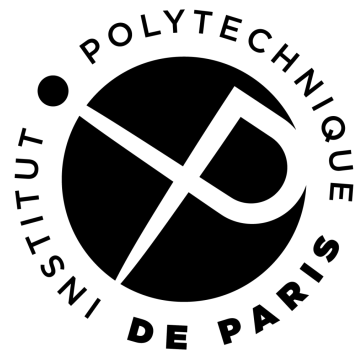

Operator overloading

Bachelor of Science - École polytechnique

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Key concepts

- You can overload the C++ operators
  - Return a new object by copy

```
c_t operator + (const c_t& a, const c_t& b)
```

  - Return one of the parameter by reference

```
c_t& operator += (c_t& a, const c_t& b)
```

- A cast operator is used to convert an object to another type

- You can print your own objects by overloading <<

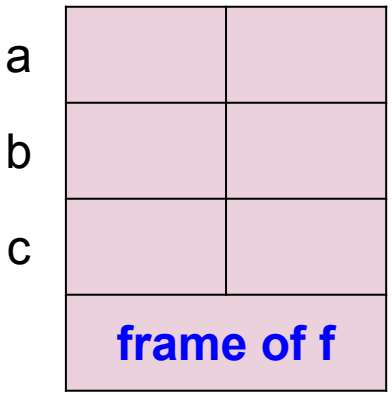
```
std::ostream& operator << (std::ostream& os, const c_t& c)
```

Operator overloading

- You can overload any operator in C++

```
struct c_t {
  double r;
  double i;
};

c_t operator + (const c_t& a, const c_t& b) {
  c_t r { a.r + b.r, a.i + b.i };
  return r;
}
```



Operator overloading

- An overloaded operator can be used with the new types

```
struct c_t {
  double r;
  double i;
};

c_t operator + (const c_t& a, const c_t& b) {
  c_t r { a.r + b.r, a.i + b.i };
  return r;
}

void f() {
  c_t a { 1, 2 }, b { 10, 12 };
  c_t c = a + b;
  ...
}
```

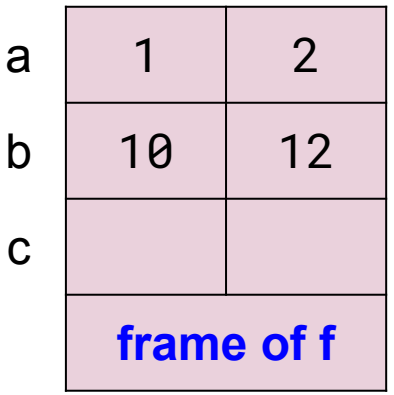
Operator overloading

- a and b are local variables => allocated in the frame

```
struct c_t {
  double r;
  double i;
};

c_t operator + (const c_t& a, const c_t& b) {
  c_t r { a.r + b.r, a.i + b.i };
  return r;
}

void f() {
  c_t a { 1, 2 }, b { 10, 12 };
  c_t c = a + b;
  ...
}
```



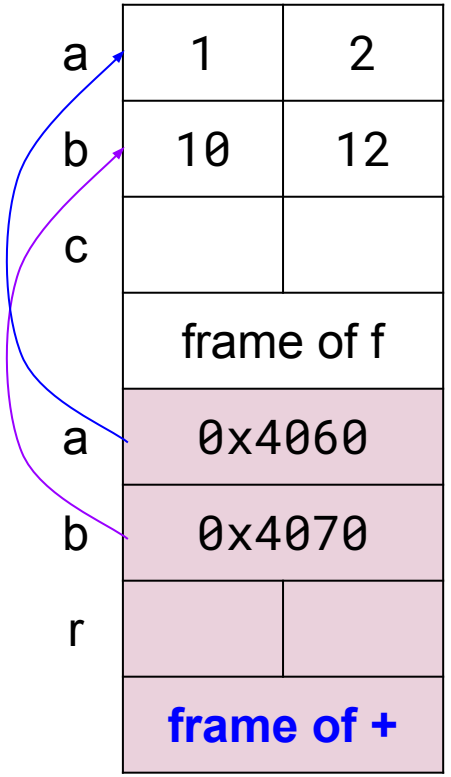
Operator overloading

- a and b are passed by reference => + receives pointers

```
struct c_t {
  double r;
  double i;
};

c_t operator + (const c_t& a, const c_t& b) {
  c_t r { a.r + b.r, a.i + b.i };
  return r;
}

void f() {
  c_t a { 1, 2 }, b { 10, 12 };
  c_t c = a + b;
  ...
}
```



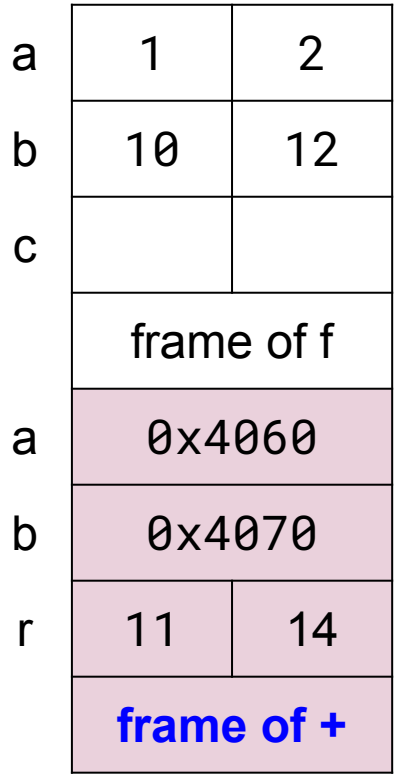
Operator overloading

- `+` uses the `a` and `b` of `f` to compute `r`

```
struct c_t {
  double r;
  double i;
};

c_t operator + (const c_t& a, const c_t& b) {
  c_t r { a.r + b.r, a.i + b.i };
  return r;
}

void f() {
  c_t a { 1, 2 }, b { 10, 12 };
  c_t c = a + b;
  ...
}
```



Operator overloading

- The result of `+` is an object (not a reference, not a pointer)
  => the fields of `r` are copied into the fields of `c`

```
struct c_t {
  double r;
  double i;
};

c_t operator + (const c_t& a, const c_t& b) {
  c_t r { a.r + b.r, a.i + b.i };
  return r;
}

void f() {
  c_t a { 1, 2 }, b { 10, 12 };
  c_t c = a + b;
  ...
}
```

a	1	2
b	10	12
c	11	14
	frame of f	

Operator overloading and return type

- Return by copy versus return by reference

```
// returns a copy when the arguments are not modified
c_t operator + (const c_t& a, const c_t& b) {
  c_t r { a.r + b.r, a.i + b.i };
  return r; // returns a copy of r
}

// returns a reference when one of the argument is modified
c_t& operator += (c_t& a, const c_t& b) {
  a.r += b.r;
  a.i += b.i;
  return a; // returns a reference to a, not a copy of a
}
```

Cast operator

- A cast operator is used to convert a type to another

```
struct c_t {
  double r;
  double i;

  operator double() const { return r; }
};

int main(int argc, char** argv) {
  c_t c { 1, 2 };
  double r = c; // => 1
  return 0;
}
```

Printing an object

- You can print your own objects thanks to operator overloading

```
struct c_t {
  double r;
  double i;
};

std::ostream& operator << (std::ostream& os, const c_t& c) {
  os << "(" << c.r << ", " << c.i << ")";
  return os;
}

int main(int argc, char** argv) {
  c_t a { 3, 4 };
  std::cout << a << std::endl; // => (3, 4)
  return 0;
}
```

Key concepts

- You can overload the C++ operators
  - Return a new object by copy
    ```
    c_t operator + (const c_t& a, const c_t& b)
    ```
  - Return one of the parameter by reference
    ```
    c_t& operator += (c_t& a, const c_t& b)
    ```
- A cast operator is used to convert an object to another type
- You can print your own objects by overloading `<<`
  ```
  std::ostream& operator << (std::ostream& os, const c_t& c)
  ```