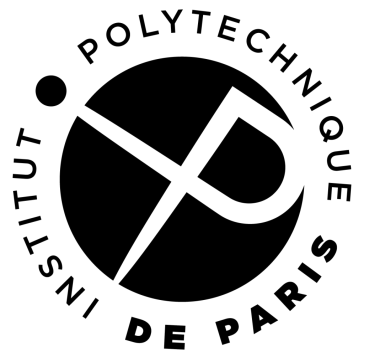

Copying versus moving

Bachelor of Science - École polytechnique

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Key concepts

- The copy constructor
  - Is used to deeply copy an object
  - `holder_t(const holder_t& t)`
- The move constructor
  - Is used to move an object into another
  - Avoid a deep copy
  - Called when the parameter will be destroyed after the call
  - `holder_t(holder_t&& t)`
  - Don’t forget to nullify the elements of `t` that are deleted in the destructor

Copy constructor

- Copying an object means performing a deep copy

```
struct holder_t {
  int* p;

  holder_t(int i)
    : p { new int { i } } { }
  holder_t(const holder_t& t)
    : p { new int { *t.p } } { };
  ~holder_t() { delete p; }
};

int main(int argc, char* argv[]) {
  holder_t x { 3 };
  holder_t y { x };
  return 0;
}
```

the “copy constructor” performs a deep copy of `t`

Copy constructor

- Copying an object means performing a deep copy

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  int* p;

  holder_t(int i)
    : p { new int { i } } { }
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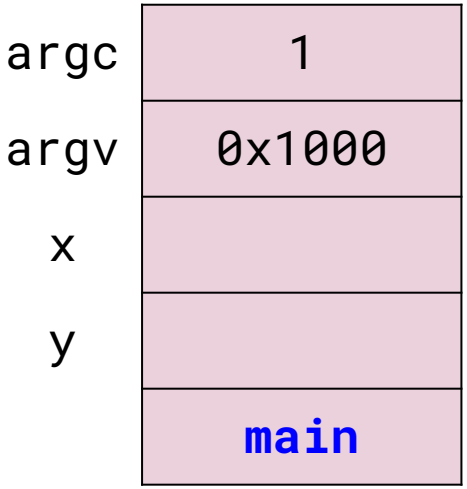
  holder_t x { 3 };
  holder_t y { x };
  return 0;
}
```



Copy constructor

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  holder_t(int i)
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  holder_t x { 3 };
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  return 0;
}
```

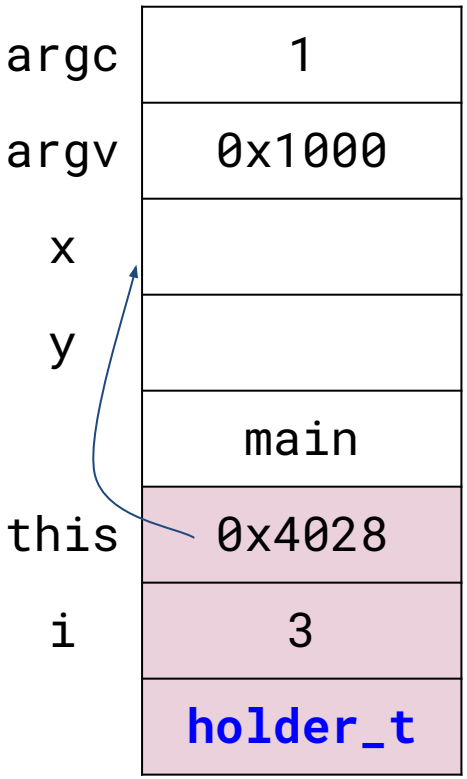

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- Copying an object means performing a deep copy

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  int* p;

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  holder_t x { 3 };
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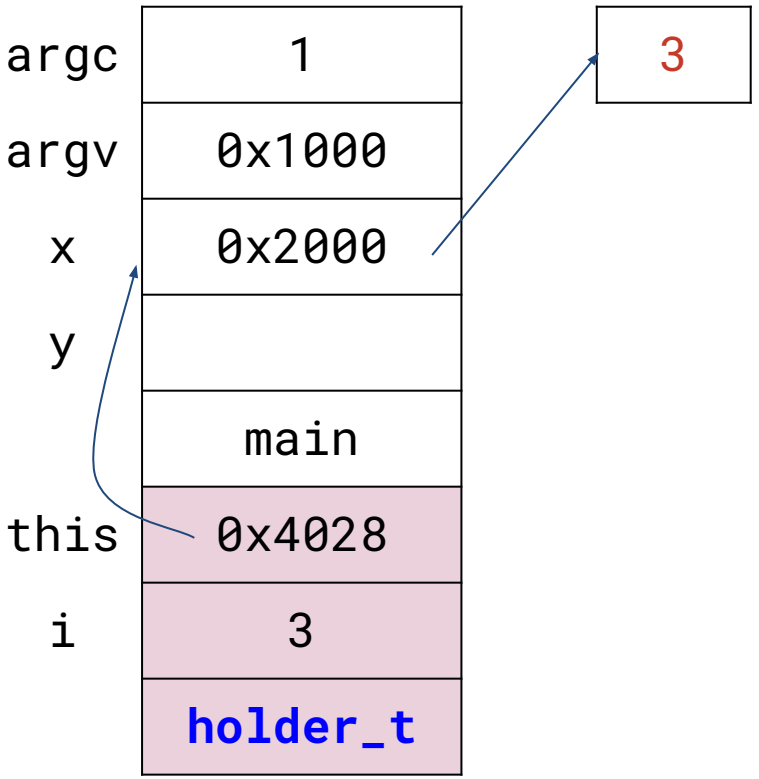

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};

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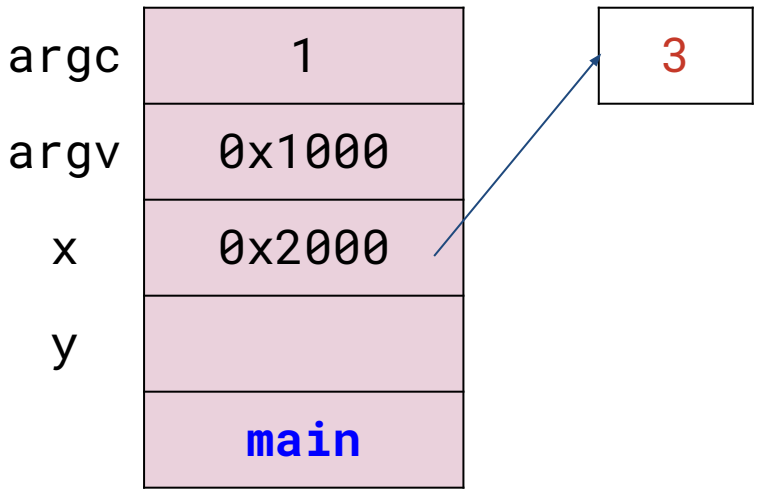

Copy constructor

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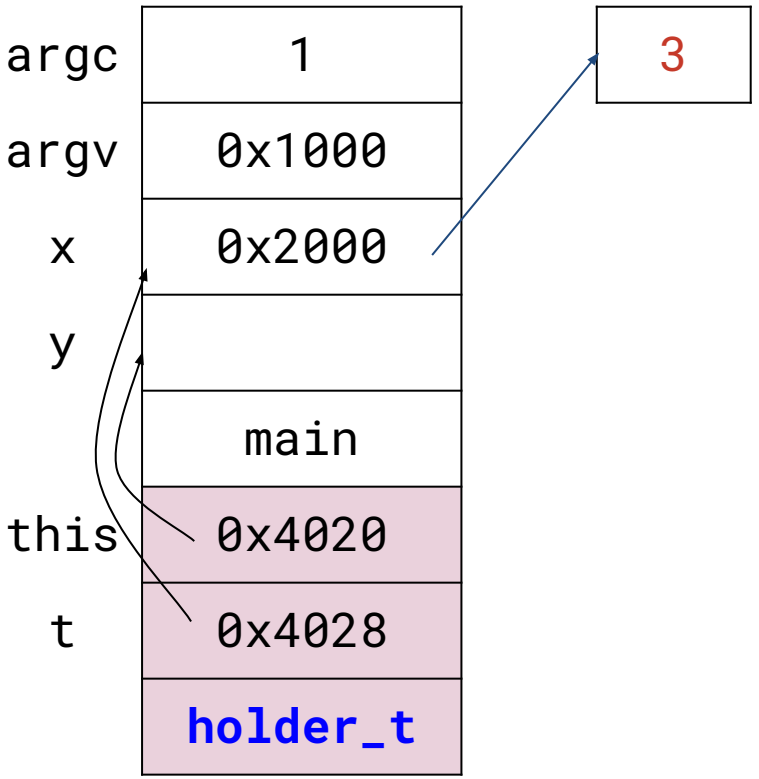

Copy constructor

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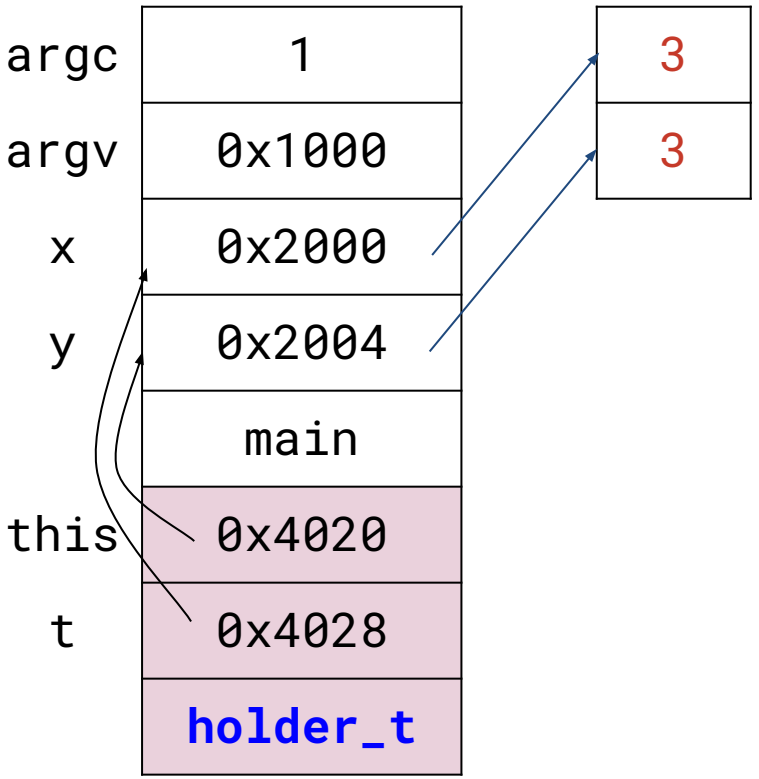

deep copy of `t` => allocate memory and copy `*t.p` into `*this->p`

Copy constructor

- Copying an object means performing a deep copy

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  int* p;

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  return 0;
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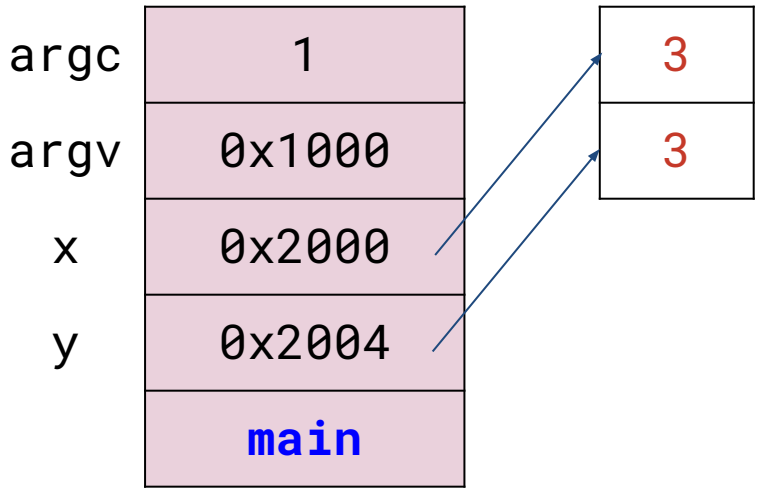


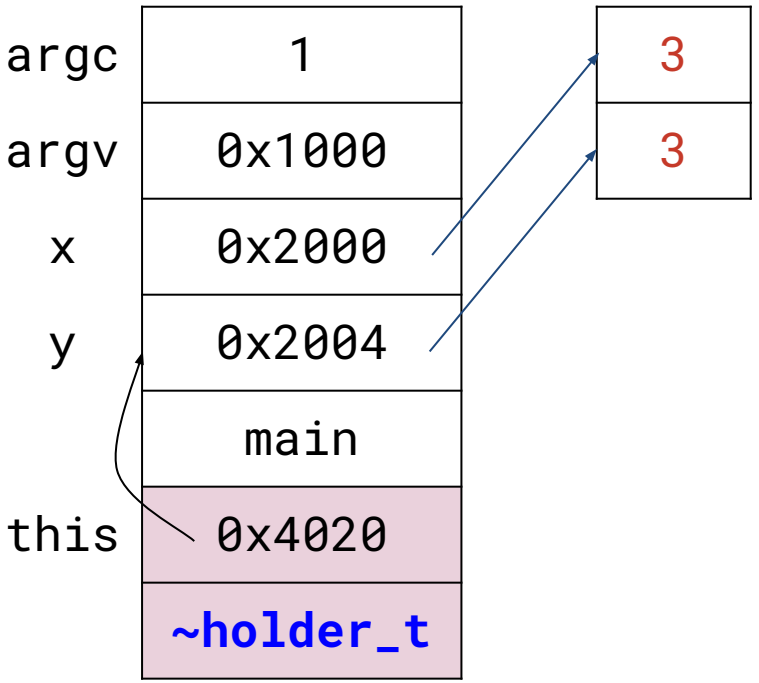
Copy constructor

- Copying an object means performing a deep copy

```
class holder_t {
  int* p;

  holder_t(int i)
    : p { new int { i } } { }
  holder_t(const holder_t& t)
    : p { new int { *t.p } } { };
  ~holder_t() { delete p; }
};

int main(int argc, char* argv[]) {
  holder_t x { 3 };
  holder_t y { x };
  return 0;
}
```



Copy constructor

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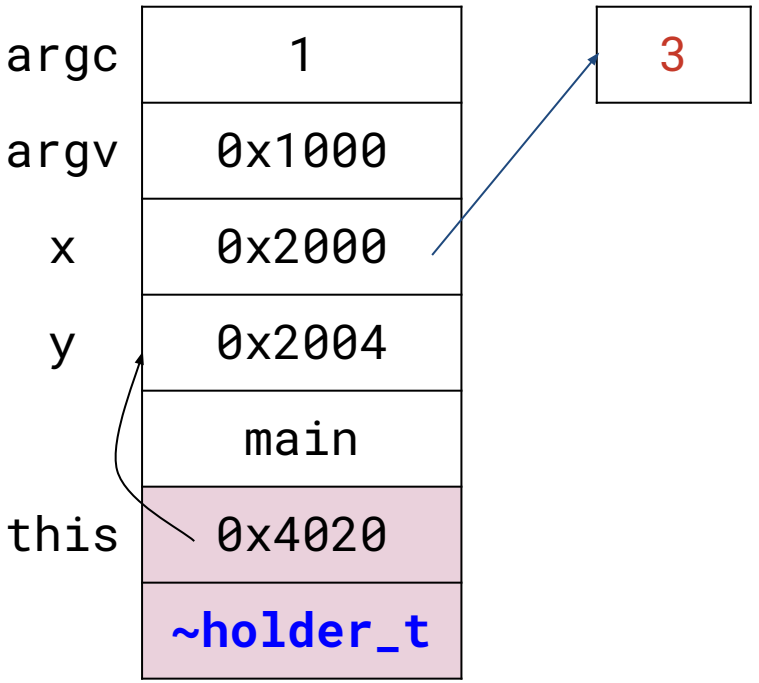

Copy constructor

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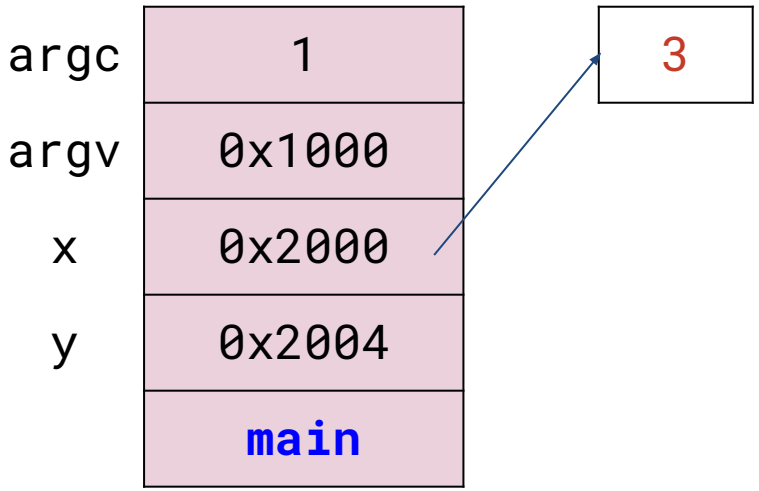

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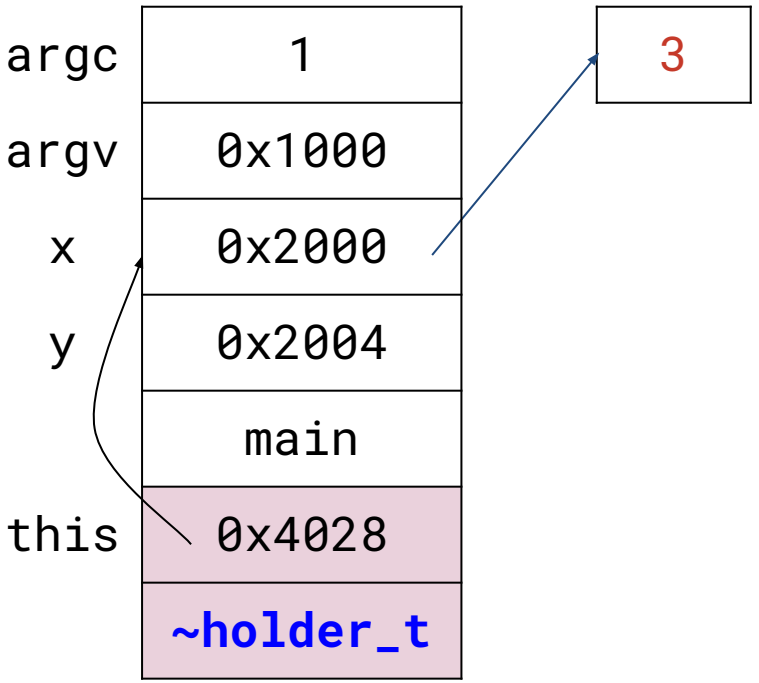

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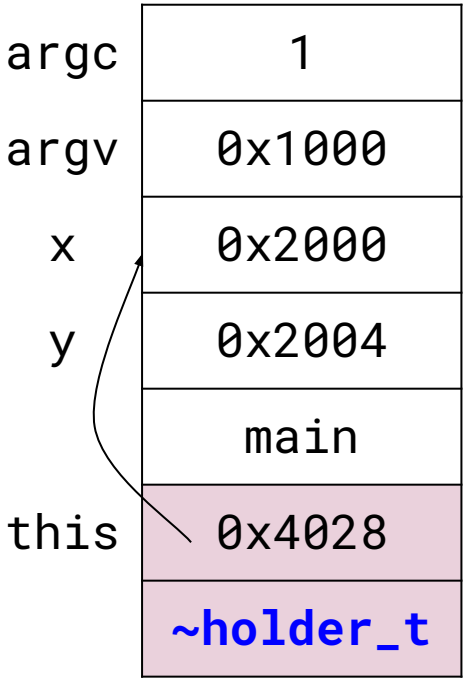

A deep copy is sometimes inefficient

- Useless copies since at each time a single instance exists

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struct holder_t {
  int* p;

  holder_t(int i)
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    : p { new int { *t.p } } { };
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};

holder_t self(holder_t h) { return h; }

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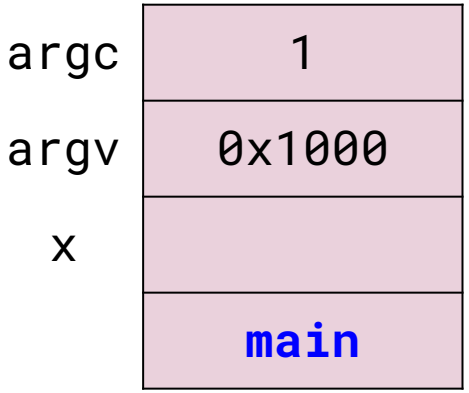

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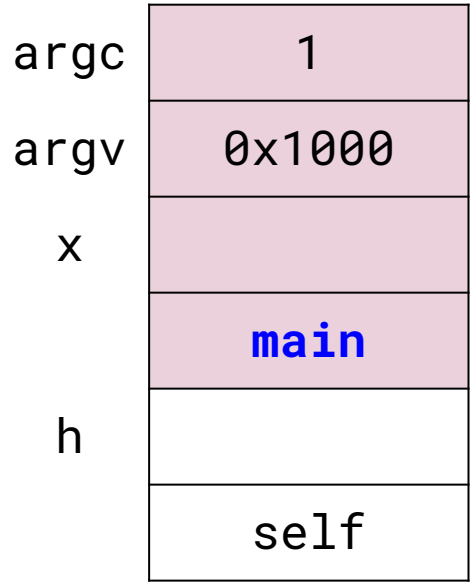

Smartly the compiler avoids a copy by directly constructing the parameter of `self` from 3

A deep copy is sometimes inefficient

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struct holder_t {
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  holder_t(int i)
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};

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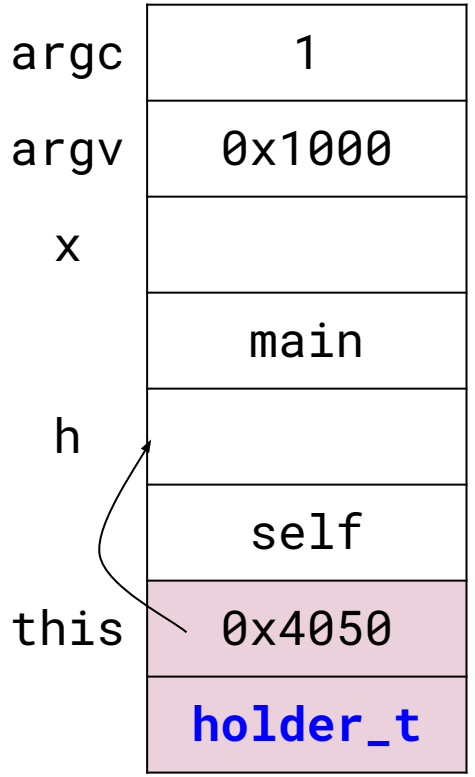
int main(int argc, char* argv[]) {
  holder_t x { self(3) };
  return 0;
}
```



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  holder_t(const holder_t& t)
    : p { new int { *t.p } } { };
  ~holder_t() { delete p; }
};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
  holder_t x { self(3) };
  return 0;
}
```

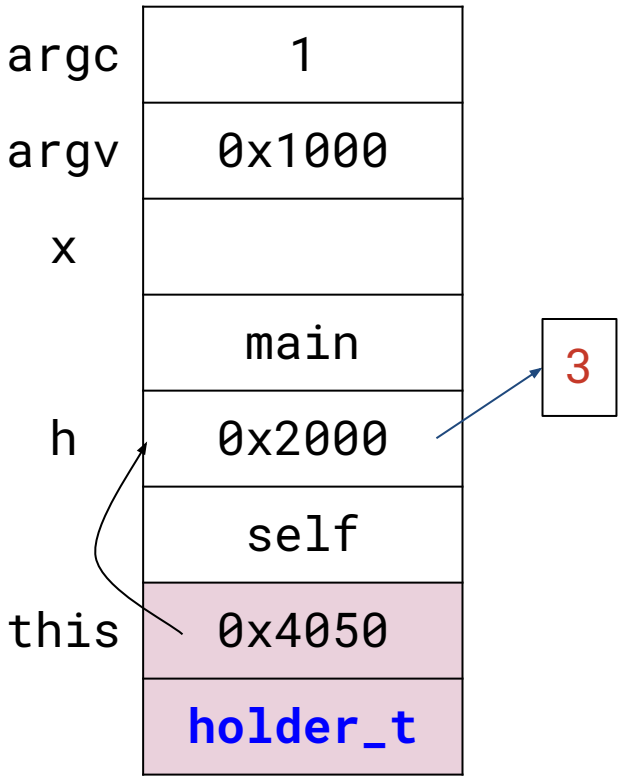

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    : p { new int { *t.p } } { };
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};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
  holder_t x { self(3) };
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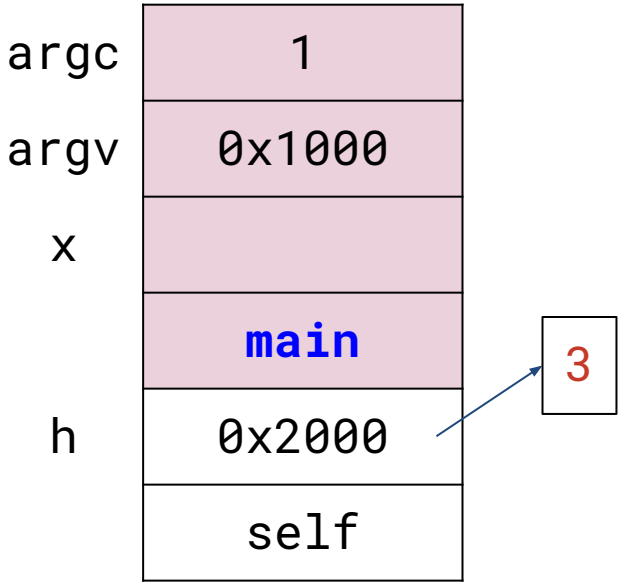
}
```



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- Useless copies since at each time a single instance exists

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struct holder_t {
  int* p;

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    : p { new int { *t.p } } { };
  ~holder_t() { delete p; }
};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
  holder_t x { self(3) };
  return 0;
}
```
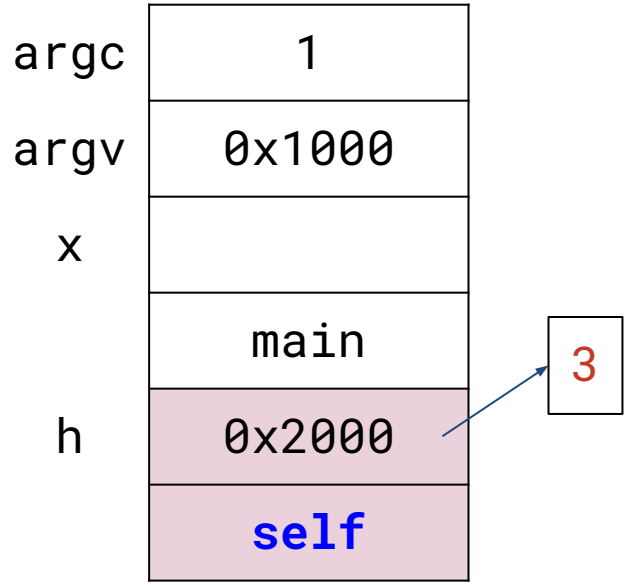
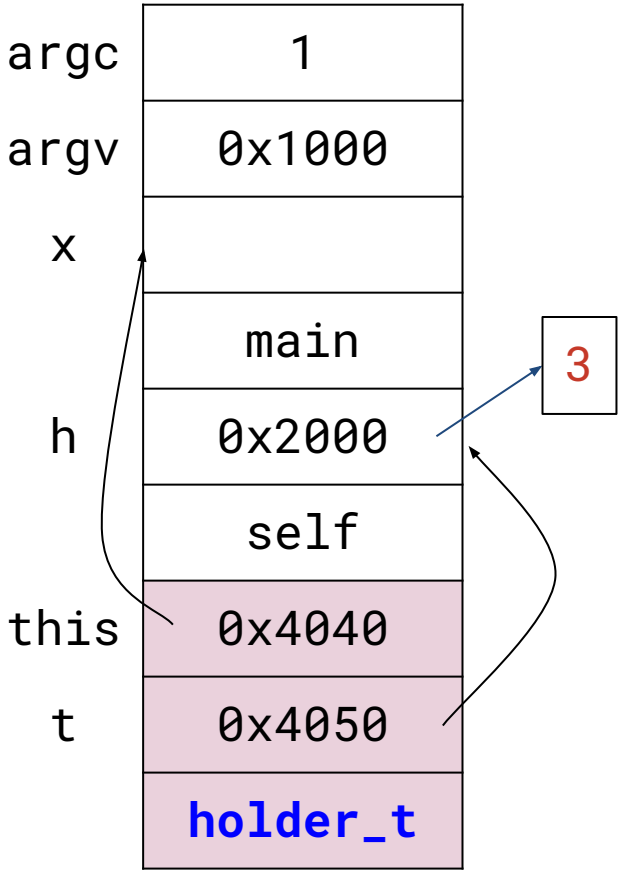



Smartly, the compiler avoids a copy by directly constructing the result in the caller

A deep copy is sometimes inefficient

- Useless copies since at each time a single instance exists

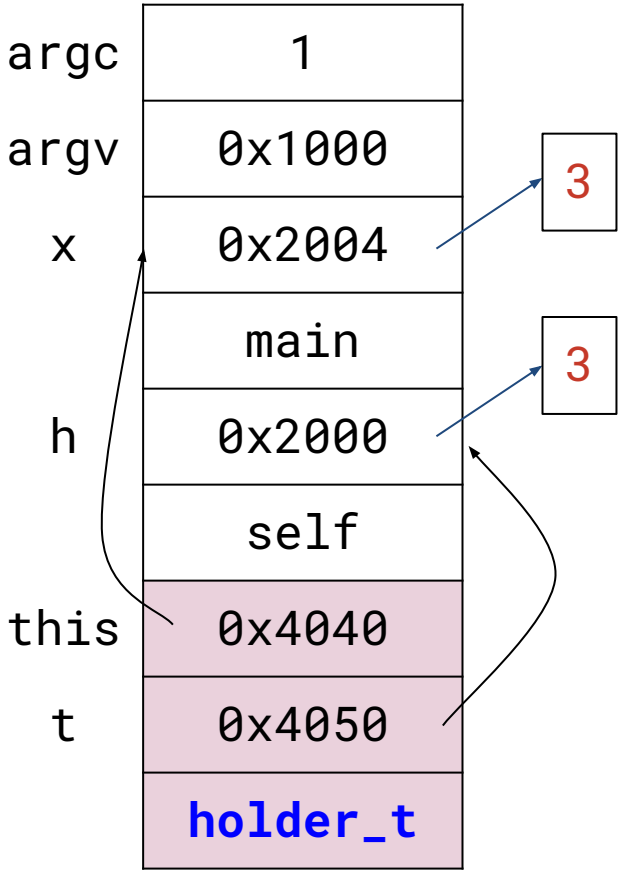
```
struct holder_t {
  int* p;

  holder_t(int i)
    : p { new int { i } } { }
  holder_t(const holder_t& t)
    : p { new int { *t.p } } { };
  ~holder_t() { delete p; }
};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
  holder_t x { self(3) };
  return 0;
}
```



A deep copy is sometimes inefficient

- The deep copy here is useless since h will be destroyed after

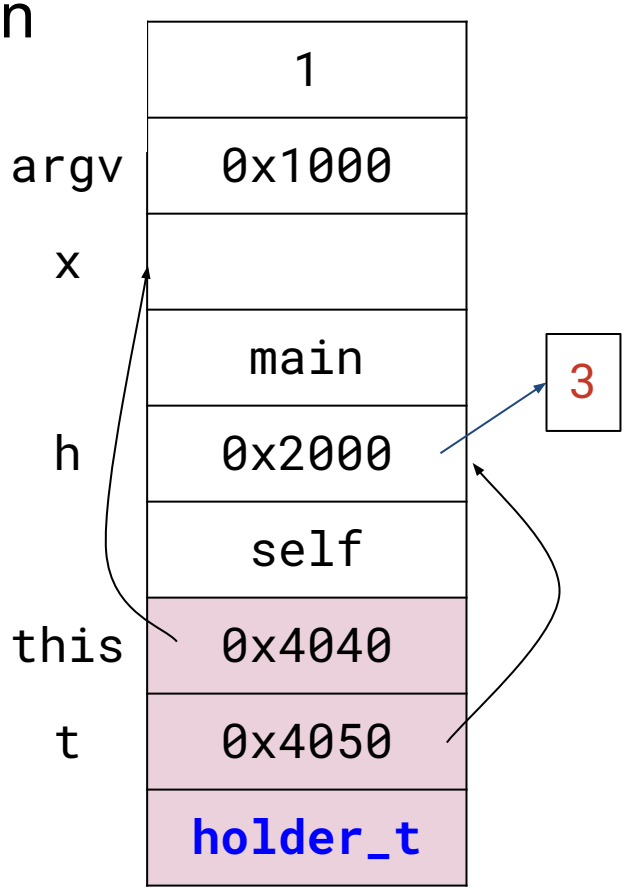
```
struct holder_t {
  int* p;

  holder_t(int i)
    : p { new int { i } } { }
  holder_t(const holder_t& t)
    : p { new int { *t.p } } { };
  ~holder_t() { delete p; }
};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
  holder_t x { self(3) };
  return 0;
}
```



The move constructor

- A move constructor receives a `holder_t&& t` used instead of the copy constructor when the parameter is destroyed just after

```
s
  holder_t(int i)
    : p { new int { i } } { }
  holder_t(holder_t&& t)
    : p { t.p } { t.p = nullptr; };
  ~holder_t() { delete p; }
};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
  holder_t x { self(3) };
  return 0;
}
```



The move constructor

- A move constructor receives a `holder_t&& t`

```
struct holder_t {
  int* p;

  holder_t(int i)
    : p { new int { i } } { }
  holder_t(holder_t&& t)
    : p { t.p } { t.p = nullptr; };
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};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
  holder_t x { self(3) };
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```

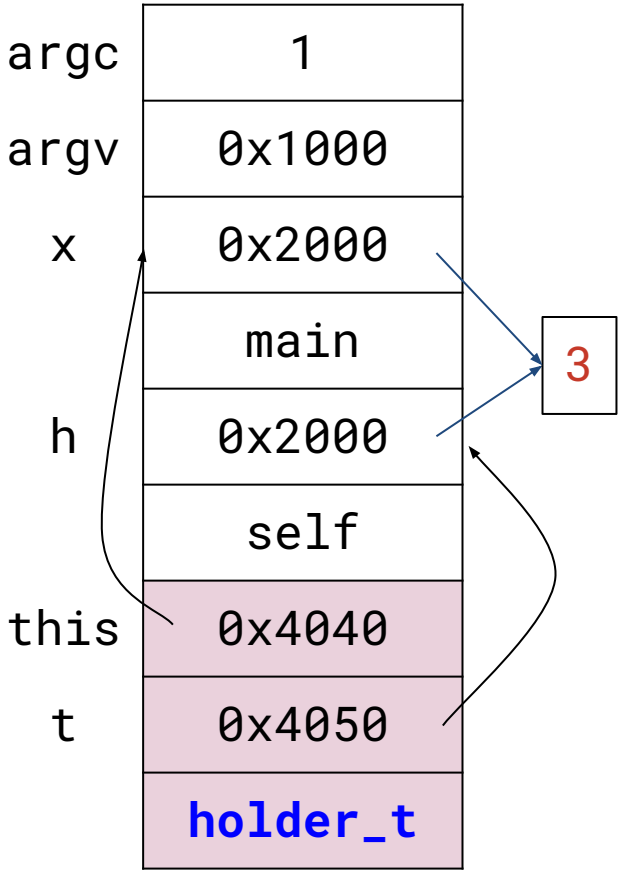

The move constructor

- A move constructor receives a `holder_t&& t`
  `t.p = nullptr` in order to avoid deleting the integer at `0x2000` in the destructor

```
s
  holder_t(int i)
    : p { new int { i } } { }
  holder_t(holder_t&& t)
    : p { t.p } { t.p = nullptr; };
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};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
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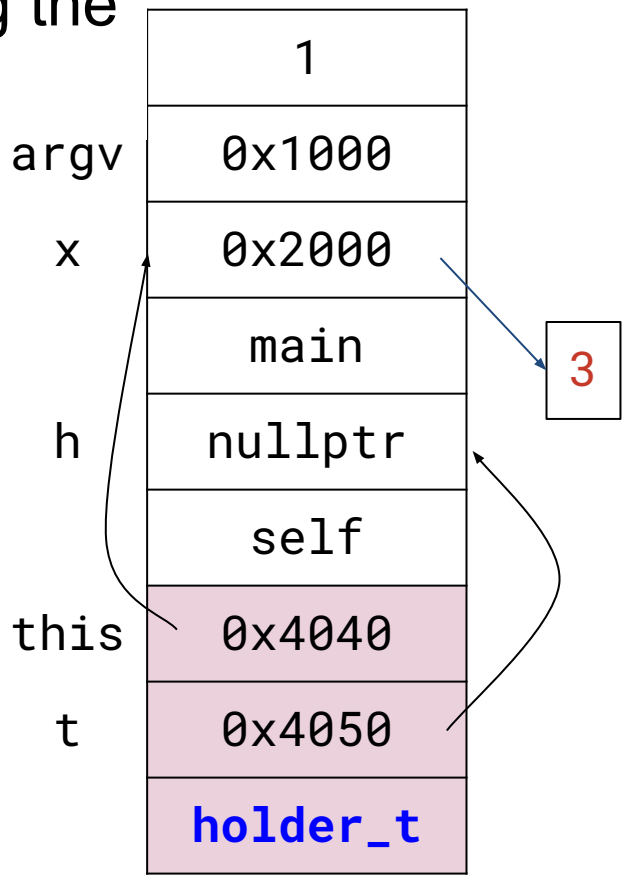

The move constructor

- A move constructor receives a `holder_t&& t`

```
struct holder_t {
  int* p;

  holder_t(int i)
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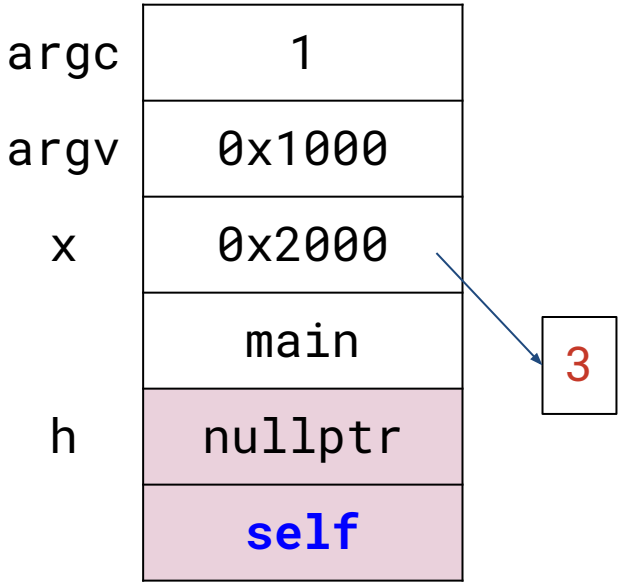

The move constructor

- A move constructor receives a `holder_t&& t`

```
struct holder_t {
  int* p;

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  holder_t(holder_t&& t)
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};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
  holder_t x { self(3) };
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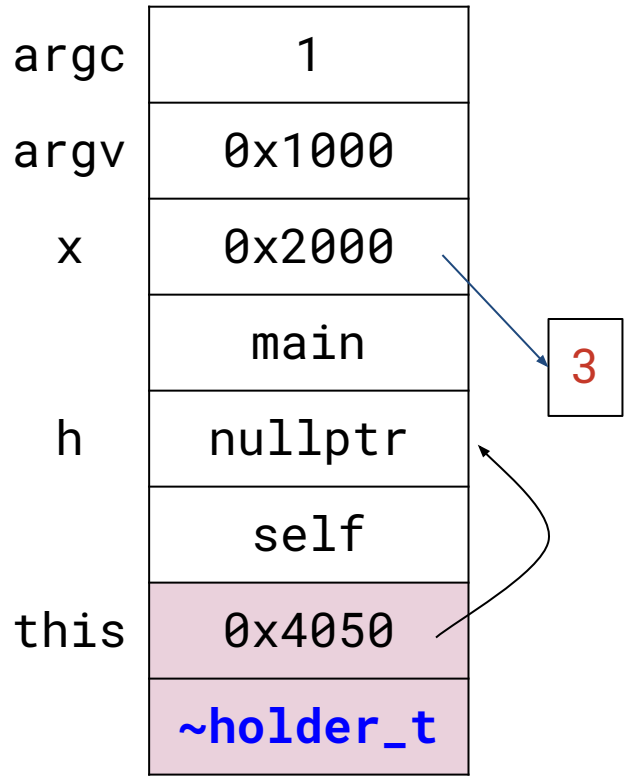

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}
```
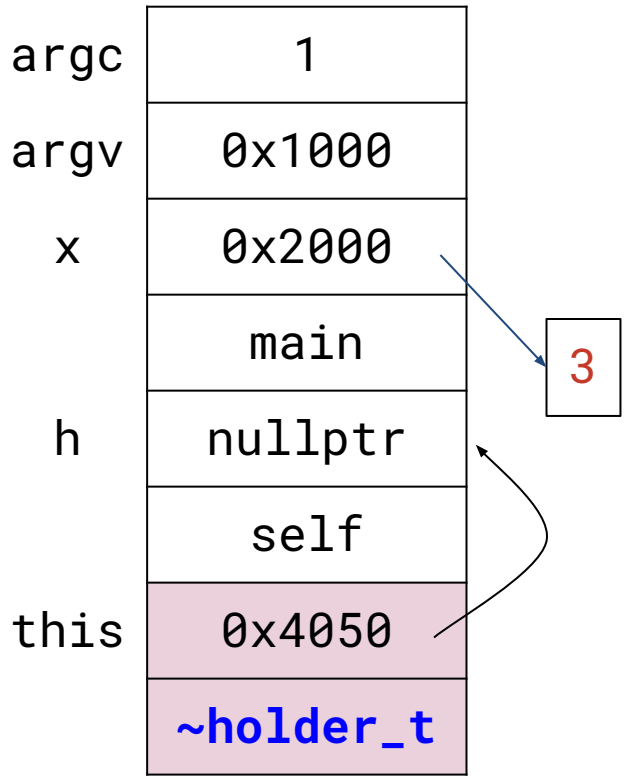
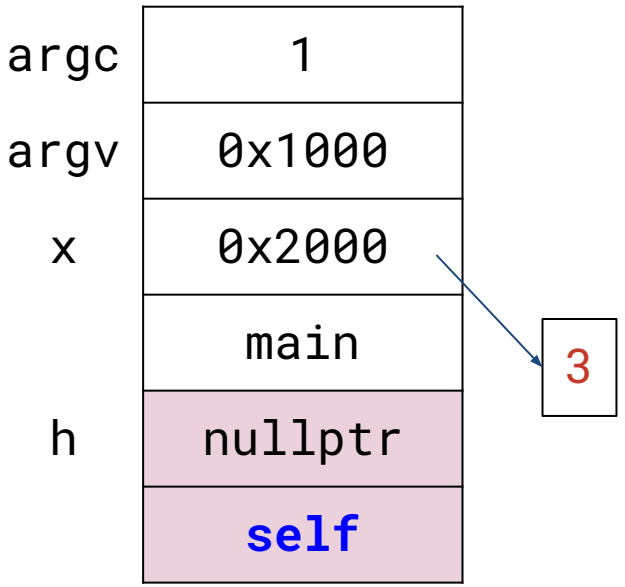



`delete` has no effect

The move constructor

- A move constructor receives a `holder_t&& t`

```
struct holder_t {
  int* p;

  holder_t(int i)
    : p { new int { i } } { }
  holder_t(holder_t&& t)
    : p { t.p } { t.p = nullptr; };
  ~holder_t() { delete p; }
};

holder_t self(holder_t h) { return h; }

int main(int argc, char* argv[]) {
  holder_t x { self(3) };
  return 0;
}
```



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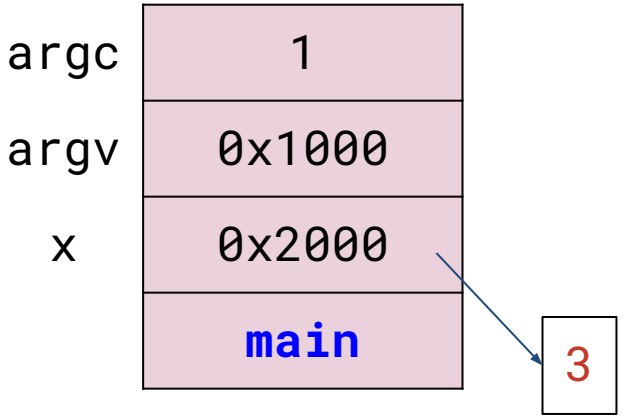

Thanks to the move constructor: 0 deep copy in this code

The rvalue reference (&&)

- A rvalue reference is a reference identified with &&
  - The compiler call a method with a rvalue reference when the parameter will be destroyed after the call
  - Useful to move instead of copy an object

- A rvalue reference is used for the move constructor
  - But can be useful for the operator =
  - And other cases

Key concepts

- The copy constructor
  - Is used to deeply copy an object
  - `holder_t(const holder_t& t)`
- The move constructor
  - Is used to move an object into another
  - Avoid a deep copy
  - Called when the parameter will be destroyed after the call
  - `holder_t(holder_t&& t)`
  - Don’t forget to nullify the elements of `t` that are deleted in the destructor