

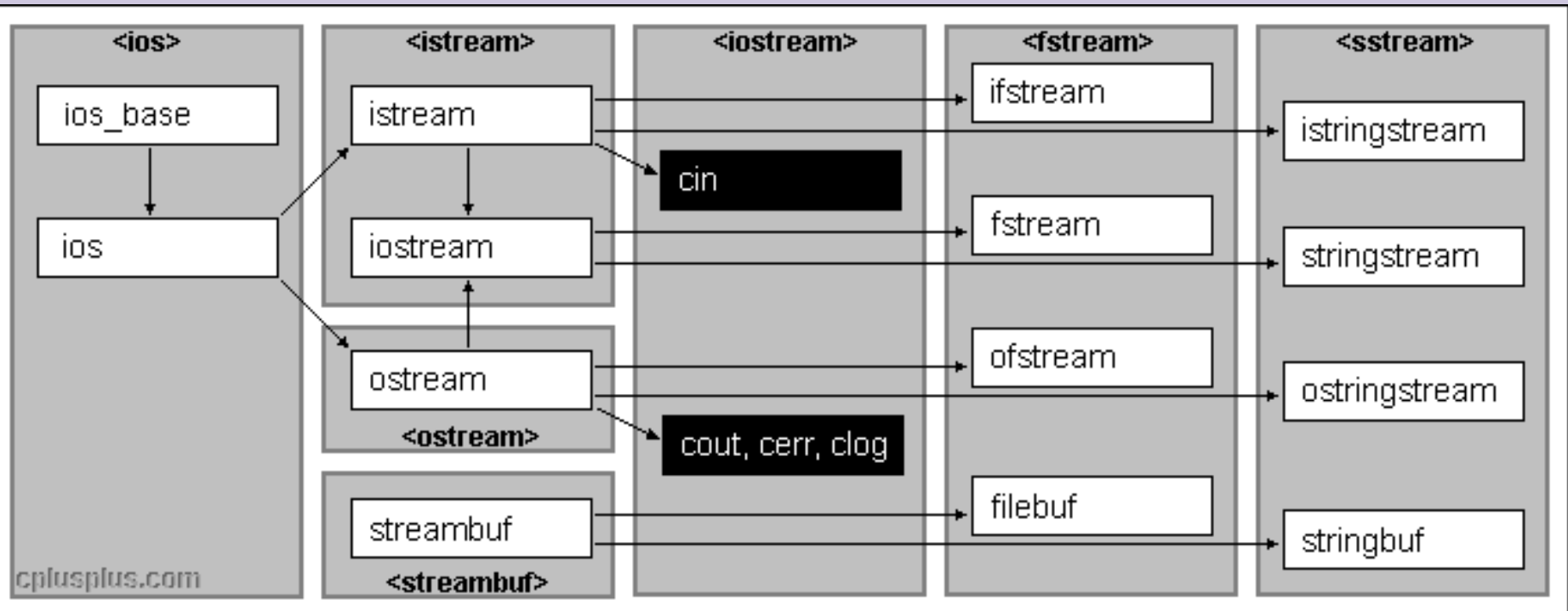


# ***Streams***

Version 1: Dr. Ofir Pele

Version 2: Dr. Erel Segal-Halevi

# *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;
```

## Output stream continued

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```

- `endl` is an example of **manipulator**. `endl` sends a `'\n'` character to the stream and flushes it.
- In fact `endl` is a function:  
`<<` operator has a version that accepts a function pointer

# Standard output stream objects

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

# Other output stream objects

- `ostream` - attached to a string.
- `ofstream` - attached to a file.

# 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
```

- Note that `>>` skips whitespaces.

# 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 `!` operator and the `void*` (conversion) operator
- normal usage:

```
while (fin >> 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)

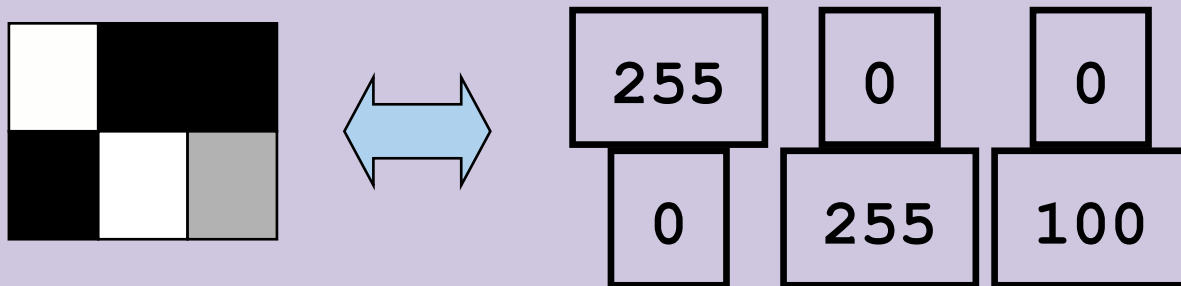
- Both `ostream` and `istream` have additional methods:
  - `ostream& put(char ch)`
  - `ostream& write(char const *str, int length)`
  - `int get() // read one char`
  - `istream& get(char& ch) // read one char`
  - `getline(char *buffer, int size, int delimiter = '\n')`
- Examples:

```
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:

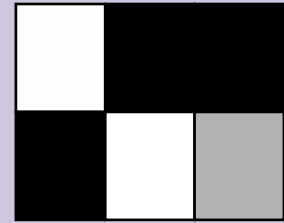
- Smaller
- No parsing (faster)
- Widely used:  
JPEG, mp3, BMP, other data

## cons:

- hard to read for humans
- Machine dependant

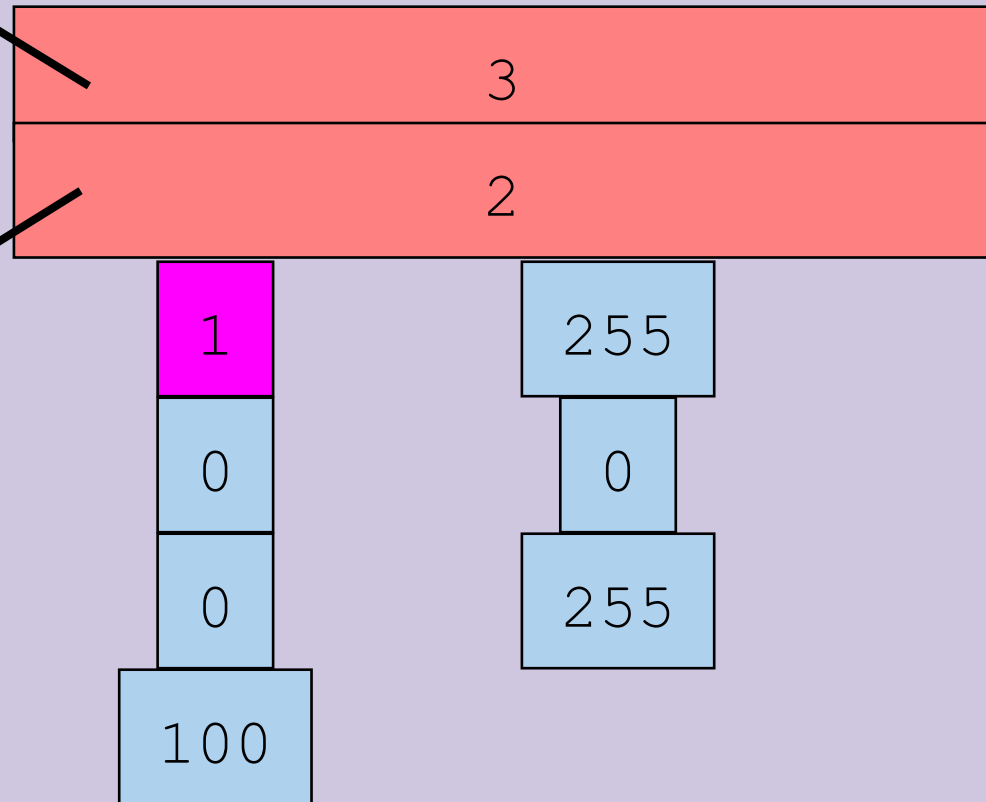


# Images as binary files

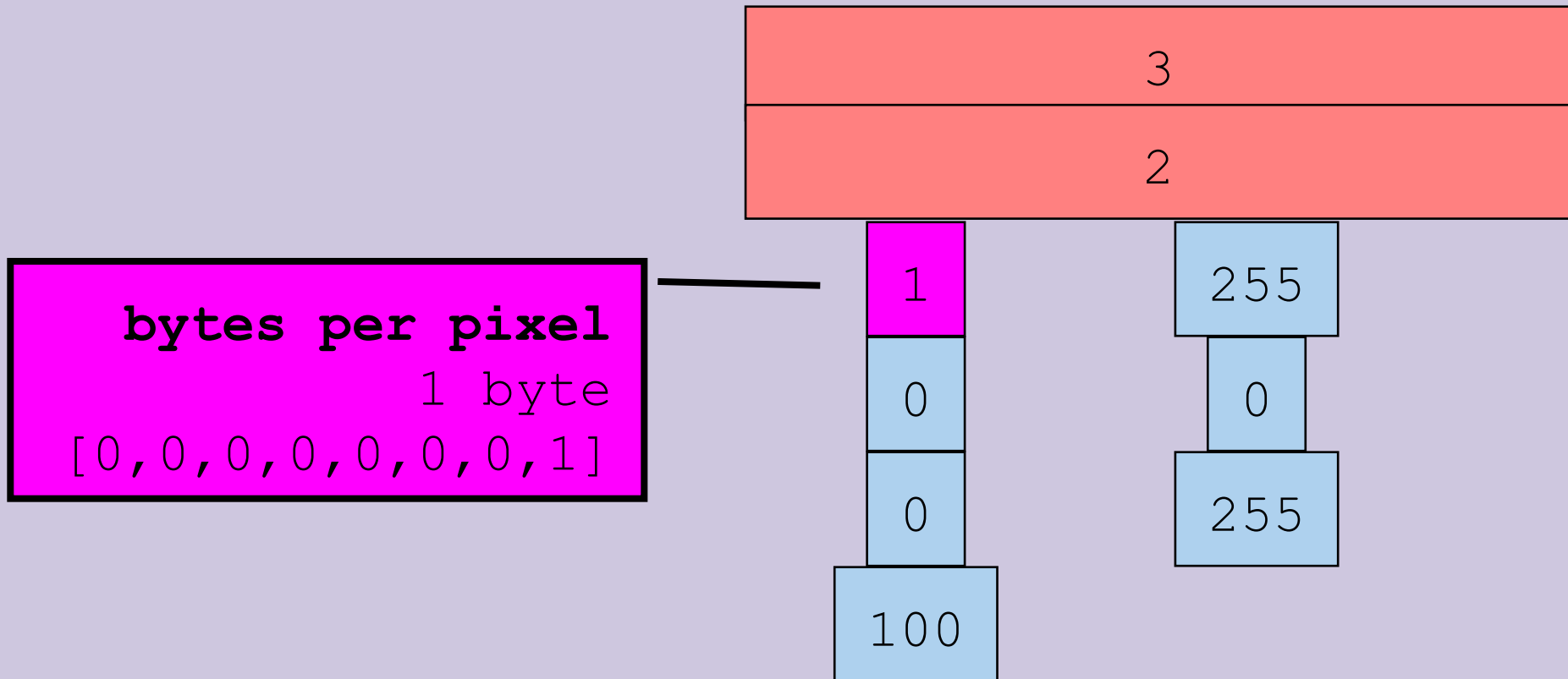
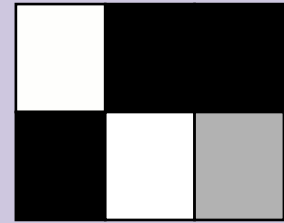


**width**  
4 bytes  
[0, ..., 0, 0, 1, 1]

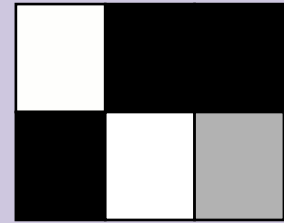
**height**  
4 bytes  
[0, ..., 0, 0, 1, 0]



# 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]