Streams

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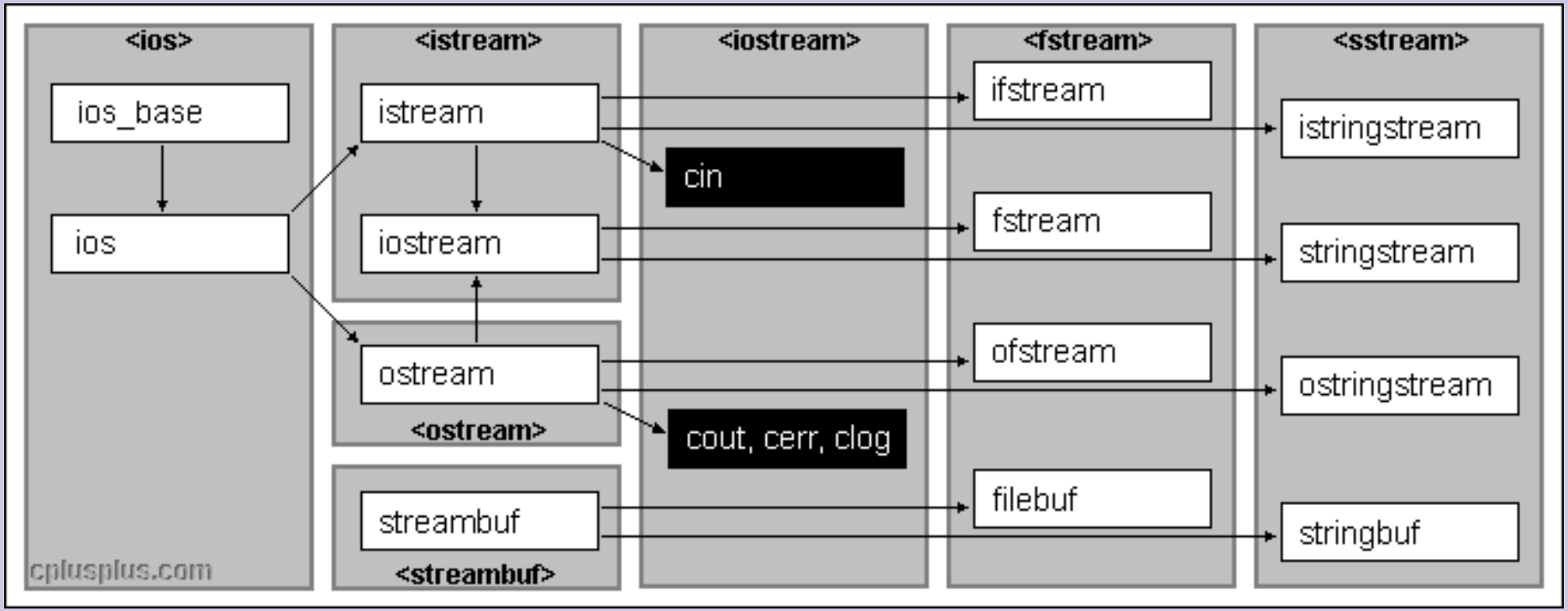
Class hierarchy



Output stream

- The **`ostream`** object overloads the **`<<`** operator for each basic type.
- The operator returns a reference to the

output stream, which allows combined output:

```
std::cout << “2 + 3 = “ << 2 + 3 << std::endl;
```

Standard output stream objects

- **`cout`** **-** attached to stdout.
- **`cerr`** **-** attached to stderr, unbuffered.
- **`clog`** **-** attached to stderr, buffered.

We can redirect stdout and stderr to different files; *see folder 2*.

Other output stream objects (folder 2)

- **`ostringstream -`** attached to a string.
- **`ofstream -`** attached to a file.

Output stream manipulators (folder 3)

- We can "write" to ostream, functions that do not create any output, but rather change some variables of the ostream.
- For example:
- ```
  cout << setprecision(4) << 1234.5678
       << setprecision(100) << 1234.5678
  ```
- "setprecision" does not print anything – it just modifies the precision level of the stream.
- *How does it work?* – operator overloading!
  http://cs.brown.edu/~jwicks/libstdc++/html_user/iomanip-source.html
  ```

Input stream

- **`istream`** is the type defined by the library for input streams.
- **`cin`** is a global object of type **`istream`** attached to stdin.
- Example:

```
#include <iostream>
int i;
std::cin >> i; // reads an int
```

Other input stream objects

- **`istringstream -`** attached to a string.
- **`ifstream -`** attached to a file.

Input stream continued

- When an error occurs (typically because the input format is not what we expect) **`cin`** enters a **`failed`** state and evaluates to **`false`**.
  - **`istream`** overloads the ! opeator and the void* (conversion) operator
- normal usage:

```
ifstream fin("database.tsv");
while (fin >> name >> phone) {
 // do something with name,phone
}
```

Input stream errors

- In failed state **`istream`** will produce no input.
- **`istream`** rewinds on error.
- Use **`clear()`** method to continue reading.

More I/O methods (folder 5)

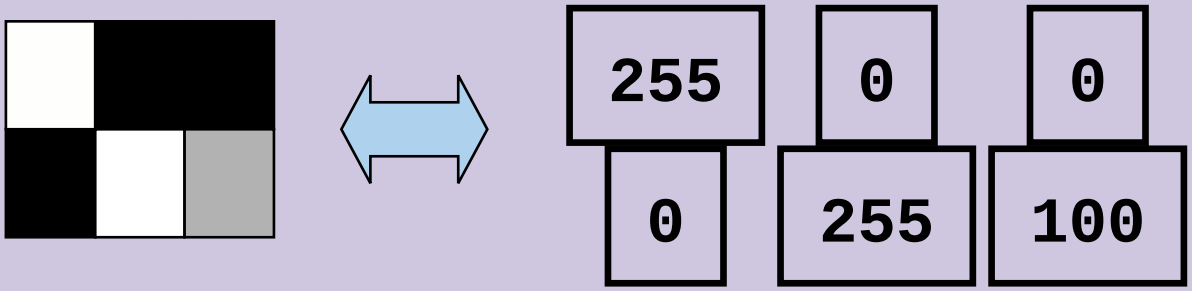
- Both **`ostream`** and **`istream`** have additional methods:
  - **`ostream& put(char ch)`**
  - **`ostream& write(char const *str, int length)`**
  - **`int get() // read one char`**
  - **`istream& get(char& ch) // read one char`**
  - **`getline(char *buffer, int size,`**
    `int delimiter = '\n')`
- Examples:

```
std::cout.put('a');
char ch1, ch2, str[256];
std::cin.get(ch1).get(ch2);
std::cin.getline(str, 256);
```

Binary files

Leading example: image files

- Images are stored as matrices of numbers (pixels)
- Here, we deal with gray-scale images
- *8* bits per pixel
  - i.e. each pixel between 0 and 255
- 255 is white, 0 is black, others are gray



storing images

- How can we store images on files?
- For each image we want to store:
  - width
  - height
  - number of bytes per pixel
  - the pixels
- Requirements: read/write easily, save space, save computation, etc.

storing images

First try: **text files**

cons:

- long
- needs parsing

pros:

- readable by humans
- easy to edit

“myImg.txt”

```
width = 3
height = 2
bytes_per_pixel = 1
255 0     0
0     255 100
```

storing images

Better solution: **Binary files**

- Save the data the way the computer holds it

pros:

- Smaller
- No parsing (faster)

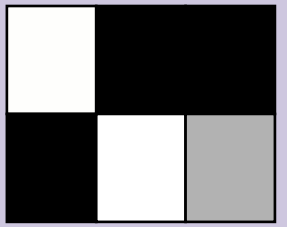
cons:

- hard to read for humans
- Machine dependant

- Widely used:

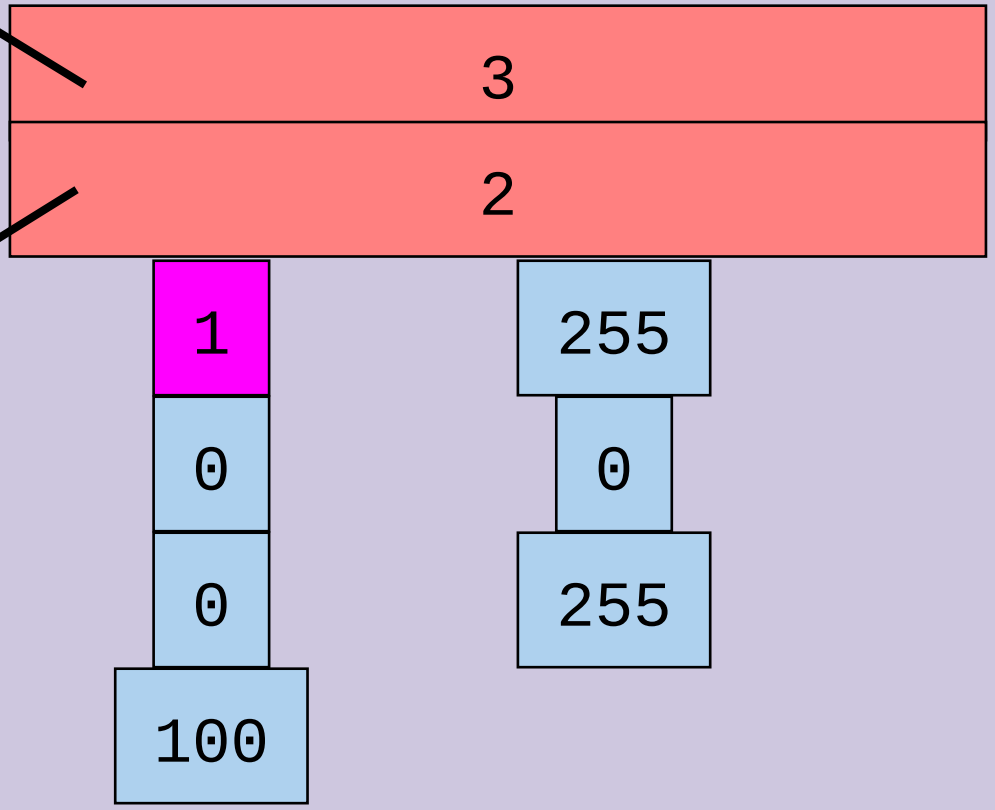
  JPEG, mp3, BMP, other data

Images as binary files

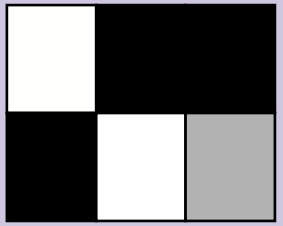


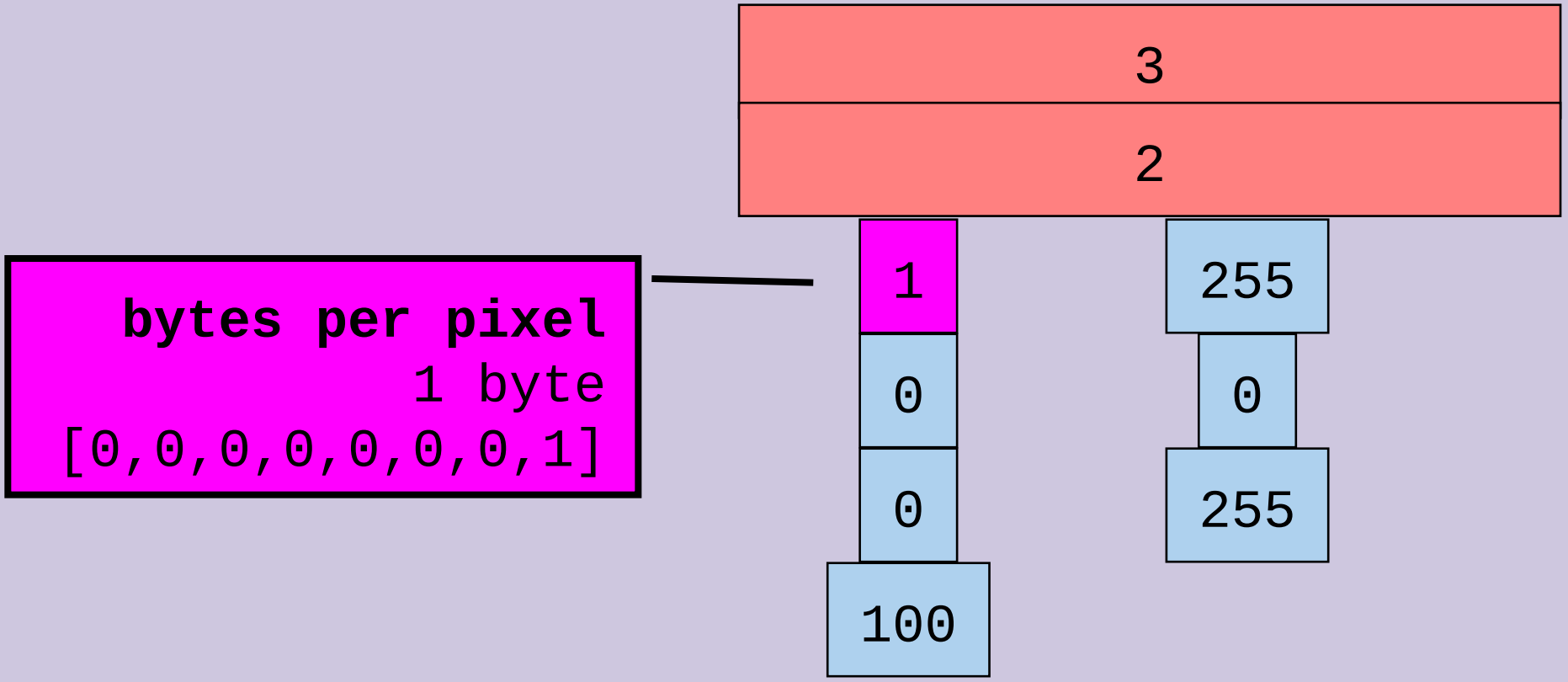
width
4 bytes
[0,…,0,0,1,1]

height
4 bytes
[0,…,0,0,1,0]

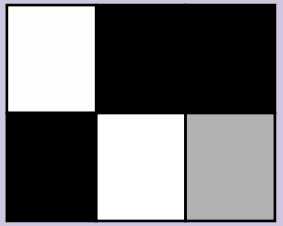


Images as binary files





Images as binary files



pixel
1 byte
[1,1,1,1,1,1,1,1]

3

2

1

0

0

100

255

0

255

pixel
1 byte
[0,0,0,0,0,0,0,0]

Images as binary files - colors

In a colorful image, each pixel should contain more information than just the light intensity.

A common way to represent colors is RGB (Red, Green, Blue).

Each pixel requires 3 bytes – one for Red, one for Green, one for Blue.

See example in folder 5.