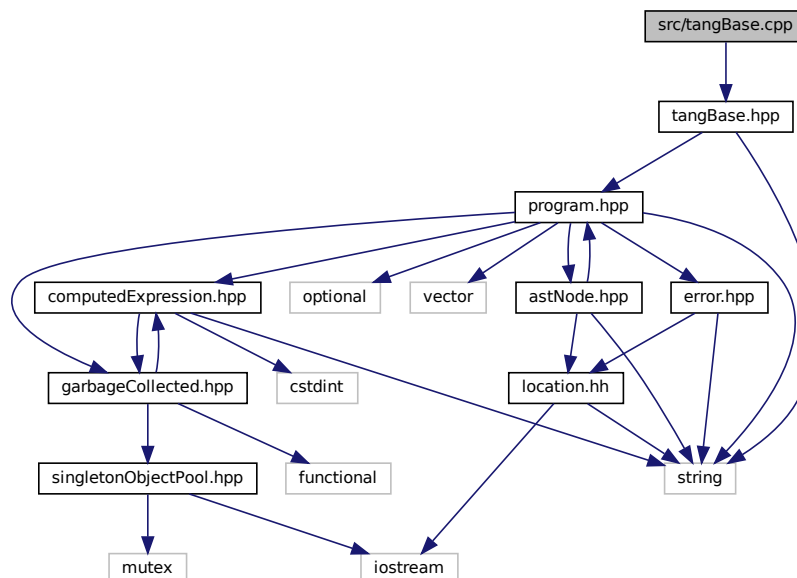
#### Parameters

|          |   |
|----------|---|
| <i>x</i> | The number of entries that should exist in the stack. |
|----------|---|

## 6.29 src/tangBase.cpp File Reference

```
#include "tangBase.hpp"
```

Include dependency graph for tangBase.cpp:



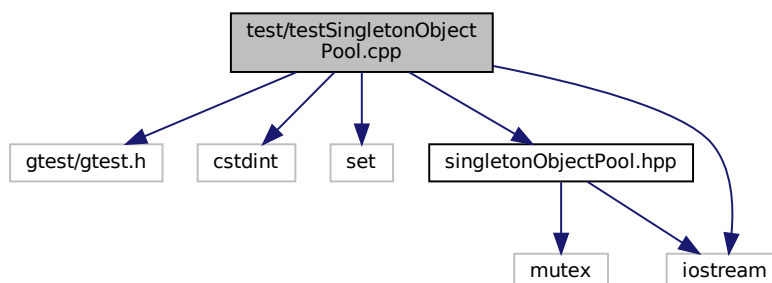
## 6.30 test/testSingletonObjectPool.cpp File Reference

```
#include <gtest/gtest.h>
#include <cstdint>
```



```
#include <set>
#include "singletonObjectPool.hpp"
#include <iostream>
```

Include dependency graph for testSingletonObjectPool.cpp:



## Functions

- **TEST** (Singleton, SameForSameType)
- **TEST** (Singleton, DifferentForDifferentTypes)
- **TEST** (Get, SuccessiveCallsProduceDifferentMemoryAddresses)
- **TEST** (Recycle, RecycledObjectIsReused)
- **TEST** (Get, SuccessiveCallsAreSequential)
- **TEST** (Get, KeepsGeneratingDifferentPointers)
- **TEST** (Recycle, WorksAfterLargeNumberOfAllocations)
- `int main` (`int argc`, `char **argv`)



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