Automatic Type Deduction: decltype

Let's take a look at what decltype does.

WE'LL COVER THE FOLLOWING

`decltype` vs `auto`

The `decltype` keyword was also introduced in C++11, though its functionality differs from `auto`. `decltype` is used to determine the type of an expression or entity.

Here is the correct format:

```
decltype(expression)
```

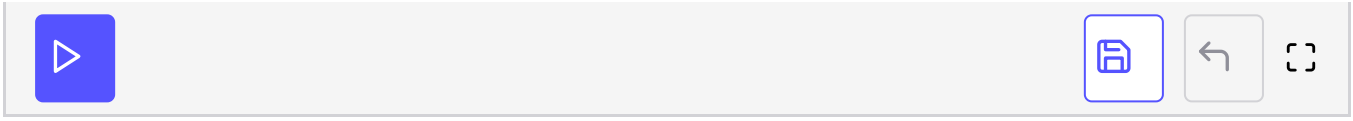
We can use auto to create variables, but `decltype` returns the type of an expression containing variables.

Rules

- If the expression is an *lvalue*, `decltype` will return **a reference to the data type to the expression**
- If the expression is an *rvalue*, `decltype` will return **the data type of the value**

```
#include <iostream>

int main() {
  int i = 1998; // Rvalue
  decltype(i) i2 = 2011; // Same as int i2 = 2011

  decltype((i)) iRef = i2; // (i) is an lvalue, reference returned
```

```
  std::cout << "iRef: " << iRef << std::endl;
  std::cout << "i2: " << i2 << std::endl;

  std::cout << std::endl;

  iRef = 2012;
  std::cout << "iRef: " << iRef << std::endl;
  std::cout << "i2: " << i2 << std::endl; // iRef is a reference after all
}
```



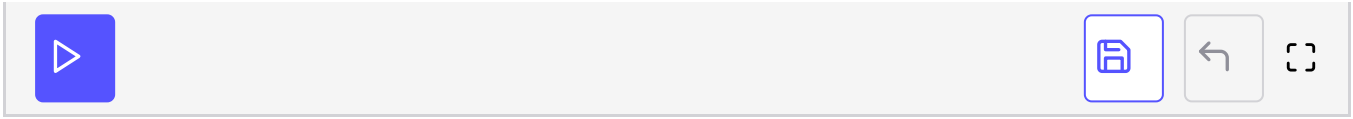
In line 7, the parentheses around `i` indicate that this is an expression instead of a variable. Hence, `decltype` computes `int&` instead of `int`.

`decltype` is not used as often as `auto`. It is useful with templates that can deduce the type of a function.

Here's another example of `decltype` in action:

```
#include <iostream>
#include <vector>

int func(int, int){ return 0; }

int main(){

  decltype(5) i = 5;                              // int

  int& intRef = i;                                     // int&
  decltype(intRef) intRefD = intRef;              // int&

  int* intPoint = &i;                             // int*
  decltype(intPoint) intPointD = intPoint;        // int*

  const int constInt = i;                         // const int
  decltype(constInt) constIntD = constInt;        // const int

  static int  staticInt = 10;                     // static int
  decltype(staticInt) staticIntD = staticInt;     // static int

  const std::vector<int> myVec;
  decltype(myVec) vecD = myVec;                   // const std::vector<int>

  auto myFunc = func;                             // (int)(*)(int, int)
  decltype(myFunc) myFuncD = myFunc;              // (int)(*)(int, int)

  // define a function pointer
  int (*myAdd1)(int, int) = [](int a, int b){ return a + b; };

  // use type inference of the C++11 compiler
  decltype(myAdd1) myAdd2 = [](int a, int b){ return a + b; };

  std::cout << "\n";
```

```
  // use the function pointer
  std::cout << "myAdd1(1, 2) = " << myAdd1(1, 2) << std::endl;

  // use the 2 variable
  std::cout << "myAdd2(1, 2) = " << myAdd2(1, 2) << std::endl;

  std::cout << "\n";

}
```



We can see how `decltype` deduces the types of different entities, including the function pointer in line 32.

In the next lesson, we'll learn how to use `decltype` and `auto` together.