# CS106L Lecture 4:

# Streams 🏞️

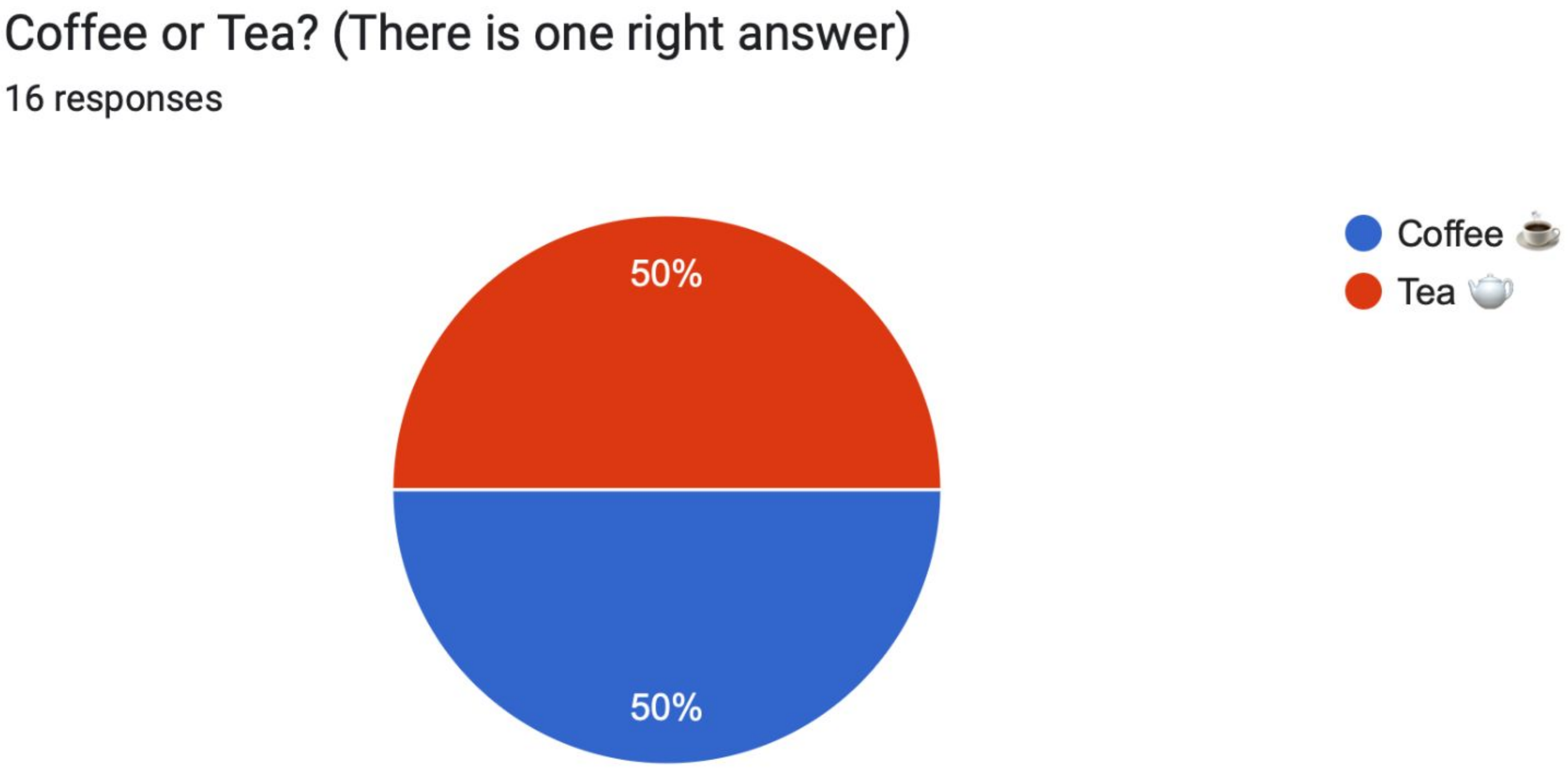
**Spring 2024**

Fabio Ibanez, Haven Whitney

# Attendance 🪄

https://tinyurl.com/streamss24

# Interesting Stats 🪄



Coffee or Tea? (There is one right answer)

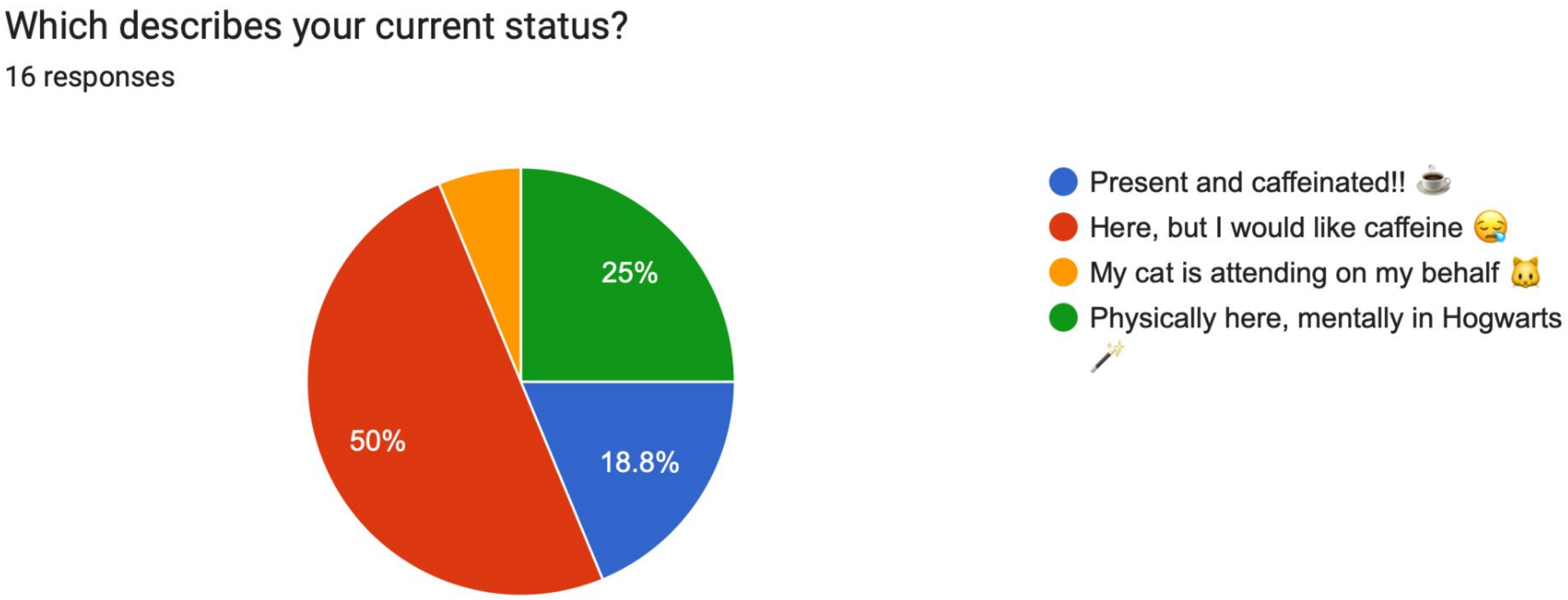
16 responses

# Personally

This is at Billy Brunch in Barcelona. 10/10

ps. I saw Haven in Barcelona!

# Interesting Stats 🪄



Which describes your current status?

16 responses

# For the people in Hogwarts (or anyone)

This is a friendly reminder to let us know how to make this class better for you by submitting feedback using our anonymous feedback form here. ***We're interested in why your cat is attending on your behalf, or why you're in Hogwarts!***

I've even make a QR code for your convenience 🤠 (the slides are up on the website):

# Plan

1. Quick recap
2. What are streams??!!
3. stringstreams
4. Output streams
5. Input streams

# A quick recap

1. **Uniform Initialization** 🦄
   a. Remember this is our “uniform way” of initializing things using `{ }`

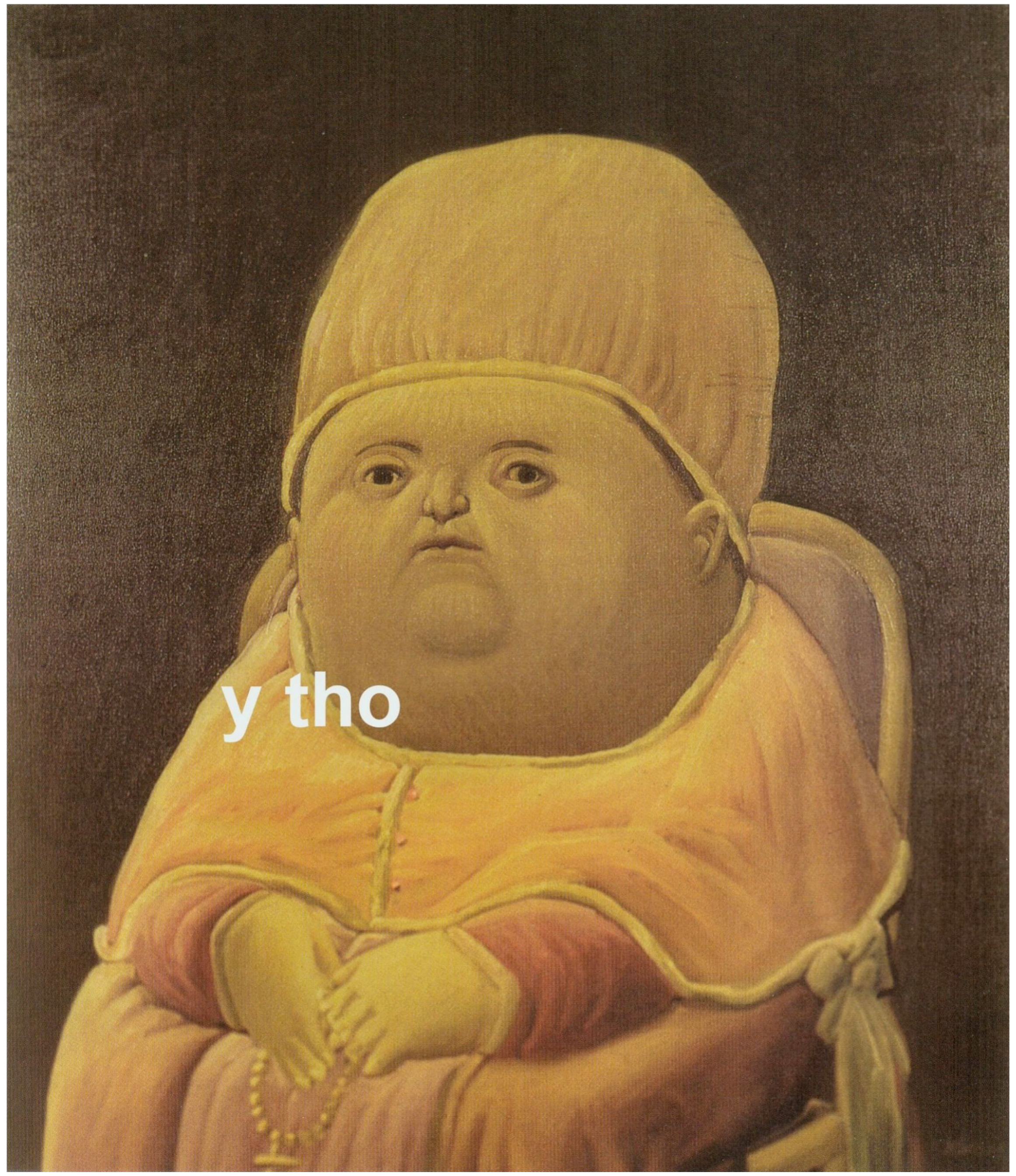
# A quick recap

1. **Uniform Initialization** 🦄
    a. Remember this is our “uniform way” of initializing things using { }
2. **References** 🦄
    a. This is our way of giving variables ***aliases*** and having multiple variables all refer the the **same thing in memory.**

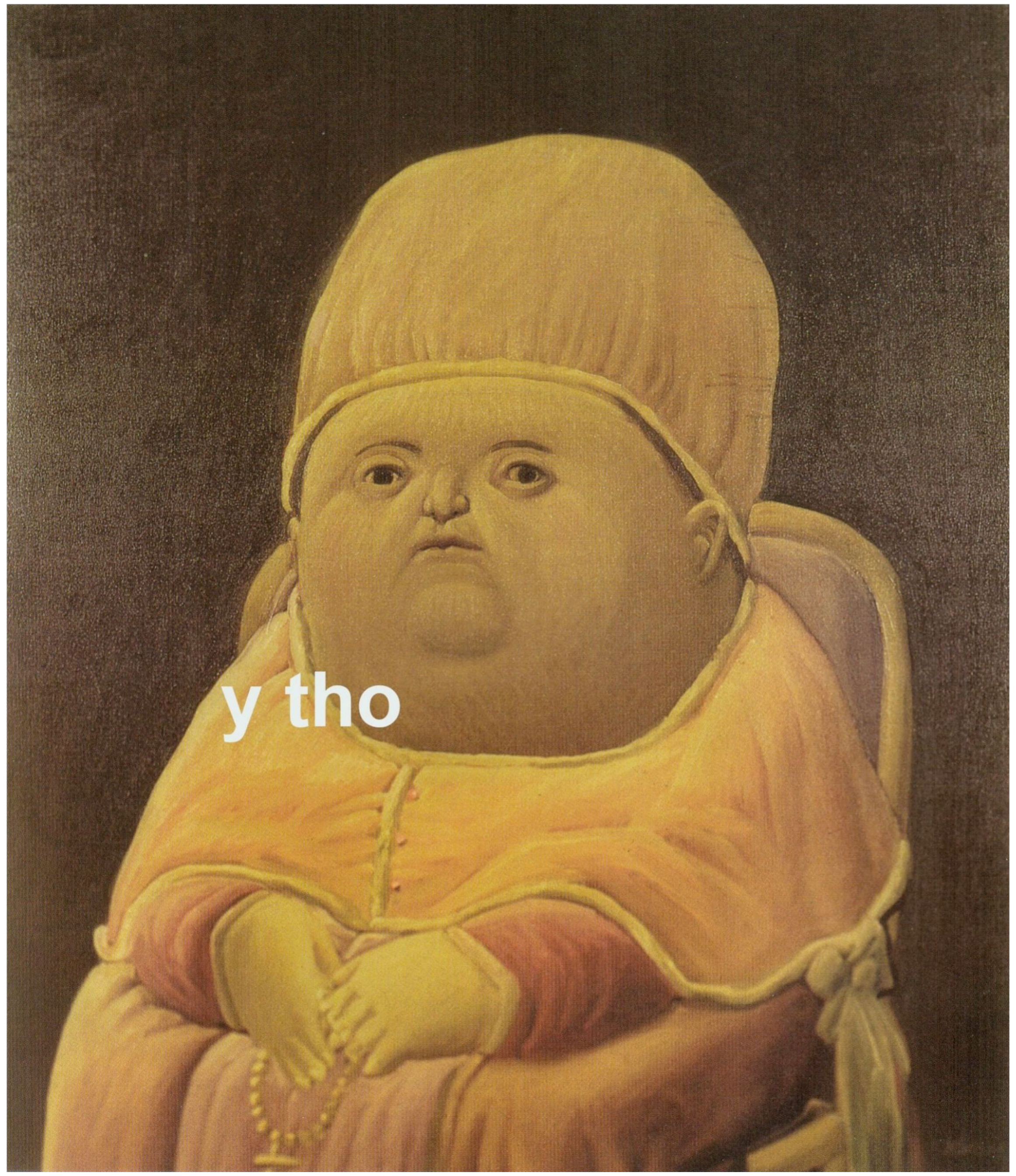
# Plan

1. ~~Quick recap~~
2. What are streams??!!
3. stringstreams
4. `cout` and `cin`
5. Output streams
6. Input streams

# Why (streams) tho?



# Why (streams) tho?



# No but actually

> "Designing and implementing a general **input/output** facility for a programming language is notoriously difficult"
>
> - *Bjarne Stroustrup*

# Streams

"~~Designing and implementing~~ a general **input/output** facility for ~~a programming language is notoriously difficult~~ C++"

- *a stream :)*

# Streams

a general **input/output** facility for C++

# Streams

~~a general **input/output** facility for C++~~

a general **input/output(IO)** abstraction for C++

# Abstractions

Abstractions often provide a consistent ***interface***, and in the case of streams the interface is for reading and writing data!

# `cout` and `cin`

Known as the standard `iostreams`

# `cout` and `cin`

Known as the standard `iostreams`

- **`cerr` and `clog`**

  **`cerr`:** used to output errors

  **`clog`:** used for non-critical event logging

read more here: GeeksForGeeks

# cout and cin

Known as the standard iostreams

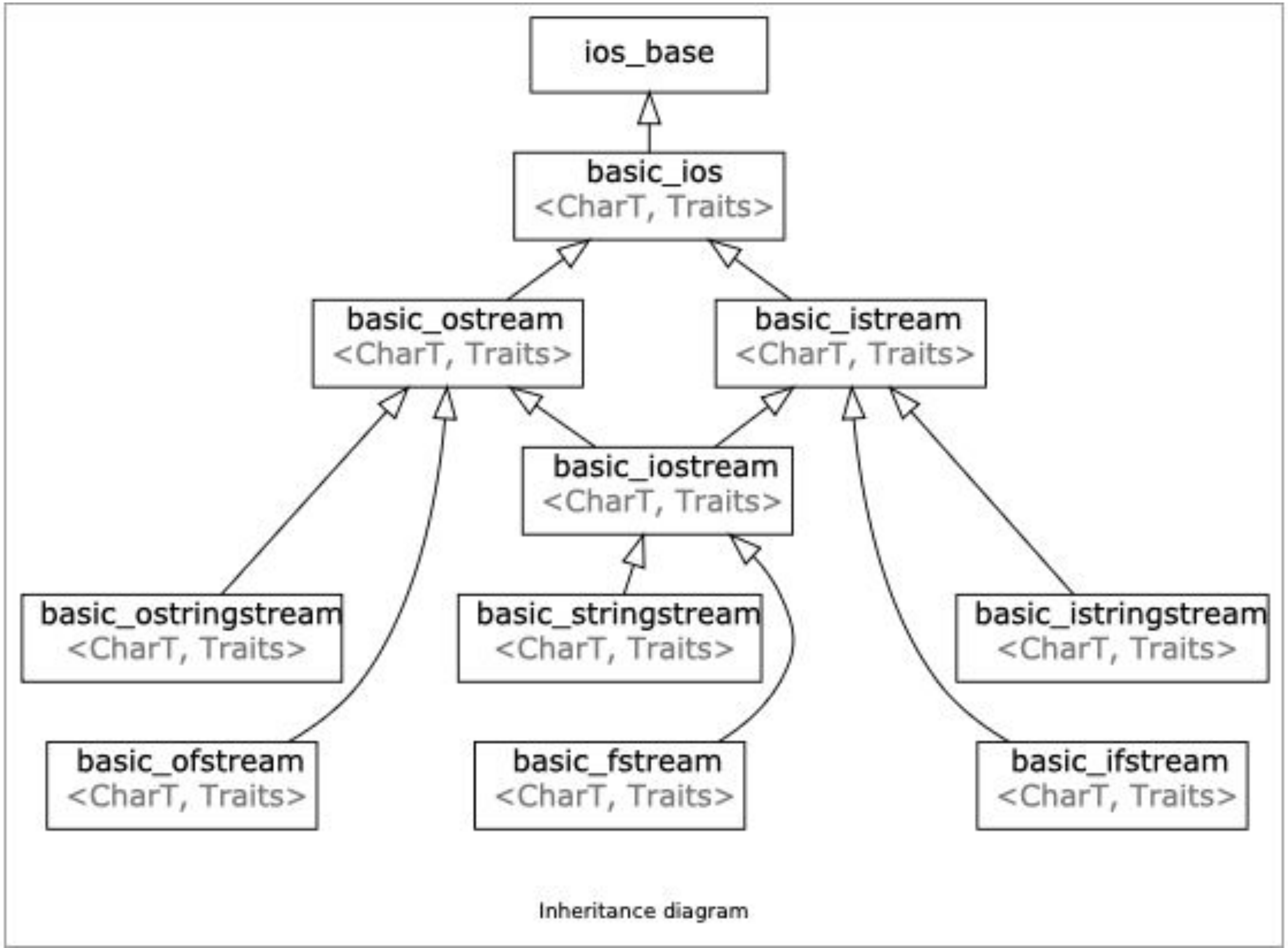
- ~~cerr and clog~~ cout and cin

  cerr: used to output errors

  clog: used for non-critical event logging

read more here: GeeksForGeeks

# `std::cout` and the IO library


ios_base
basic_ios <CharT, Traits>
basic_ostream <CharT, Traits>
basic_istream <CharT, Traits>
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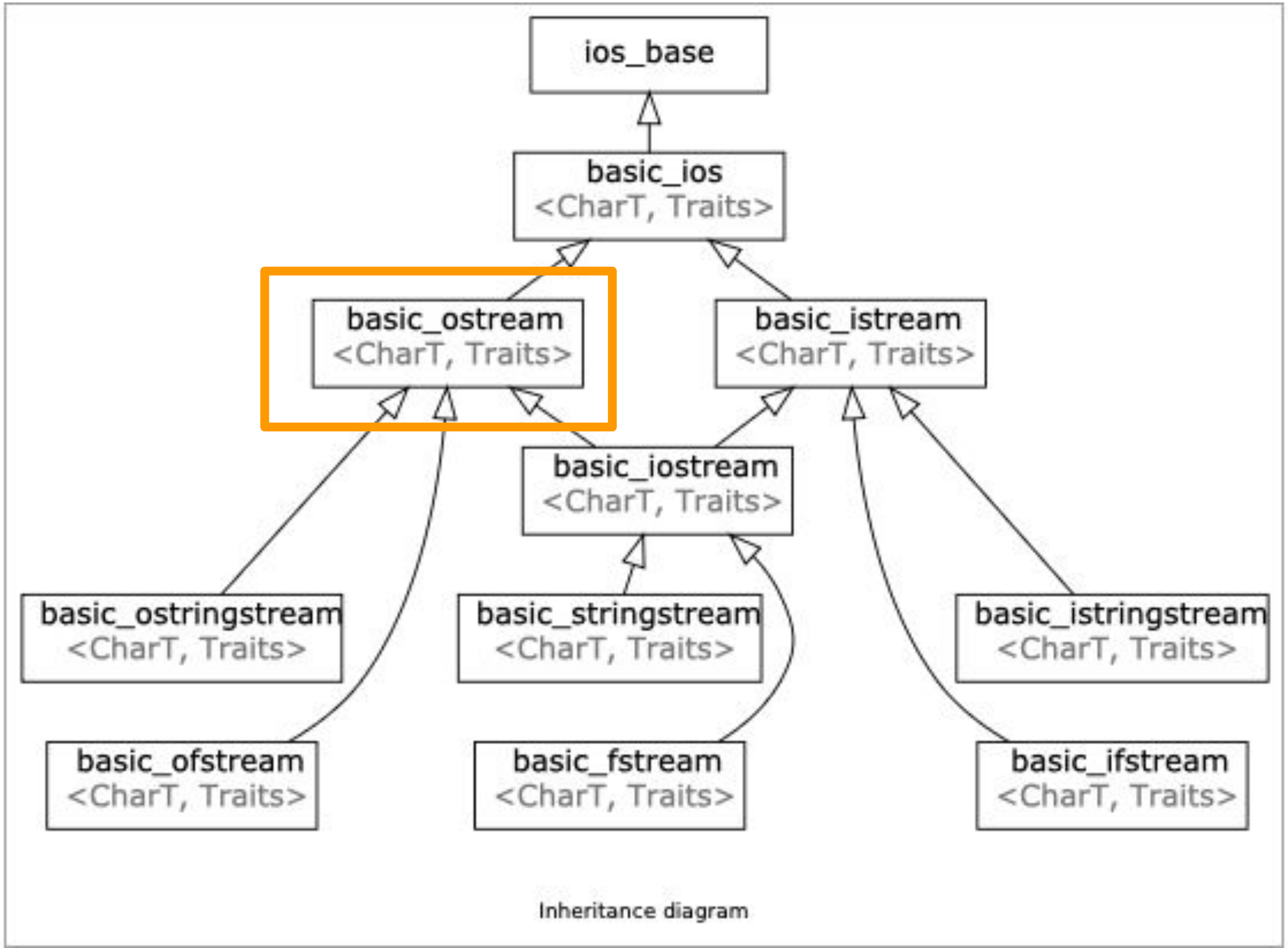
Inheritance diagram

# `std::cout` and the IO library



ios_base
basic_ios <CharT, Traits>
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Inheritance diagram

# A familiar stream!

```
std::cout << “Hello, World” << std::endl;
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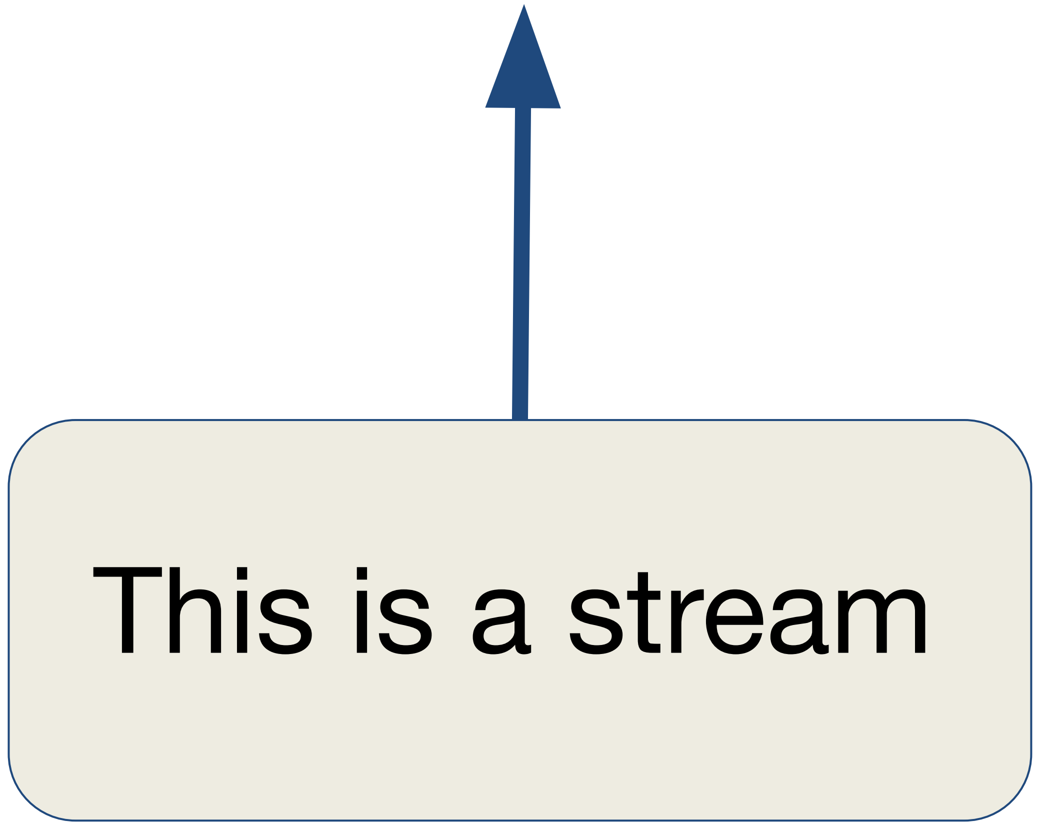
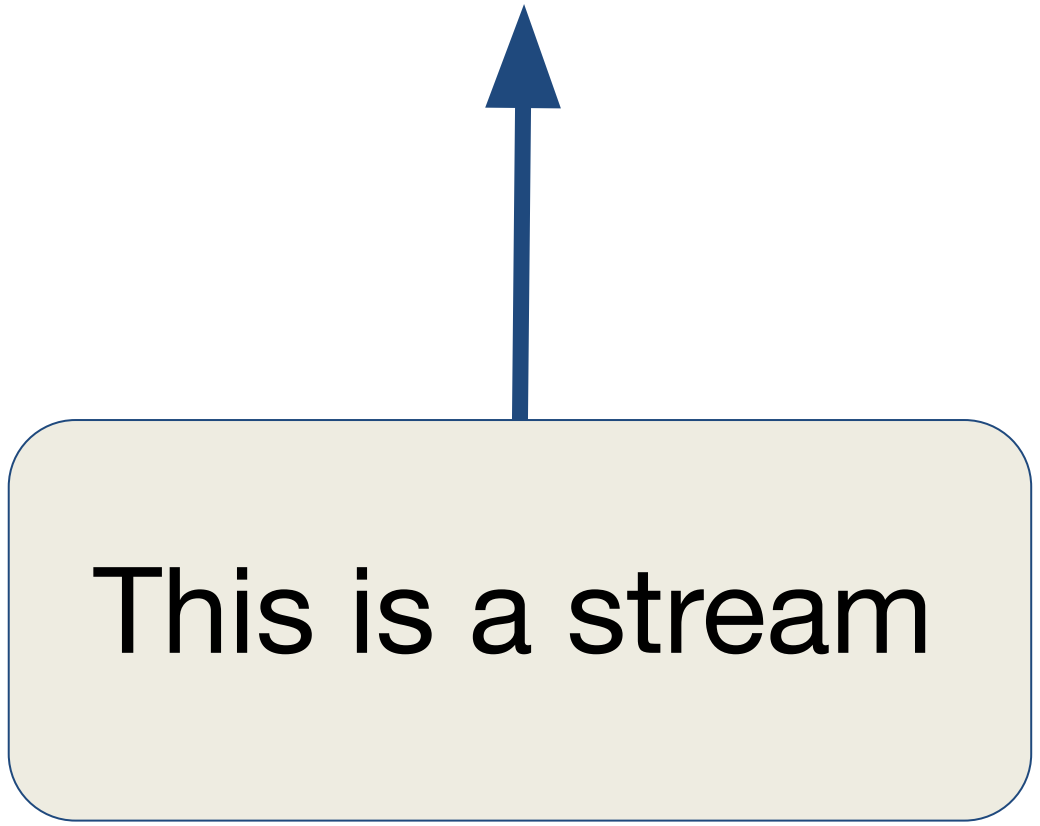


This is a stream

# A familiar stream!

```
std::cout << “Hello, World” << std::endl;
```

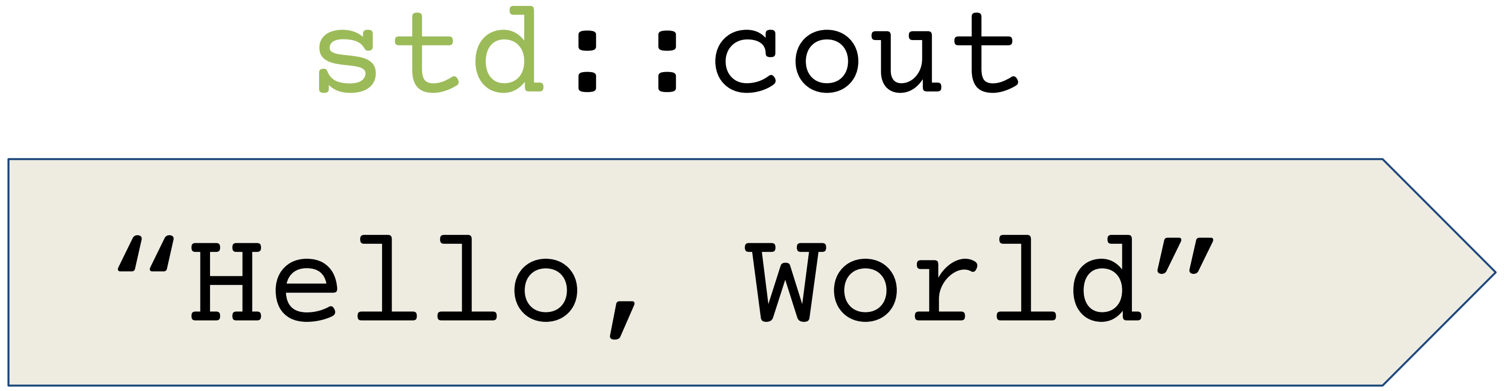


This is a stream

The `std::cout` stream is an instance of `std::ostream` which represents the standard output stream!

# std::cout

```
std::cout << “Hello, World” << std::endl;
```

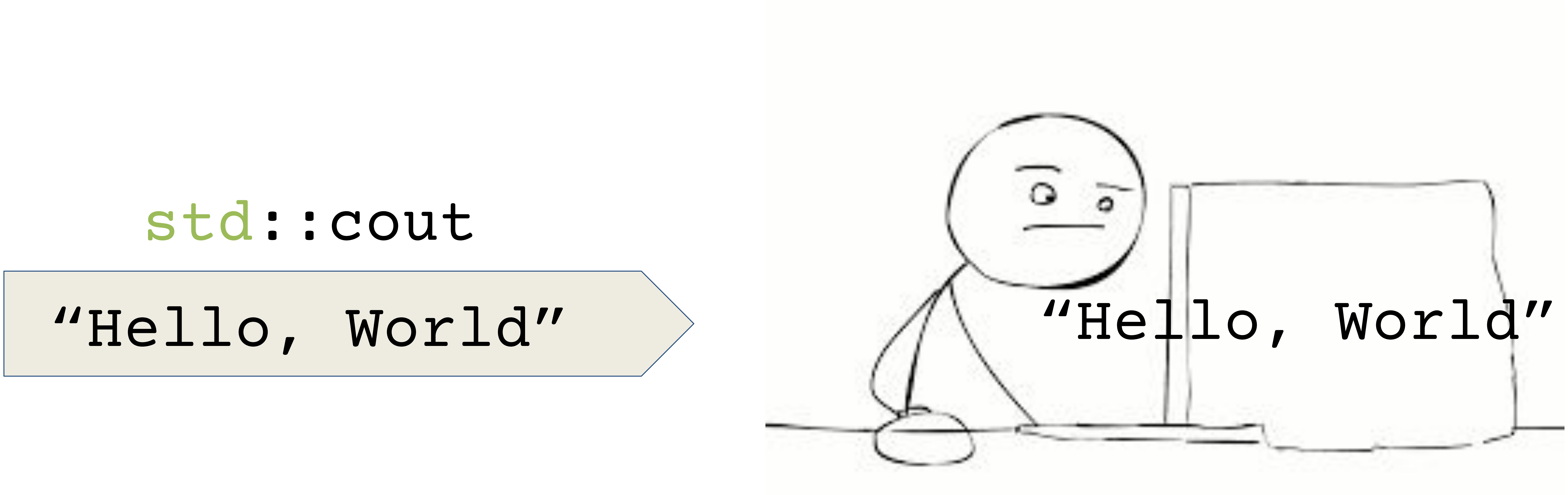


std::cout

“Hello, World”

# std::cout

```
std::cout << “Hello, World” << std::endl;
```



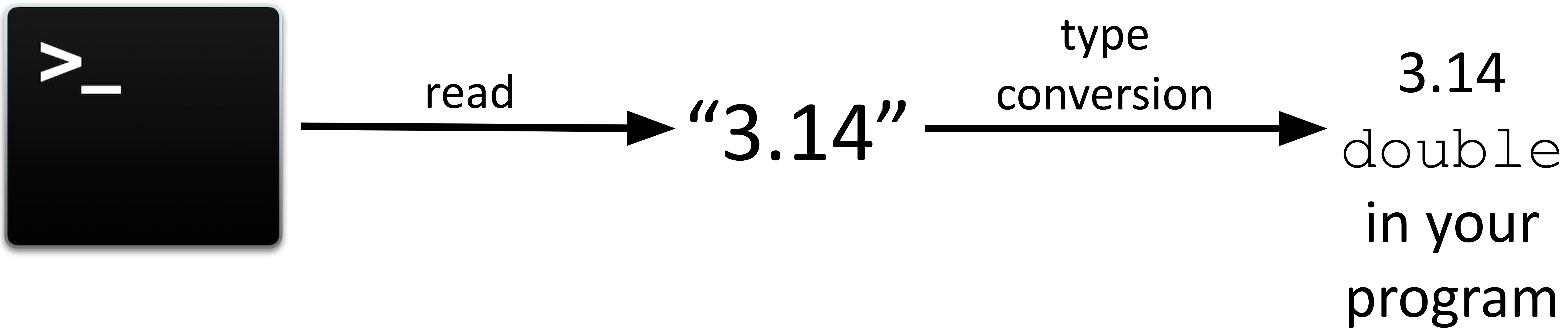
std::cout

“Hello, World”

# But how do we go from external source to program?

# An Input Stream

How do you read a `double` from your console?



read

“3.14”

type conversion

3.14 `double` in your program

# An Input Stream

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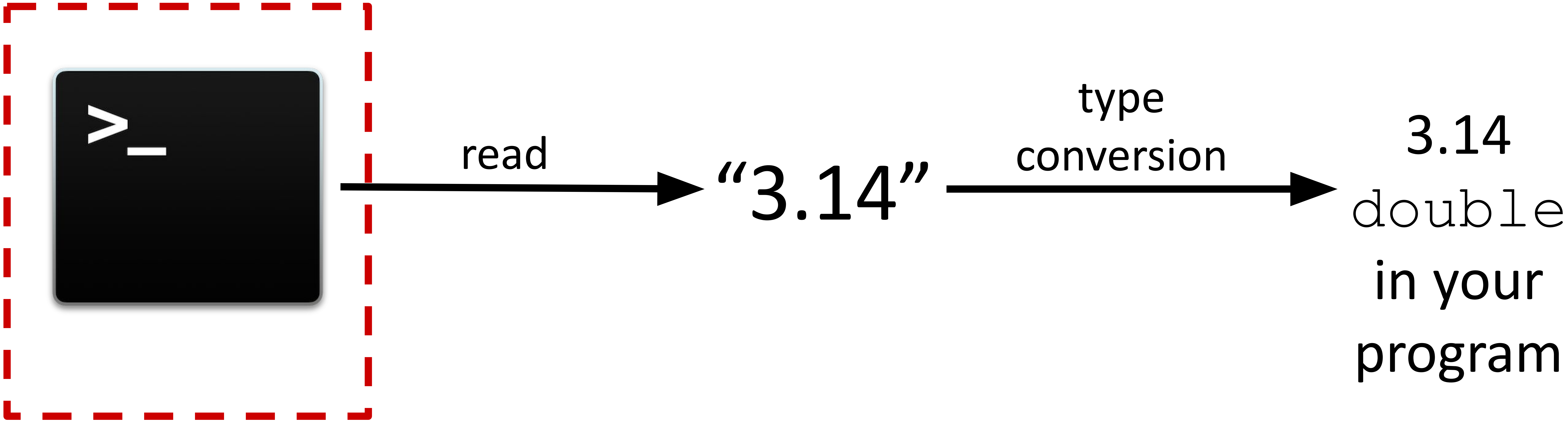

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# An Input Stream

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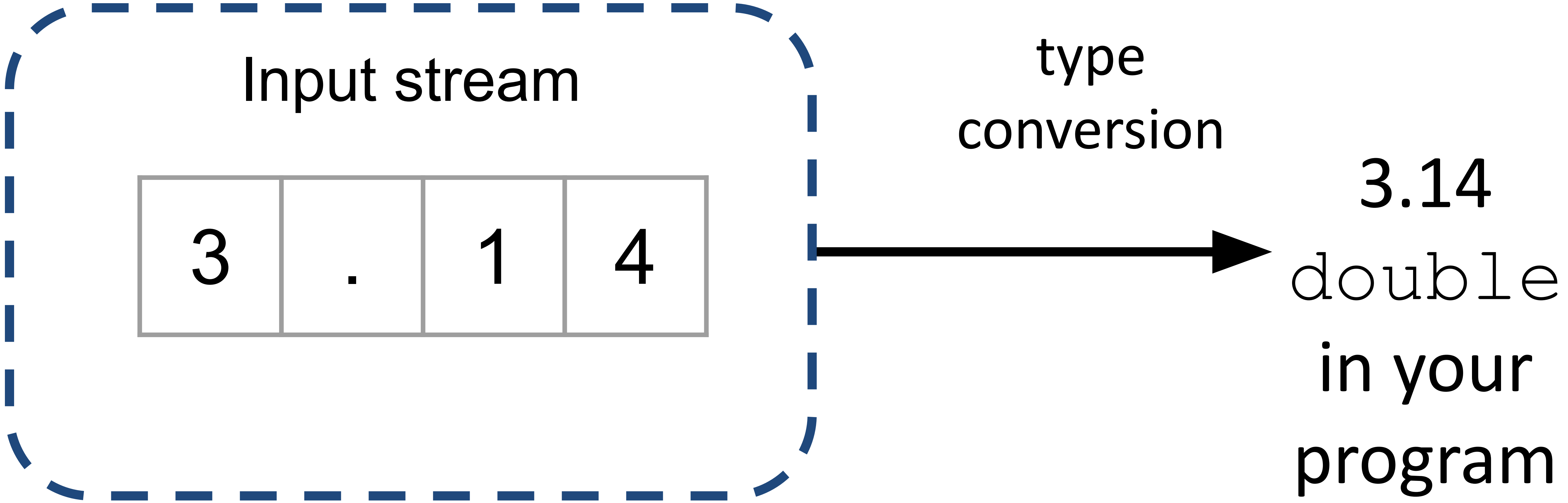


# An Input Stream

How do you read a `double` from your console?

`std::cin` is the console **input stream**!

The `std::cin` stream is an instance of **`std::istream`** which represents the standard input stream!

```
void verifyPi()
{
  double pi;
  std::cin >> pi;
  /// verify the value of pi!
  std::cout << pi / 2 << ‘\n’;
}
```

# std::cin

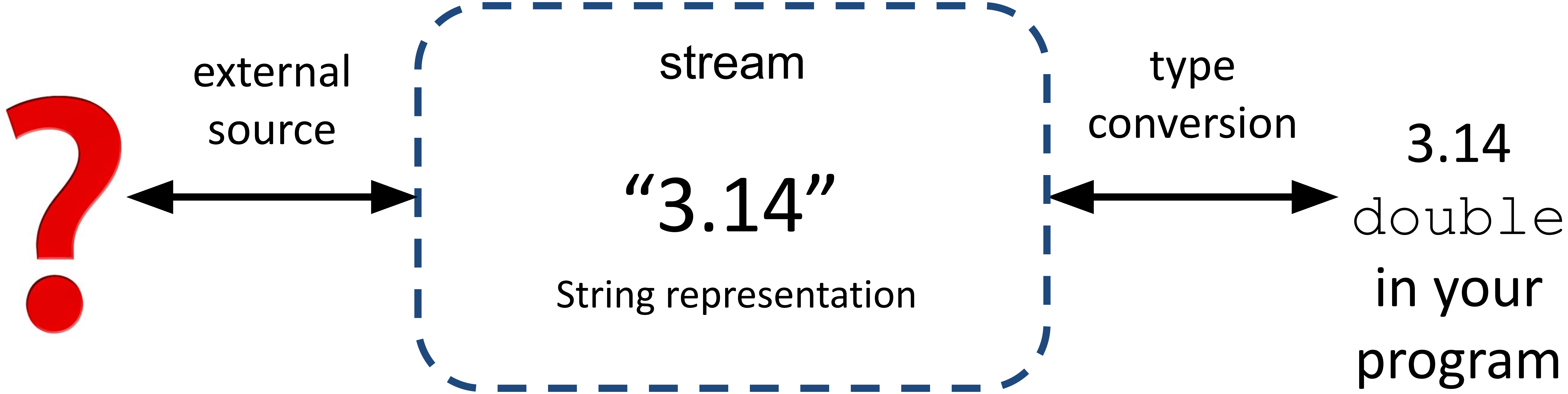
```
int main()
{
  double pi;
  std::cin >> pi;
  /// verify the value of pi!
  std::cout << pi / 2 << ‘\n’;

  return 0;
}
```

Console

```
“1.57”
```

# Generalizing the Stream



external source

stream

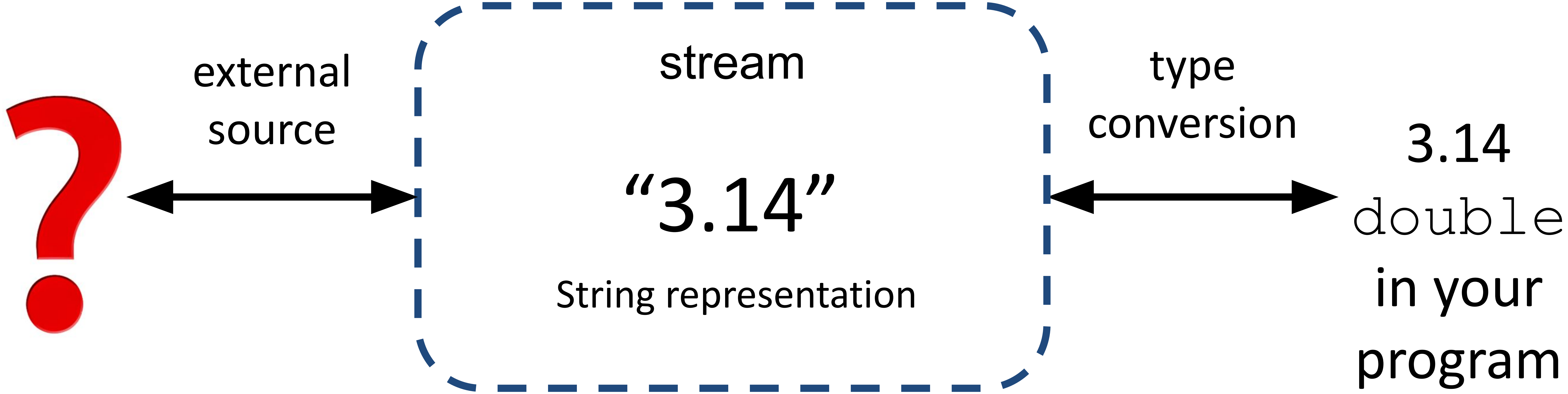
"3.14"

String representation

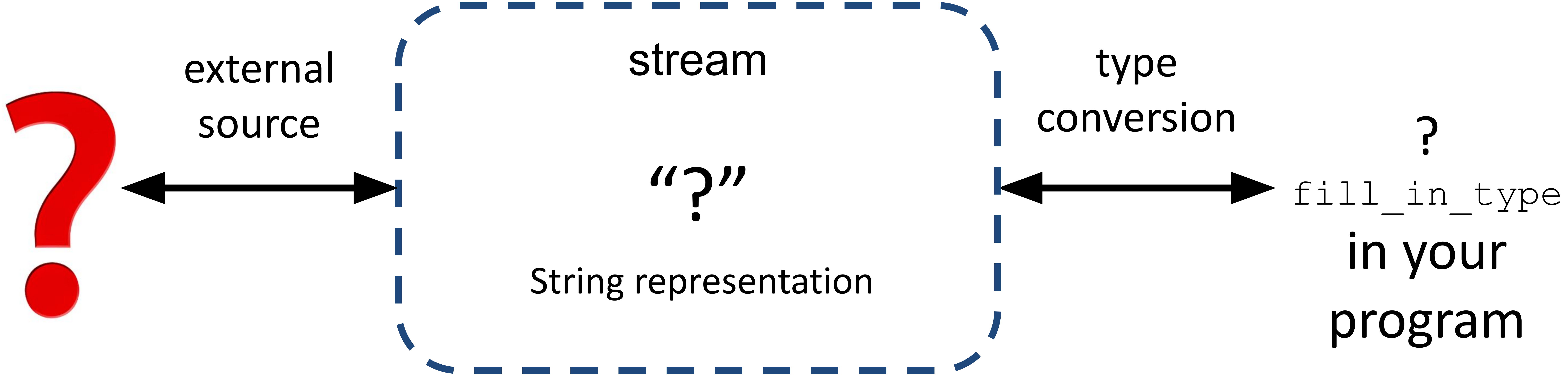
type conversion

3.14 `double` in your program

# Generalizing the Stream



# Implementation vs Abstraction



external source

stream

“?”

String representation

type conversion

?

`fill_in_type`

in your program

# Why is this even useful?

Streams allow for a **universal** way of **dealing with external data**

# What streams actually are

## Classifying different types of streams

**Input streams (I)**

- a way to read data from a source

**Output streams (O)**

- a way to write data to a destination

# What streams actually are

## Classifying different types of streams

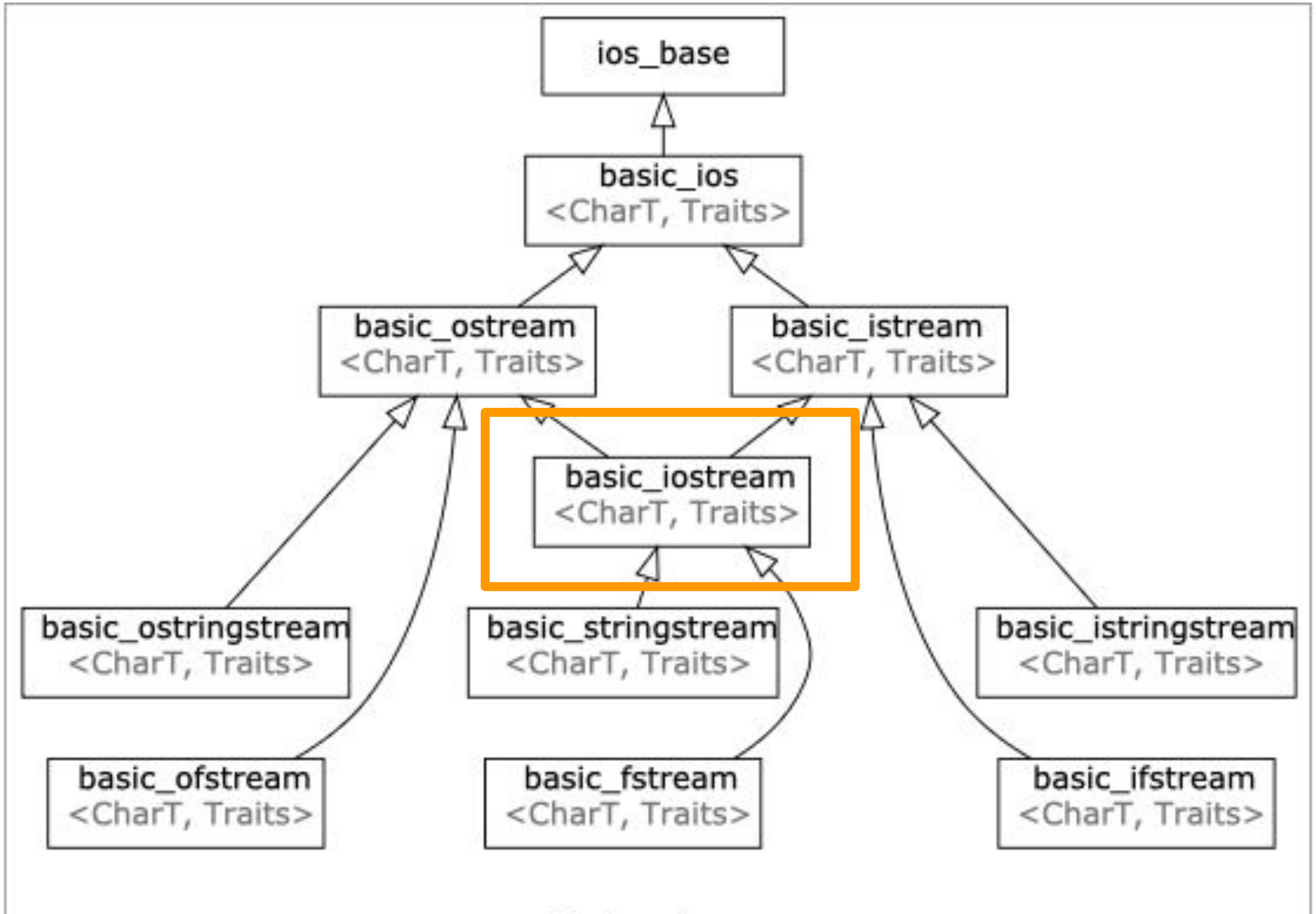
**Input streams (I)**

- a way to read data from a source
  - Are inherited from **std::istream**
  - ex. reading in something from the console (`std::cin`)
  - primary operator: **>>** (called the extraction operator)

**Output streams (O)**

- a way to write data to a destination
  - Are inherited from **std::ostream**
  - ex. writing out something to the console (`std::cout`)
  - primary operator: **<<** (called the insertion operator)

# What streams actually are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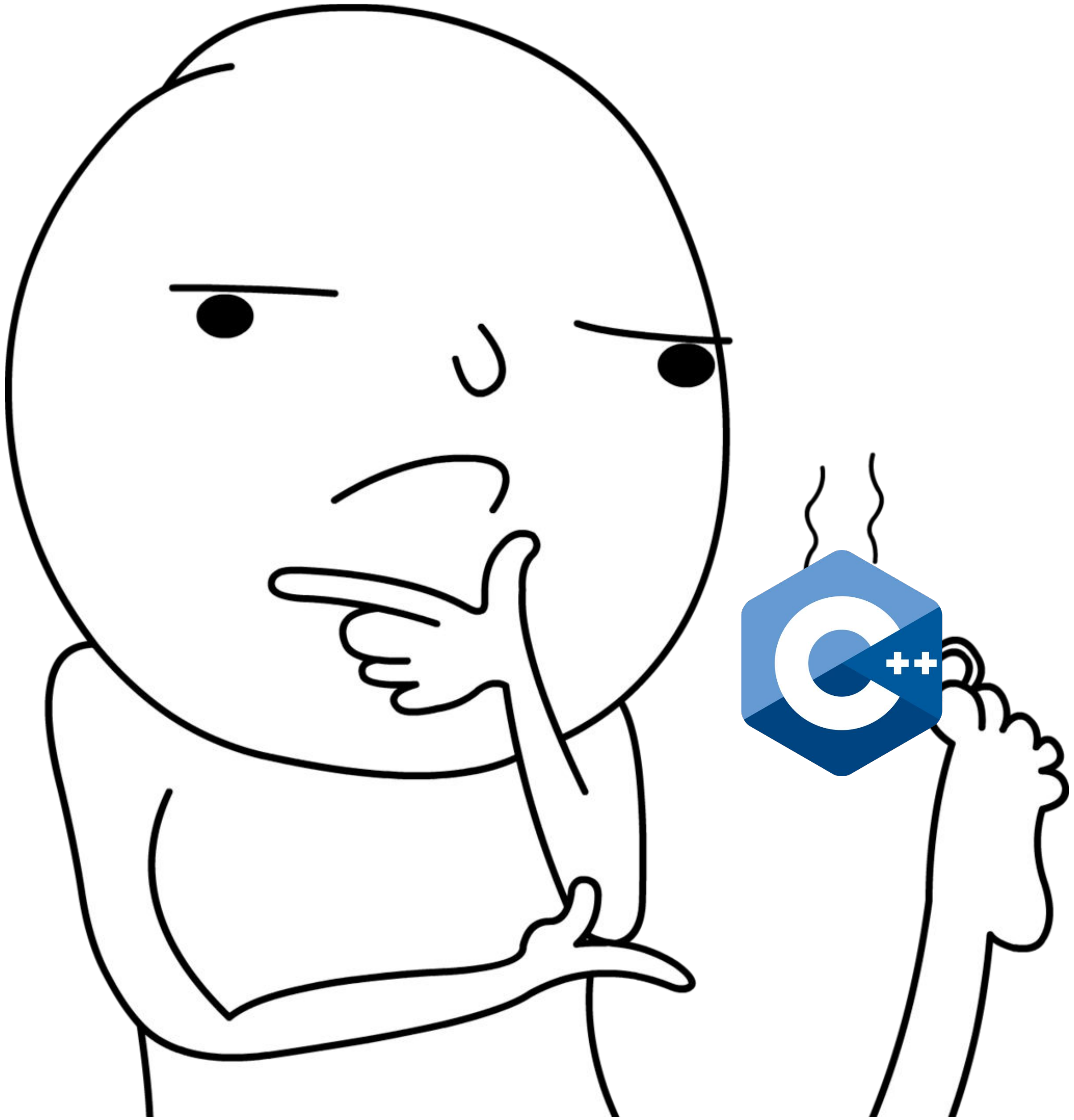
Inheritance diagram

# What questions do we have?



# Plan

1. ~~Quick recap~~
2. ~~What are streams??!!~~
3. stringstreams!
4. `cout` and `cin`
5. Output streams
6. Input streams

# std::stringstream

**What?**

a way to treat strings as streams

**Utility?**

`stringstreams` are useful for use-cases that deal with mixing data types

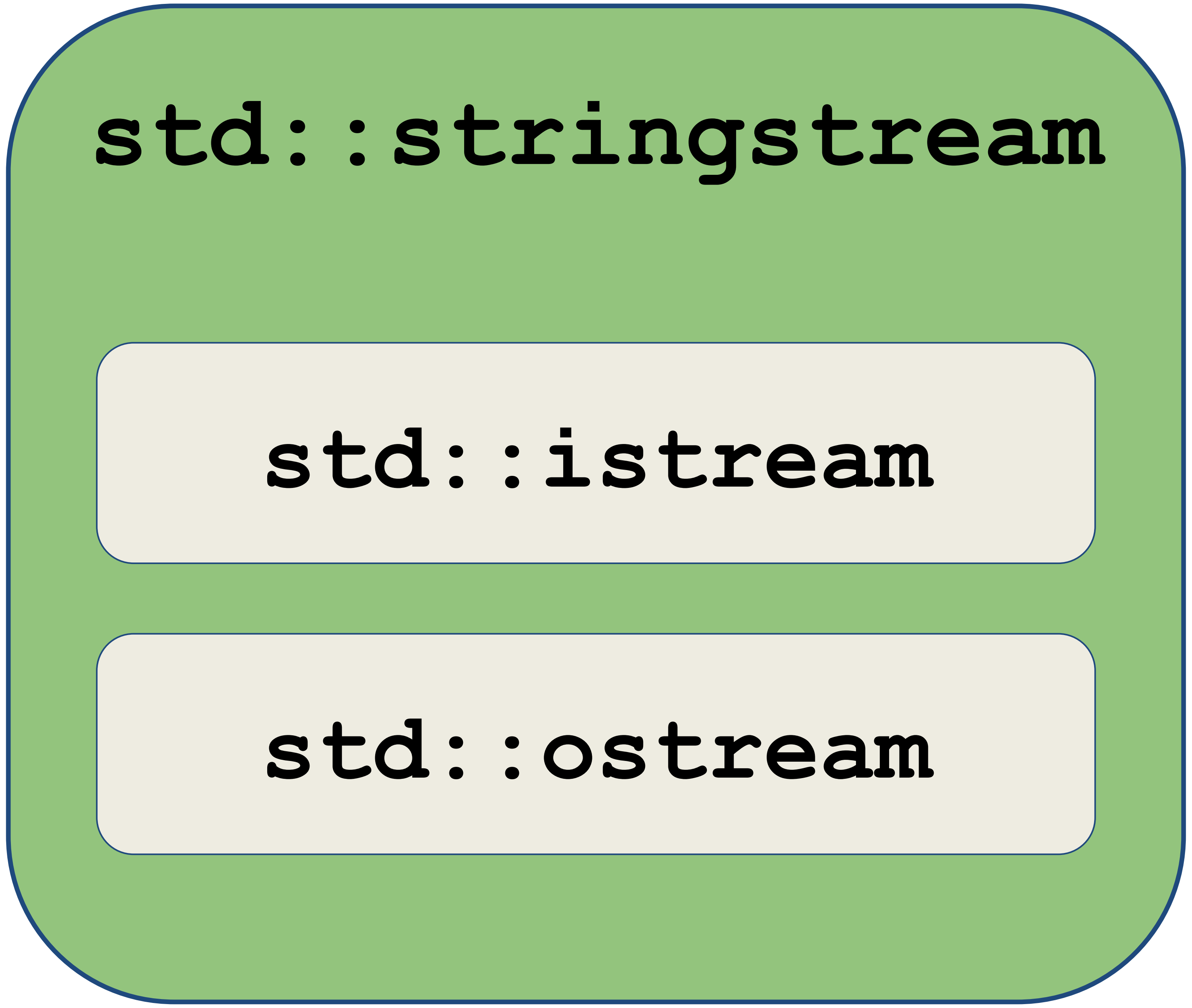
# std::stringstream

**What?**

a way to treat strings as streams

**Utility?**

`stringstreams` are useful for use-cases that deal with mixing data types

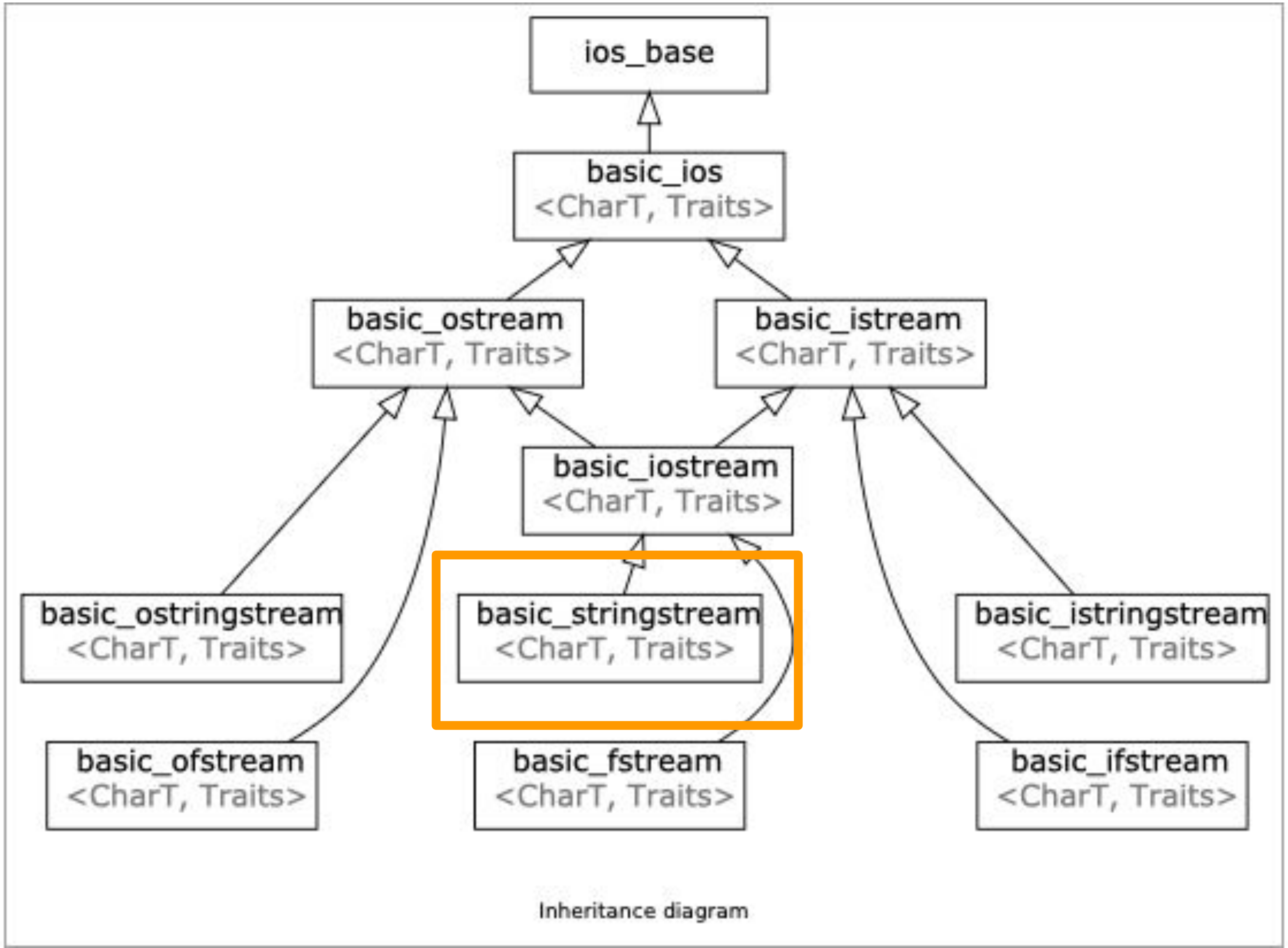


std::stringstream

std::istream

std::ostream

# What streams actually are



# std::stringstream example

```
int main() {
  /// partial Bjarne Quote
  std::string initial_quote = “Bjarne Stroustrup C makes it easy to shoot
  yourself in the foot”;

  /// create a stringstream
  std::stringstream ss(initial_quote);

  /// data destinations
  std::string first;
  std::string last;
  std::string language, extracted_quote;

  ss >> first >> last >> language >> extracted_quote;
  std::cout << first << “ ” << last << “ said this: ”<< language << “ “ <<
  extracted_quote << std::endl;
}
```

initialize `stringstream` with string constructor

# std::stringstream example

```
int main() {
  /// partial Bjarne Quote
  std::string initial_quote = “Bjarne Stroustrup C makes it easy to shoot
  yourself in the foot”;

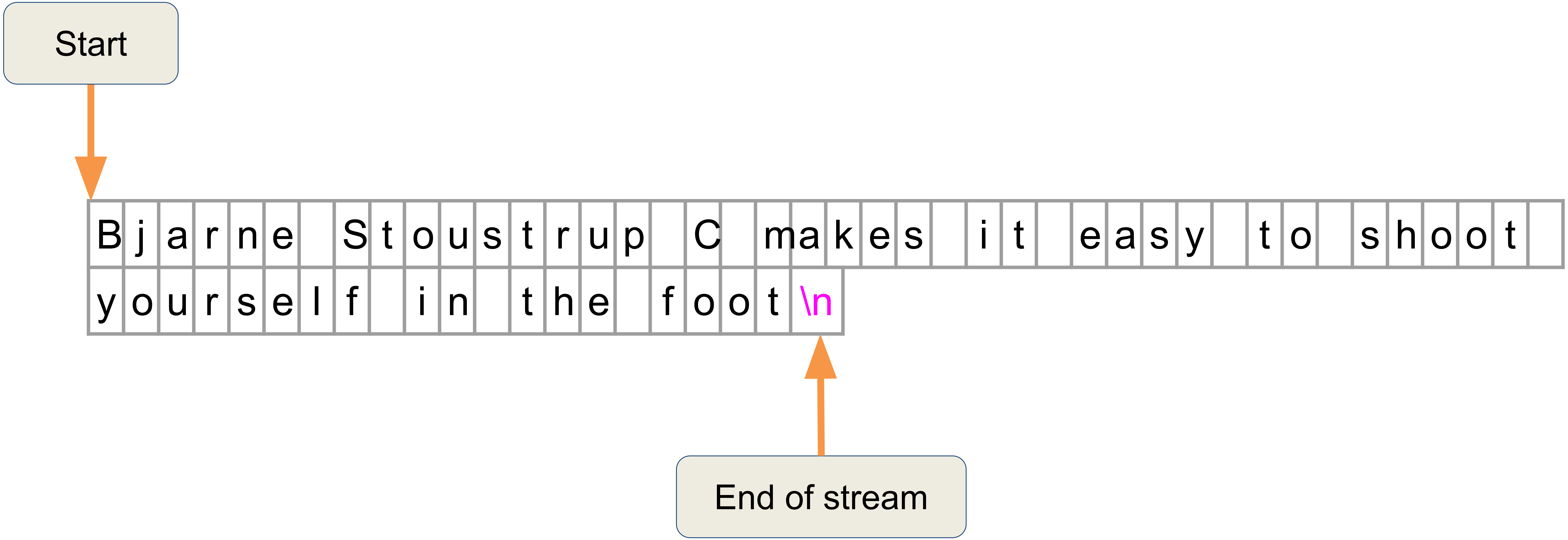
  /// create a stringstream
  std::stringstream ss;
  ss << initial_quote;

  /// data destinations
  std::string first;
  std::string last;
  std::string language, extracted_quote;

  ss >> first >> last >> language >> extracted_quote;
  std::cout << first << “ ” << last << “ said this: ”<< language << “ “ <<
  extracted_quote << std::endl;
}
```

since this is a stream we can also **insert** the `initial_string` like this!

# what the stream looks like!



Start

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| y | o | u | r | s | e | l | f | | i | n | | t | h | e | | f | o | o | t | \n | | | | | | | | | | | | | | | | | | | | | |

End of stream

# std::stringstream example

```
int main() {
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  /// create a stringstream
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  ss >> first >> last >> language;
  std::cout << first << “ ” << last << “ said this: ”<< language << “ “ <<
  extracted_quote << std::endl;
}
```

Remember! Streams move data from one place to another

# std::stringstream example

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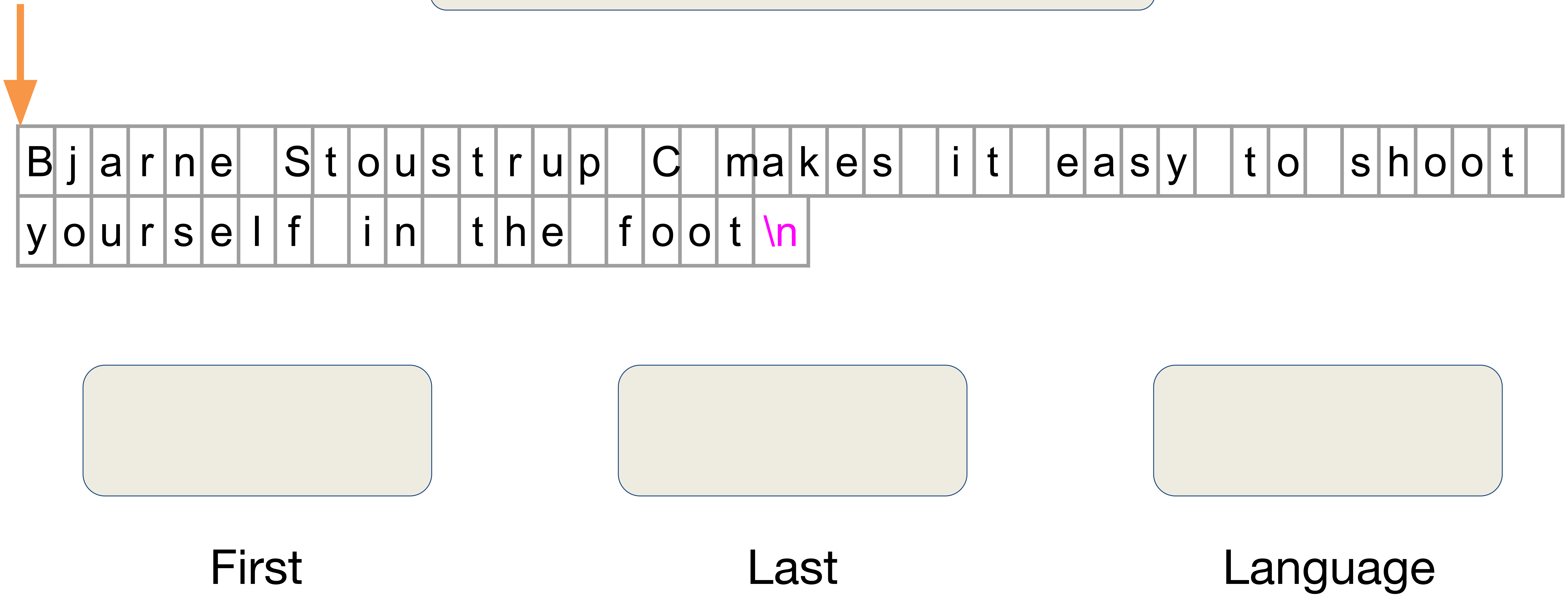
  ss >> first >> last >> language;
  std::cout << first << “ ” << last << “ said this: ”<< language << “ “ <<
  extracted_quote << std::endl;
}
```

We’re making use of the extractor operator

# what the stream looks like!

```
ss >> first >> last >> language;
```



Bjarne Stoustrup C makes it easy to shoot
yourself in the foot \n

First

Last

Language

# what the stream looks like!

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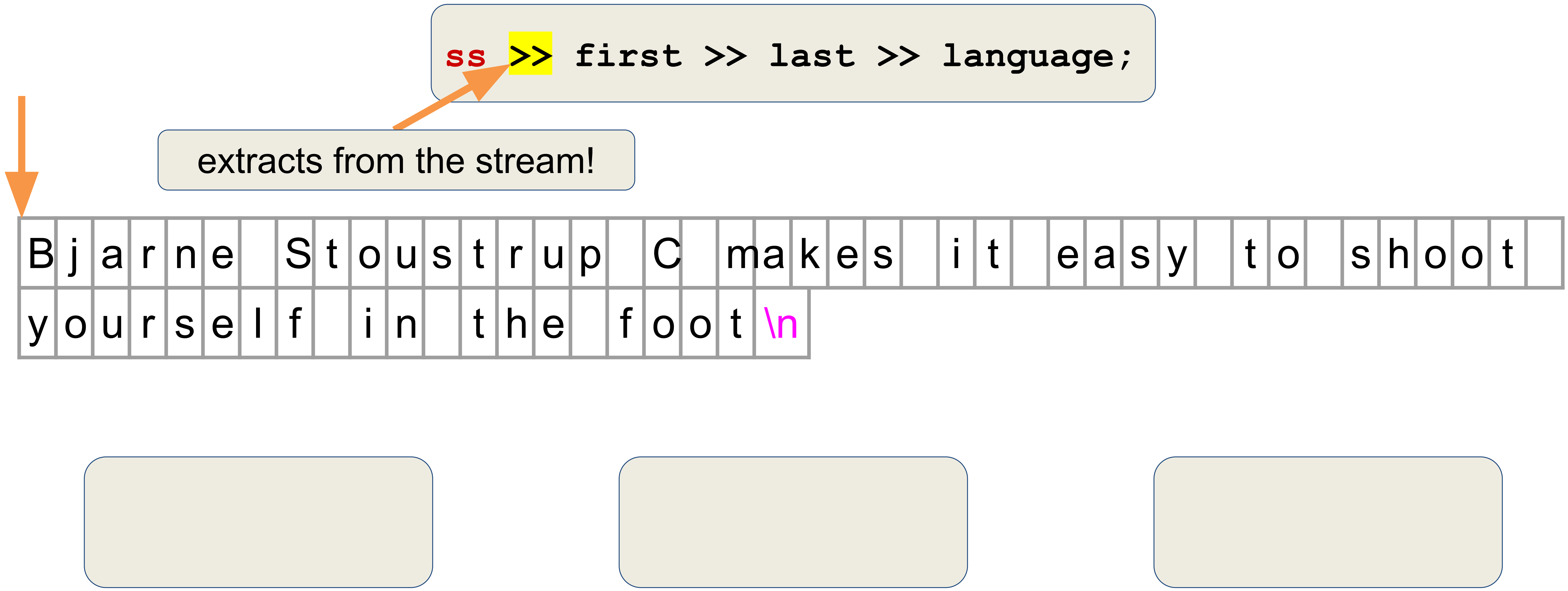

extracts from the stream!

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| y | o | u | r | s | e | l | f | | i | n | | t | h | e | | f | o | o | t | \n | | | | | | | | | | | | | | | | | | | | | |

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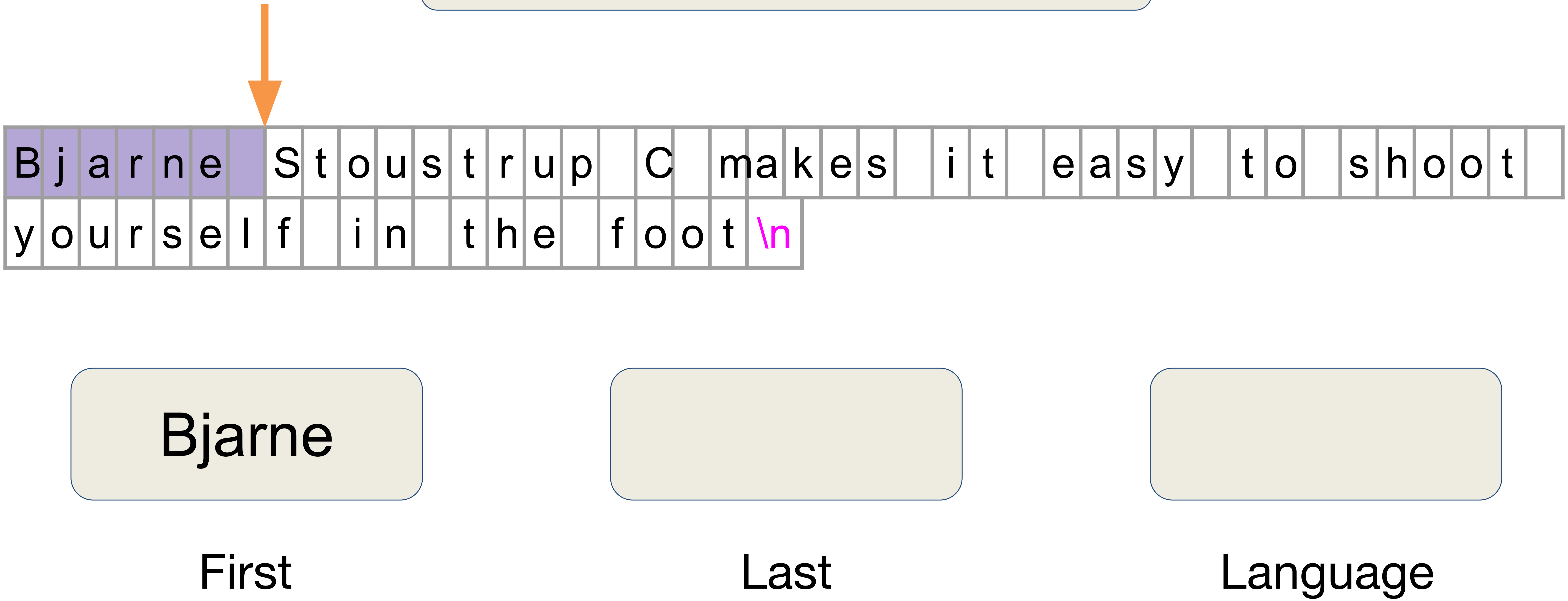

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Bjarne

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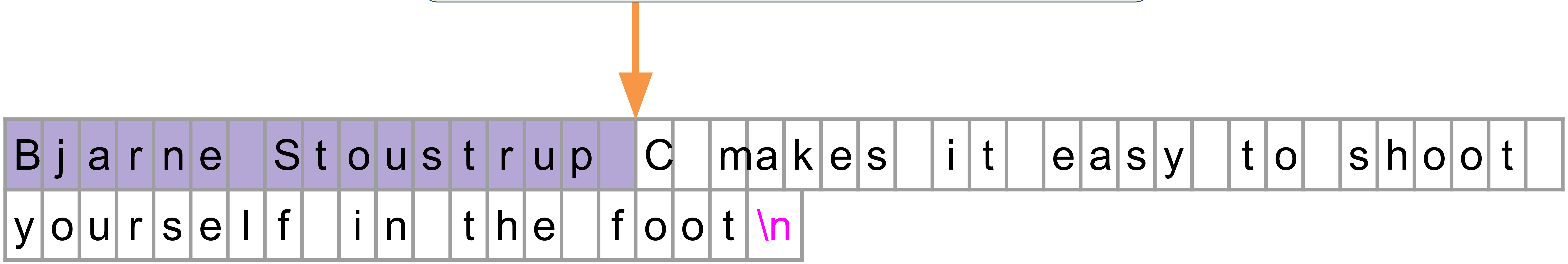

```
Bjarne Stroustrup C makes it easy to shoot
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```

Bjarne

First

Stroustrup

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# what the stream looks like!

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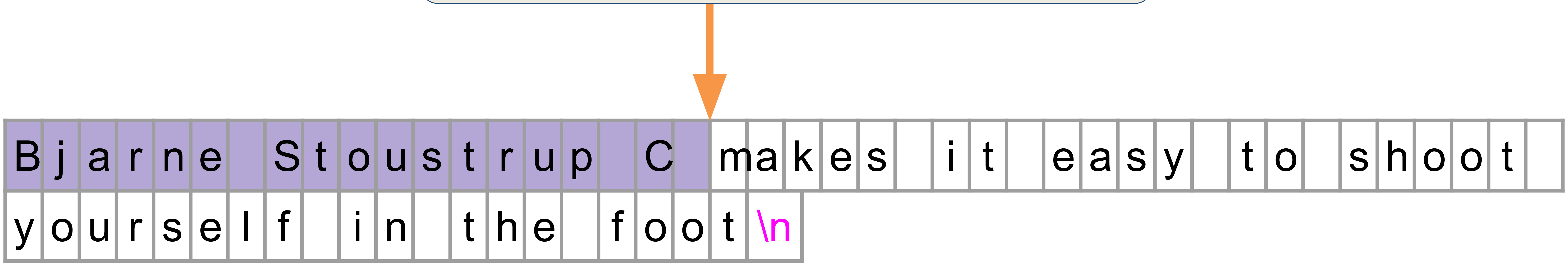

B j a r n e   S t o u s t r u p   C m a k e s   i t   e a s y   t o   s h o o t
y o u r s e l f   i n   t h e   f o o t \n

| Bjarne | Stroustrup | C |
|---|---|---|
| First | Last | Language |

# std::stringstream example

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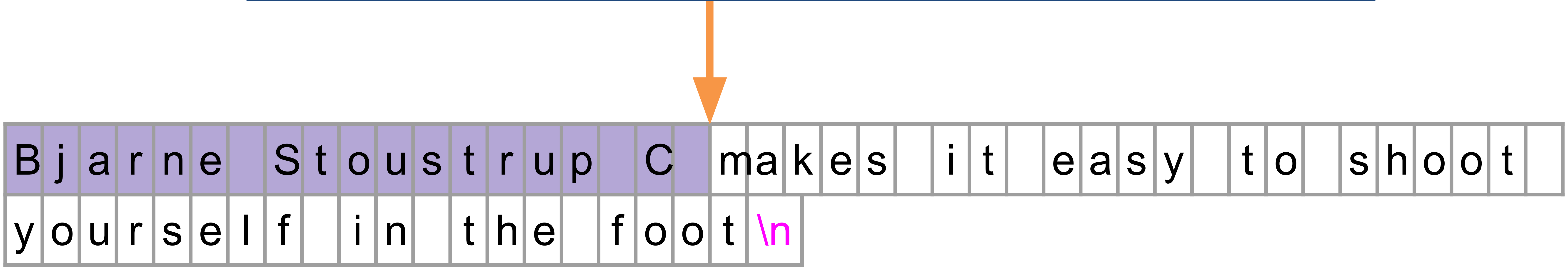
  ss >> first >> last >> language;
  std::cout << first << “ ” << last << “ said this: ” << language << “ “ <<
  extracted_quote << std::endl;
}
```

We want to extract the quote!

# what the stream looks like!

```
ss >> first >> last >> language >> extracted_quote;
```



Bjarne Stroustrup C makes it easy to shoot
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Bjarne

First

Stroustrup

Last

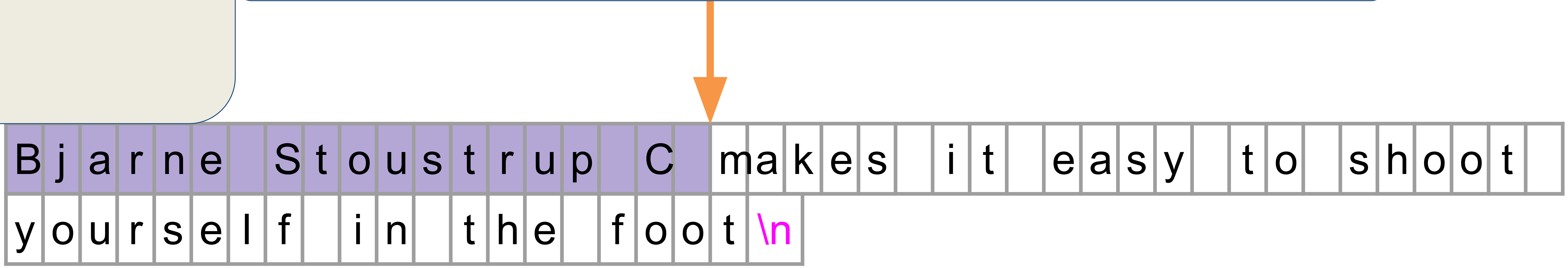
C

Language

# what the stream looks like!

**Problem:**
?

```
ss >> first >> last >> language >> extracted_quote;
```



Bjarne Stroustrup C makes it easy to shoot
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Stroustrup

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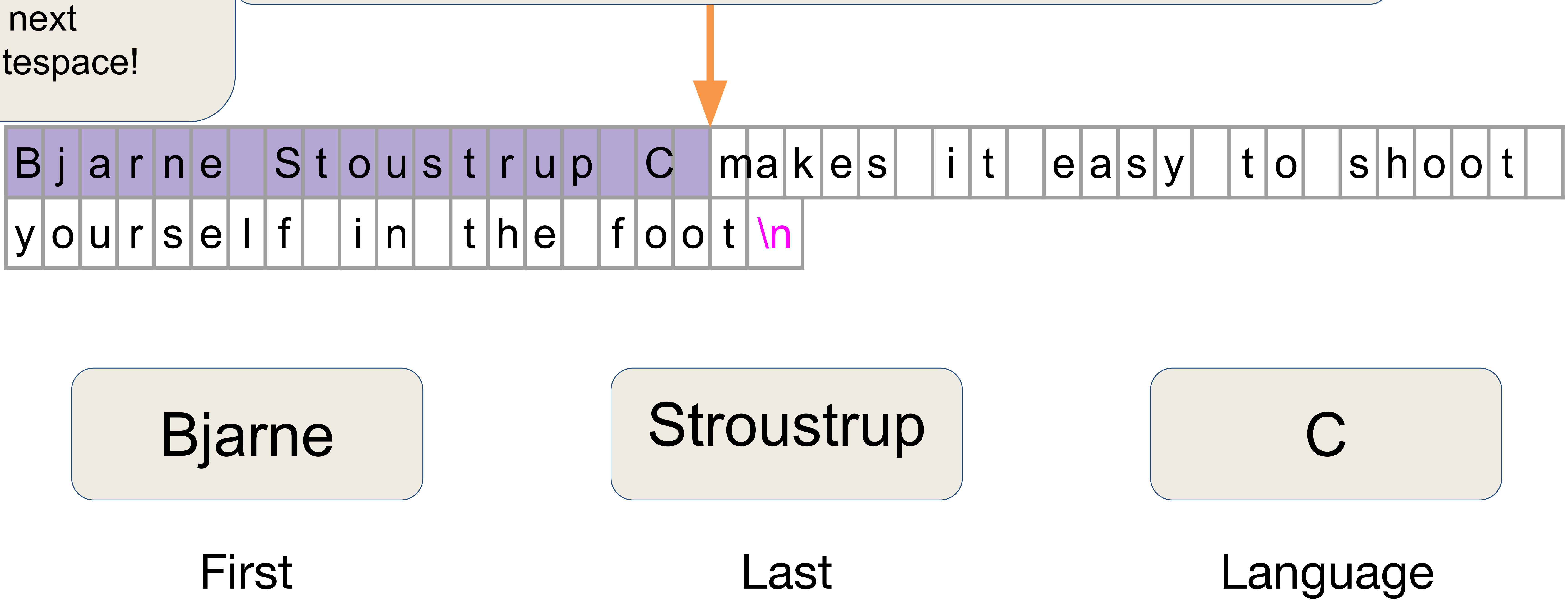
Language

# what the stream looks like!

**Problem:**
The **>>** operator only reads until the next whitespace!

```
ss >> first >> last >> language >> extracted_quote;
```



Bjarne Stroustrup C makes it easy to shoot yourself in the foot\n

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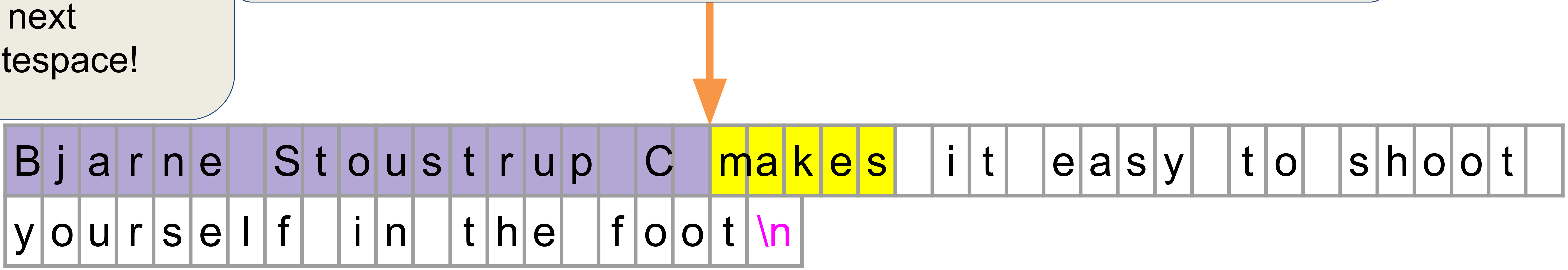

```
Bjarne Stroustrup C makes it easy to shoot
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```

| Bjarne | Stroustrup | C |
|---|---|---|
| First | Last | Language |

# Use `getline()`!

```
istream& getline(istream& is, string& str, char delim)
```

- **`getline()`** reads an input stream, `is`, up until the `delim` char and stores it in some buffer, `str`.

# Use getline()!

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- **getline()** reads an input stream, `is`, up until the `delim` char and stores it in some buffer, `str`.

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# Use `getline()`!

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```

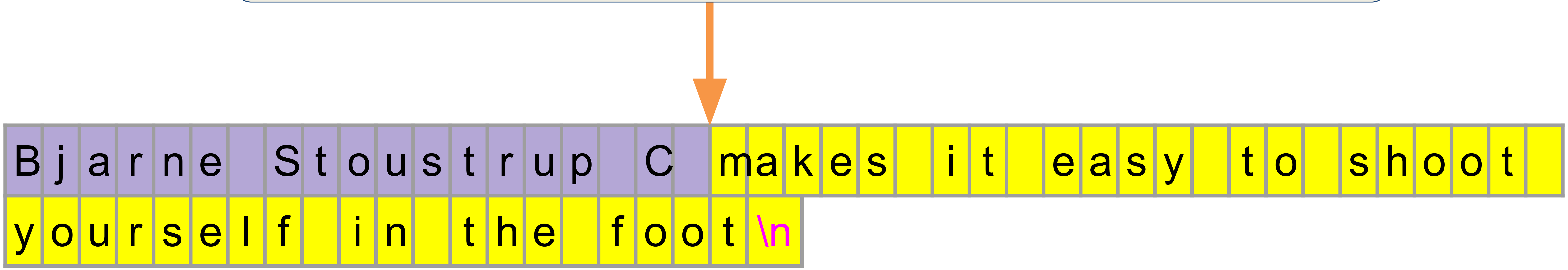
- **`getline()`** reads an input stream, `is`, up until the `delim` char and stores it in some buffer, `str`.

- The `delim` char is by default `‘\n’`.

- **`getline()`** ***consumes*** the delim character!
  - PAY ATTENTION TO THIS :)

# use std::getline()!

```
ss >> first >> last >> language >> extracted_quote;
```



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  /// data destinations
  std::string first;
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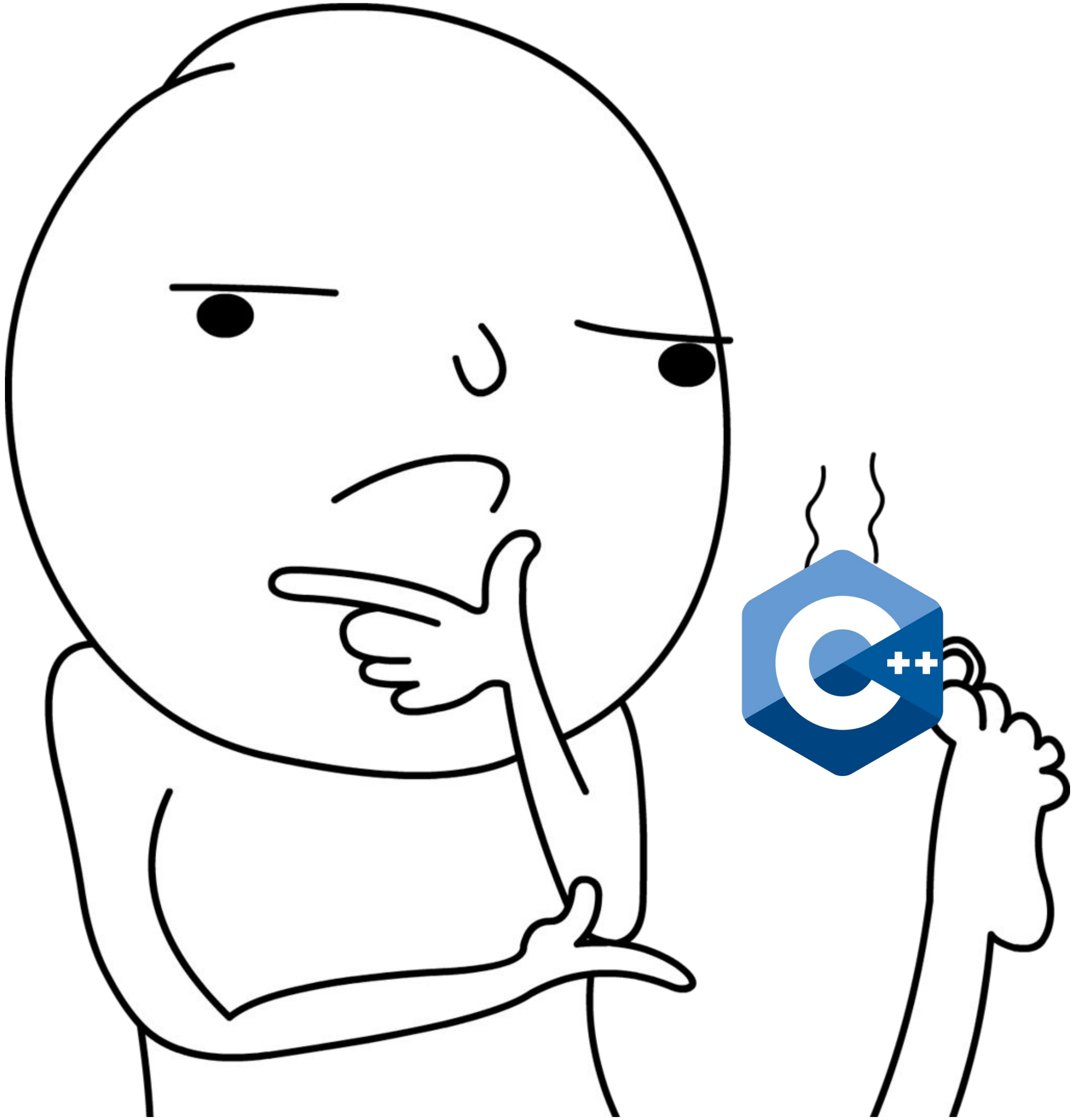
  std::string language, extracted_quote;
  ss >> first >> last >> language;
  std::getline(ss, extracted_quote);
  std::cout << first << “ ” << last << “ said this: \” << language << “ “ <<
  extracted_quote + “\“ << std::endl;
}
```

# What questions do we have?



# Plan

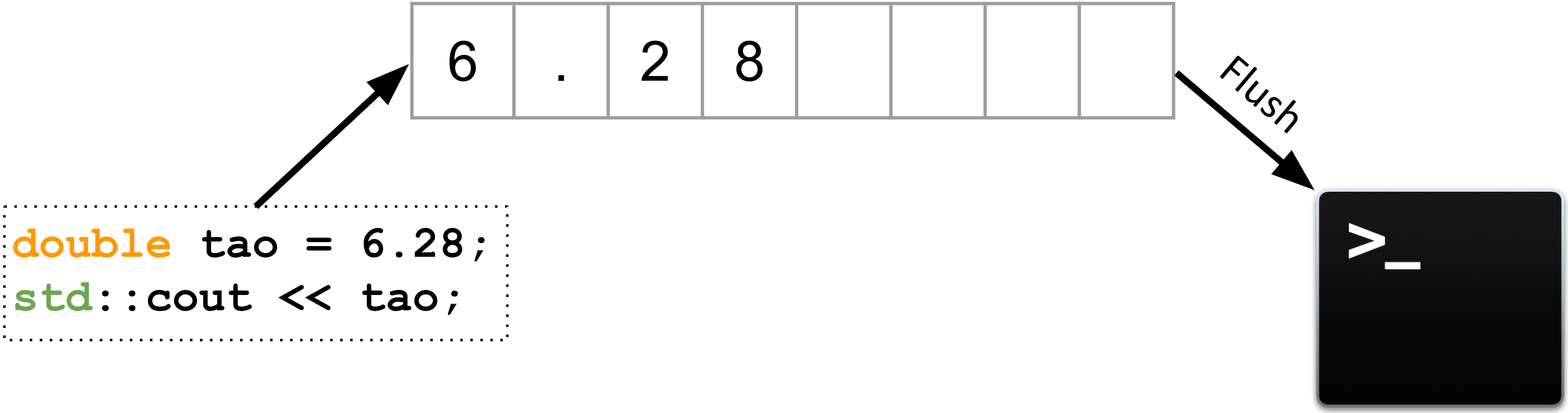
1. ~~Quick recap~~
2. ~~What are streams??!!~~
3. ~~stringstreams~~
4. Output streams
5. Input streams

# Output Streams

- a way to write data to a destination/external source
  - ex. writing out something to the console (`std::cout`)
  - use the << operator to ***send*** to the output stream

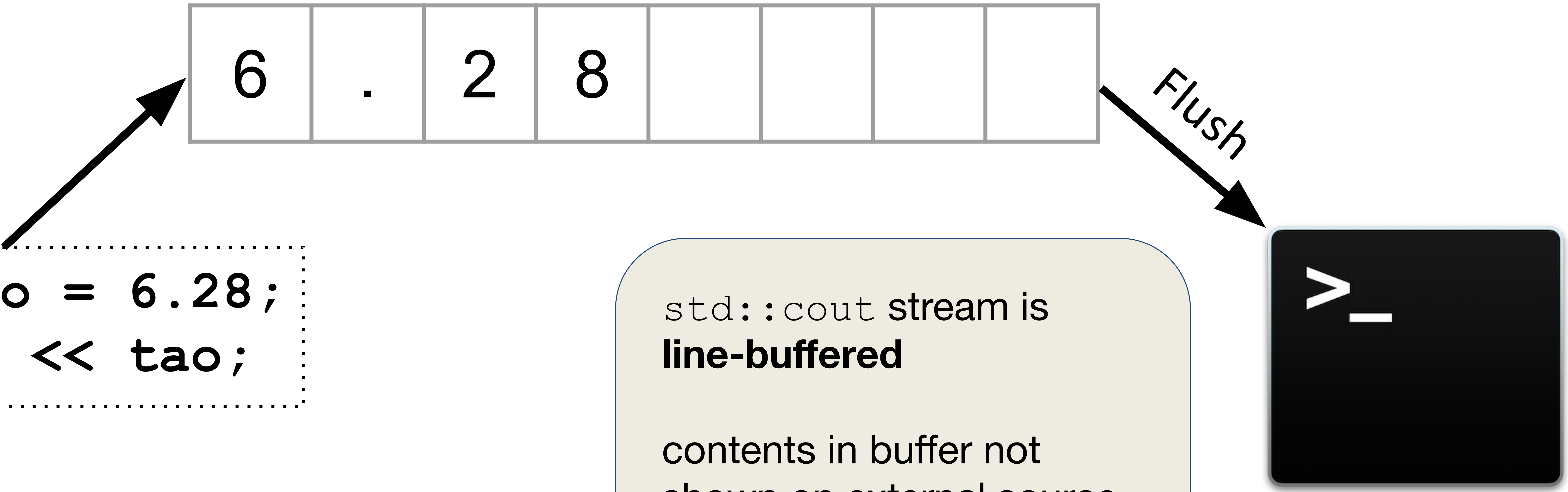
# Zooming in on Output Streams!

Character in output streams are stored in an intermediary buffer before being flushed to the destination



```
double tao = 6.28;
std::cout << tao;
```

# Zooming in on Output Streams!

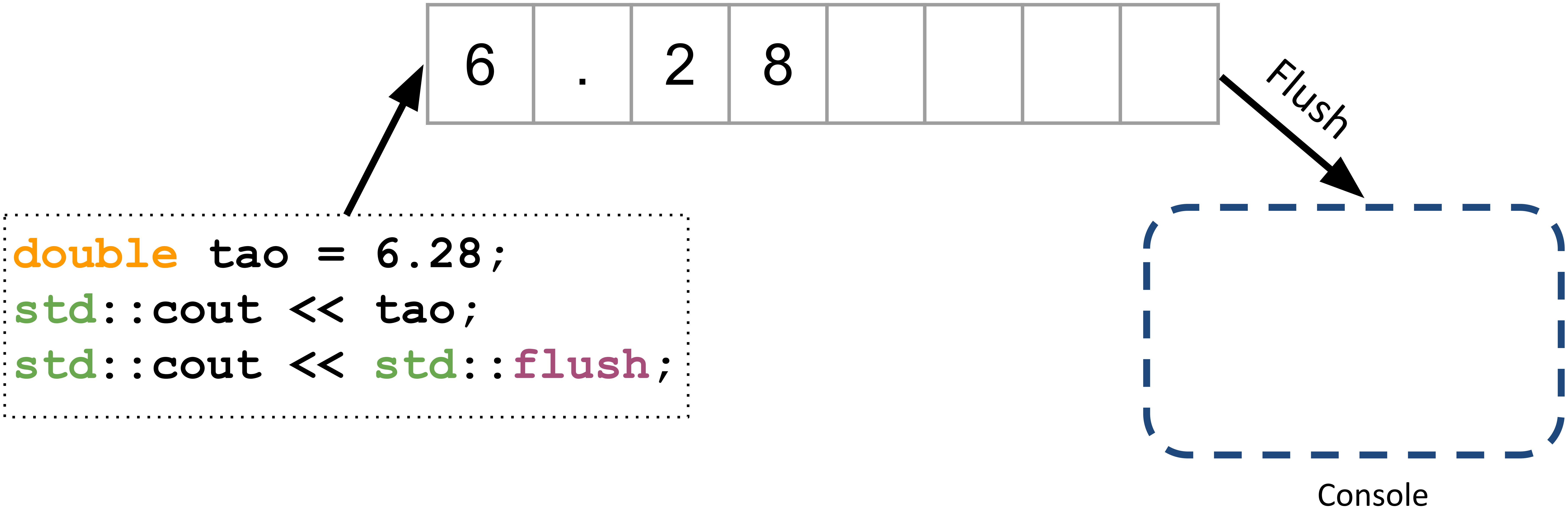


```
double tao = 6.28;
std::cout << tao;
```

`std::cout` stream is **line-buffered**

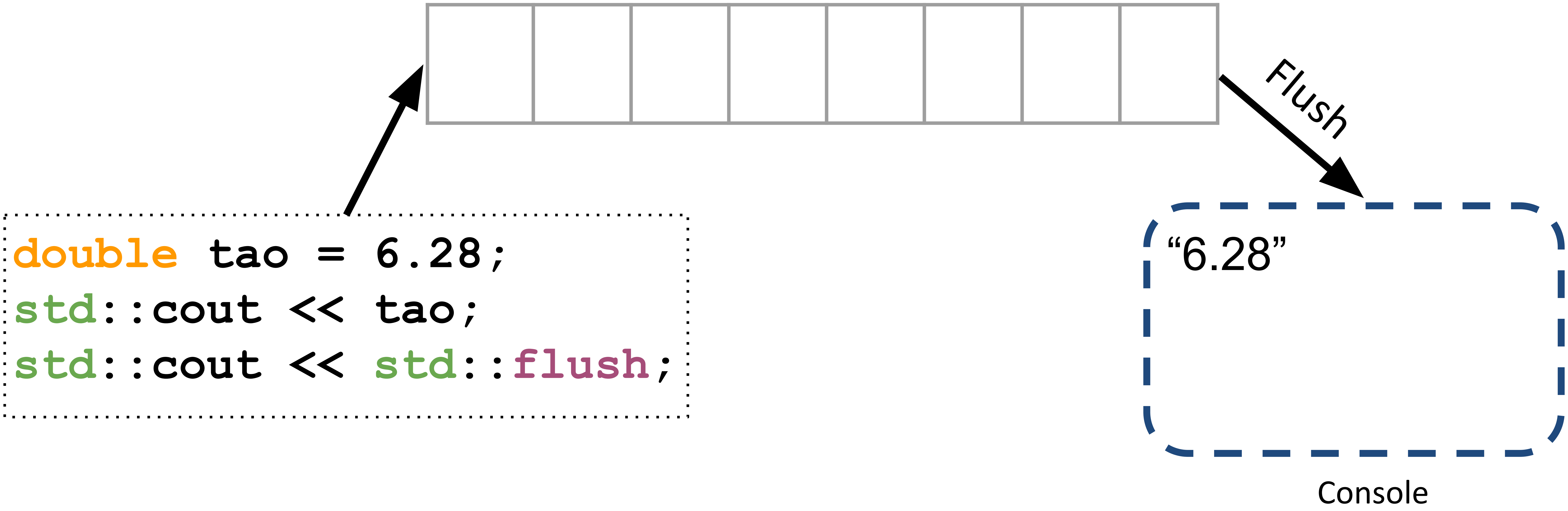
contents in buffer not shown on external source until an explicit flush occurs!

# Zooming in on Output Streams!



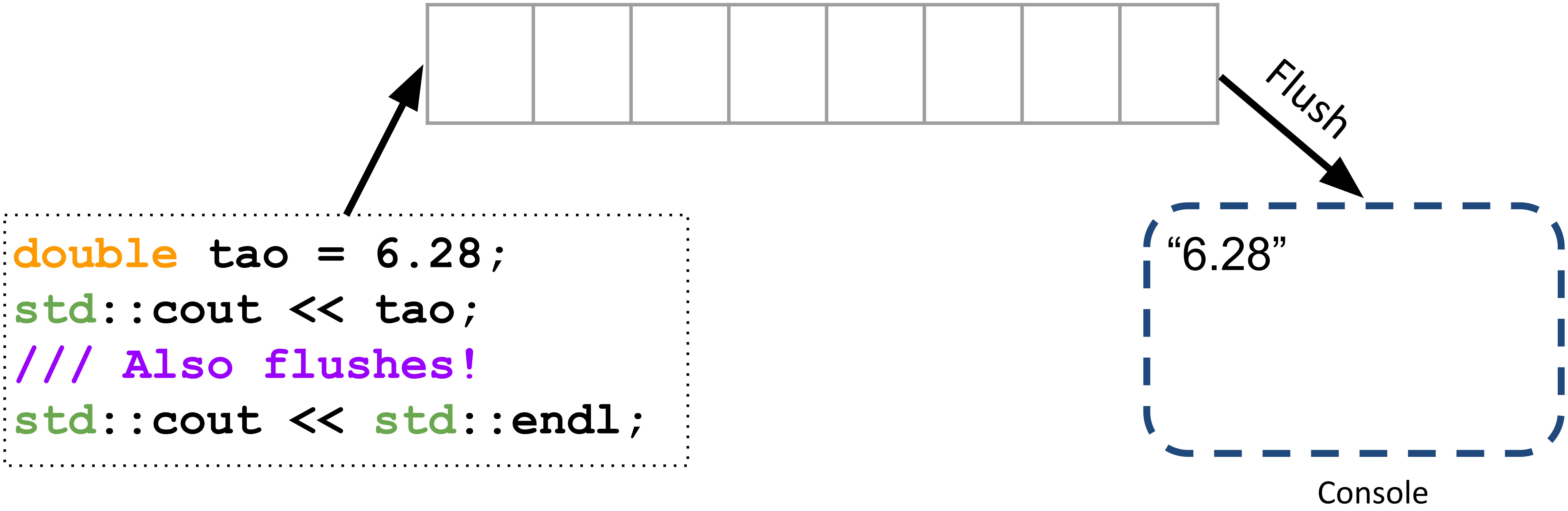
```
double tao = 6.28;
std::cout << tao;
std::cout << std::flush;
```

# Zooming in on Output Streams!



```
double tao = 6.28;
std::cout << tao;
std::cout << std::flush;
```

# Zooming in on Output Streams!



```
double tao = 6.28;
std::cout << tao;
/// Also flushes!
std::cout << std::endl;
```

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```

**Output:**

```
“1”
“2”
“3”
“4”
“5”
```

`std::endl` tells the `cout` stream to end the line!

# Here’s without `std::endl`

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i;
  }
  return 0;
}
```

**Output:**

“12345”

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```

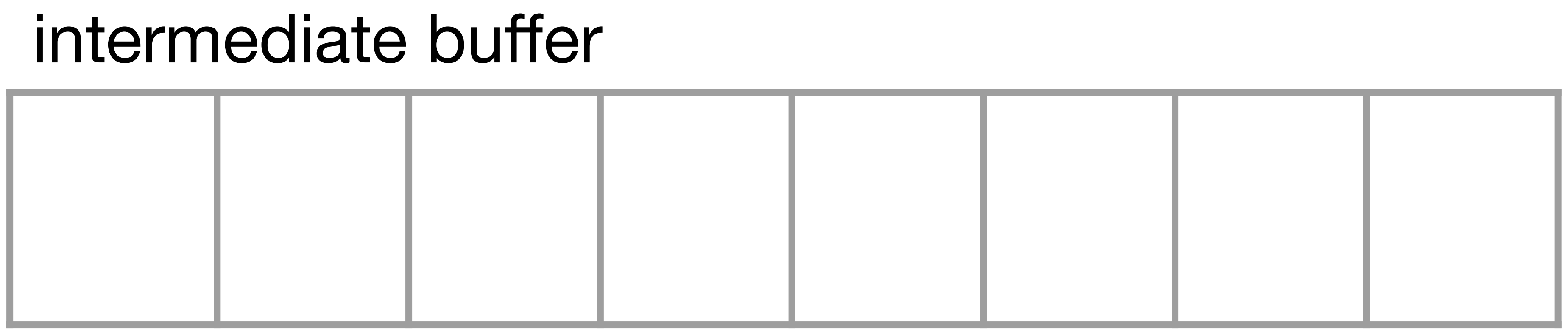
**Output:**

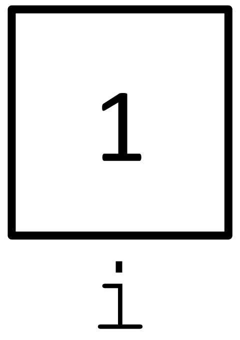
```
“1”
“2”
“3”
“4”
“5”
```

`std::endl` ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```





**Output:**

std::endl ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ‘1’ | ‘\n’ | | | | | | |

1

i

`endl` also flushes! So it is immediately sent to destination

**Output:**

`std::endl` ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```

2

i

intermediate buffer

When a stream is flushed the **intermediate buffer is cleared!**

**Output:**

“1”

`std::endl` ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```

2

i

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | ‘\n’ | | | | | | |

Next integer is put into the stream and immediately flushed!

**Output:**

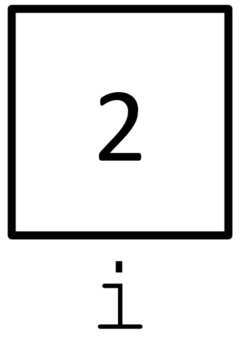
“1”

std::endl ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```

intermediate buffer



Next integer is put into the stream and immediately flushed!

**Output:**

"1"
"2"

`std::endl` ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```

2

i

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | ‘\n’ | | | | | | |

Next integer is put into the stream and immediately flushed!

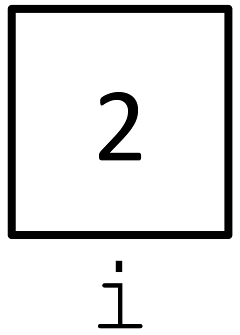
**Output:**

“1”
“2”

std::endl ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```



intermediate buffer

Next integer is put into the stream and immediately flushed!

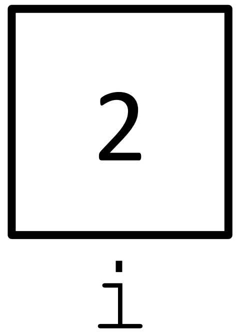
**Output:**

“1”
“2”
“3”

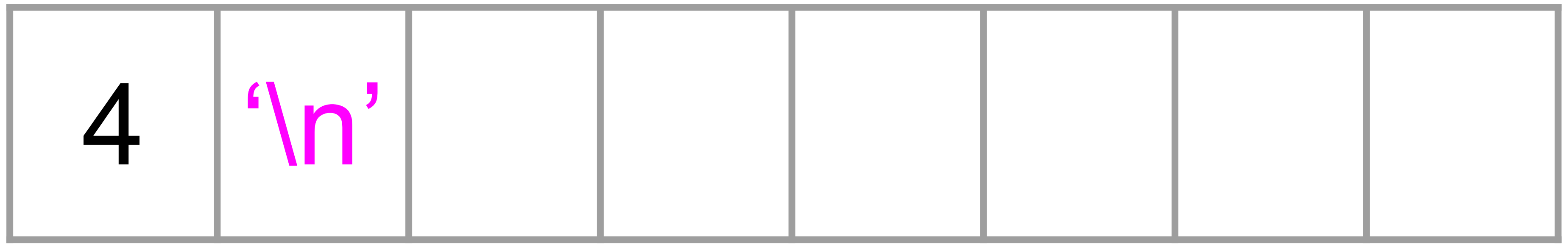
std::endl ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```



intermediate buffer



Next integer is put into the stream and immediately flushed!

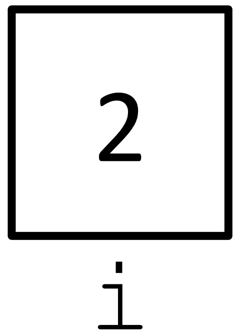
**Output:**

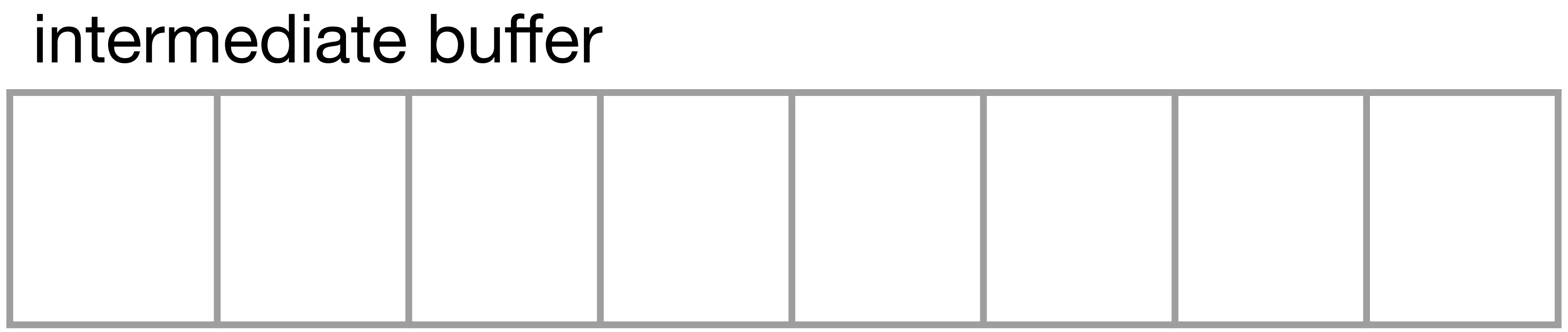
"1"
"2"
"3"

`std::endl` ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```





Next integer is put into the stream and immediately flushed!

**Output:**

"1"
"2"
"3"
"4"

`std::endl` ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```

2

i

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | ‘\n’ | | | | | | |

Next integer is put into the stream and immediately flushed!

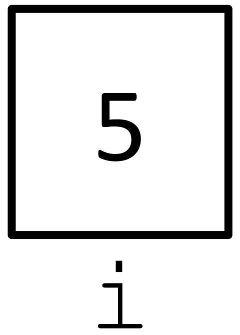
**Output:**

“1”
“2”
“3”
“4”

`std::endl` ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```



intermediate buffer

and this happens until we break out of our loop!

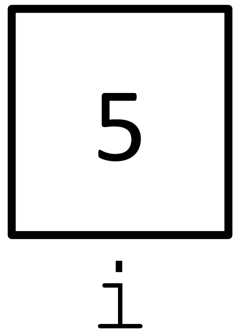
**Output:**

"1"
"2"
"3"
"4"
"5"

std::endl ***also*** tells the stream to **flush**

# std::endl

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << std::endl;
  }
  return 0;
}
```



intermediate buffer

flushing is an expensive operation!

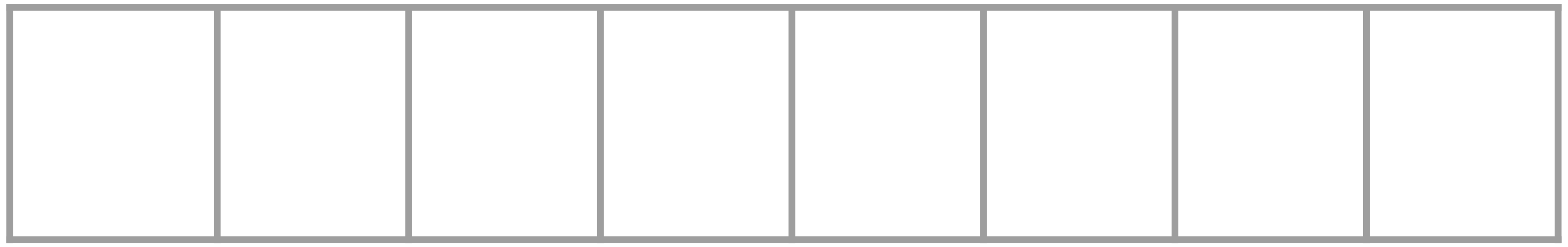
`std::endl` ***also*** tells the stream to flush

**Output:**

```
"1"
"2"
"3"
"4"
"5"
```

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```



1

i

C++ is (kinda) smart! It knows when to auto flush

**Output:**

Let's try just adding the '\n' character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```

1

i

Let’s try just adding the '\n' character

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | ‘\n’ | | | | | | |

C++ is (kinda) smart! It knows when to auto flush

**Output:**

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```

2

i

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | '\n' | | | | | | |

C++ is (kinda) smart! It knows when to auto flush

**Output:**

Let's try just adding the '\n' character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
→   std::cout << i << '\n';
  }
  return 0;
}
```

2

i

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | '\n' | 2 | '\n' | | | | |

C++ is (kinda) smart! It knows when to auto flush

**Output:**

Let's try just adding the `'\n'` character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | '\n' | 2 | '\n' | | | | |

3

i

C++ is (kinda) smart! It knows when to auto flush

**Output:**

Let's try just adding the '\n' character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```

3

i

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | '\n' | 2 | '\n' | 3 | '\n' | | |

C++ is (kinda) smart! It knows when to auto flush

**Output:**

Let's try just adding the `'\n'` character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```

4

i

intermediate buffer

|   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 1 | '\n' | 2 | '\n' | 3 | '\n' |   |   |

C++ is (kinda) smart! It knows when to auto flush

**Output:**

Let's try just adding the '\n' character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```

4

i

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | '\n' | 2 | '\n' | 3 | '\n' | 4 | '\n' |

C++ is (kinda) smart! It knows when to auto flush

**Output:**

Let's try just adding the '\n' character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```

5

i

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | '\n' | 2 | '\n' | 3 | '\n' | 4 | '\n' |

C++ is (kinda) smart! It knows when to auto flush

**Output:**

Let's try just adding the '\n' character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```

5

i

intermediate buffer

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | '\n' | 2 | '\n' | 3 | '\n' | 4 | '\n' |

😱🤯 Our intermediate buffer is full!

**Output:**

Let's try just adding the '\n' character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```

5

i

intermediate buffer

**C++: FLUSH**

**Output:**

"1"

"2"

"3"

"4"

Let's try just adding the '\n' character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
 → std::cout << i << '\n';
  }
  return 0;
}
```

5

i

intermediate buffer

|   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 5 | '\n' |   |   |   |   |   |   |

Yay!

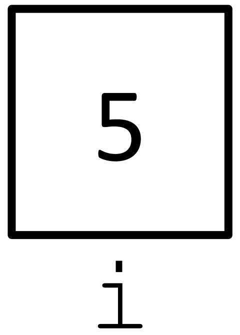
**Output:**

```
"1"
"2"
"3"
"4"
```

Let's try just adding the '\n' character

# '\n' 🤠

```
int main()
{
  for (int i=1; i <= 5; ++i) {
    std::cout << i << '\n';
  }
  return 0;
}
```



intermediate buffer

Let’s try just adding the '\n' character

**Yay!**

**Output:**

"1"
"2"
"3"
"4"
"5"

# `Recall`

- **`cerr` and `clog`**

  **`cerr:`** used to output errors (unbuffered)

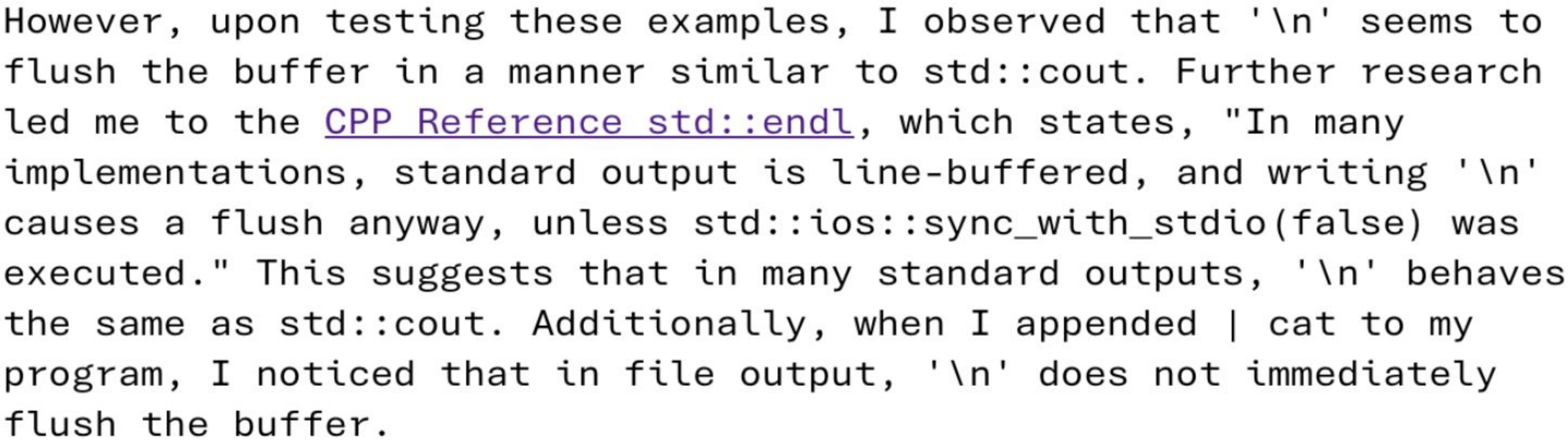
  **`clog:`** used for non-critical event logging (buffered)

read more here: GeeksForGeeks

# A shoutout and clarification

So it turns out the previous example isn’t necessarily true. Let me explain.

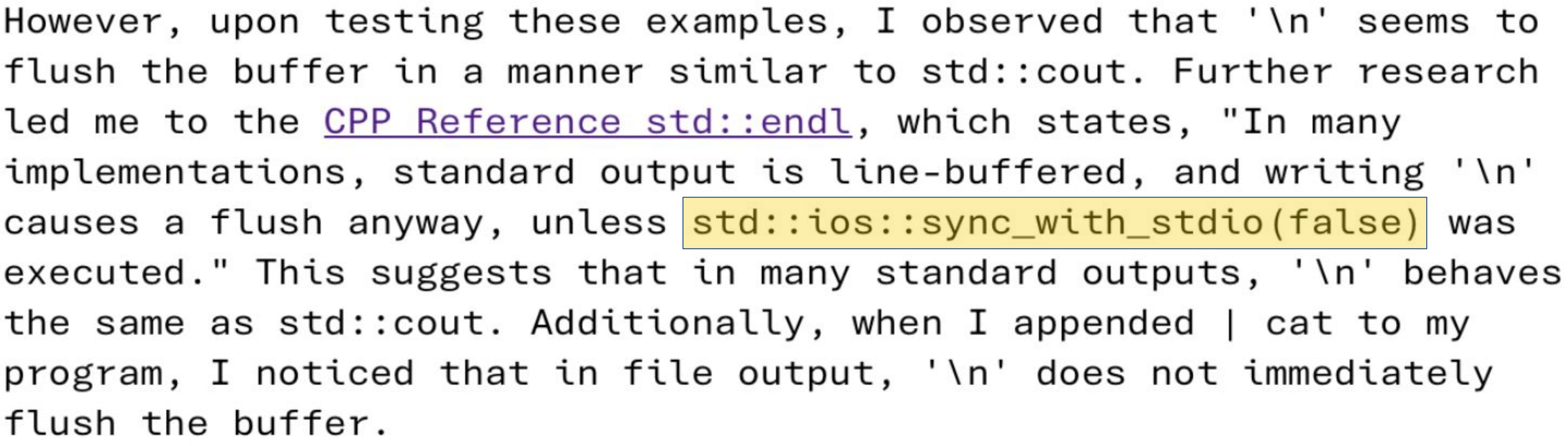
# A shoutout and clarification



However, upon testing these examples, I observed that '\n' seems to flush the buffer in a manner similar to std::cout. Further research led me to the CPP Reference std::endl, which states, "In many implementations, standard output is line-buffered, and writing '\n' causes a flush anyway, unless std::ios::sync_with_stdio(false) was executed." This suggests that in many standard outputs, '\n' behaves the same as std::cout. Additionally, when I appended | cat to my program, I noticed that in file output, '\n' does not immediately flush the buffer.

*In case you're looking at these slides Aolin, thank you for pointing this out!*

# A shoutout and clarification



However, upon testing these examples, I observed that '\n' seems to flush the buffer in a manner similar to std::cout. Further research led me to the CPP Reference std::endl, which states, "In many implementations, standard output is line-buffered, and writing '\n' causes a flush anyway, unless std::ios::sync_with_stdio(false) was executed." This suggests that in many standard outputs, '\n' behaves the same as std::cout. Additionally, when I appended | cat to my program, I noticed that in file output, '\n' does not immediately flush the buffer.

*In case you're looking at these slides Aolin, thank you for pointing this out!*

# A shoutout and clarification

```
int main()
{
  std::ios::sync_with_stdio(false)
  for (int i=1; i <= 5; ++i) {
    std::cout << i << ‘\n’;
  }
  return 0;
}
```

*In case you’re looking at these slides Aolin, thank you for pointing this out!*

# A shoutout and clarification

```
int main()
{
  std::ios::sync_with_stdio(false)
  for (int i=1; i <= 5; ++i) {
    std::cout << i << ‘\n’;
  }
  return 0;
}
```

Read more about this here!

*In case you’re looking at these slides Aolin, thank you for pointing this out!*

YOU WASTED ENOUGH OF MY TIME
CAN I PLEASE HAVE MY LIFE BACK?
memeshappen.com

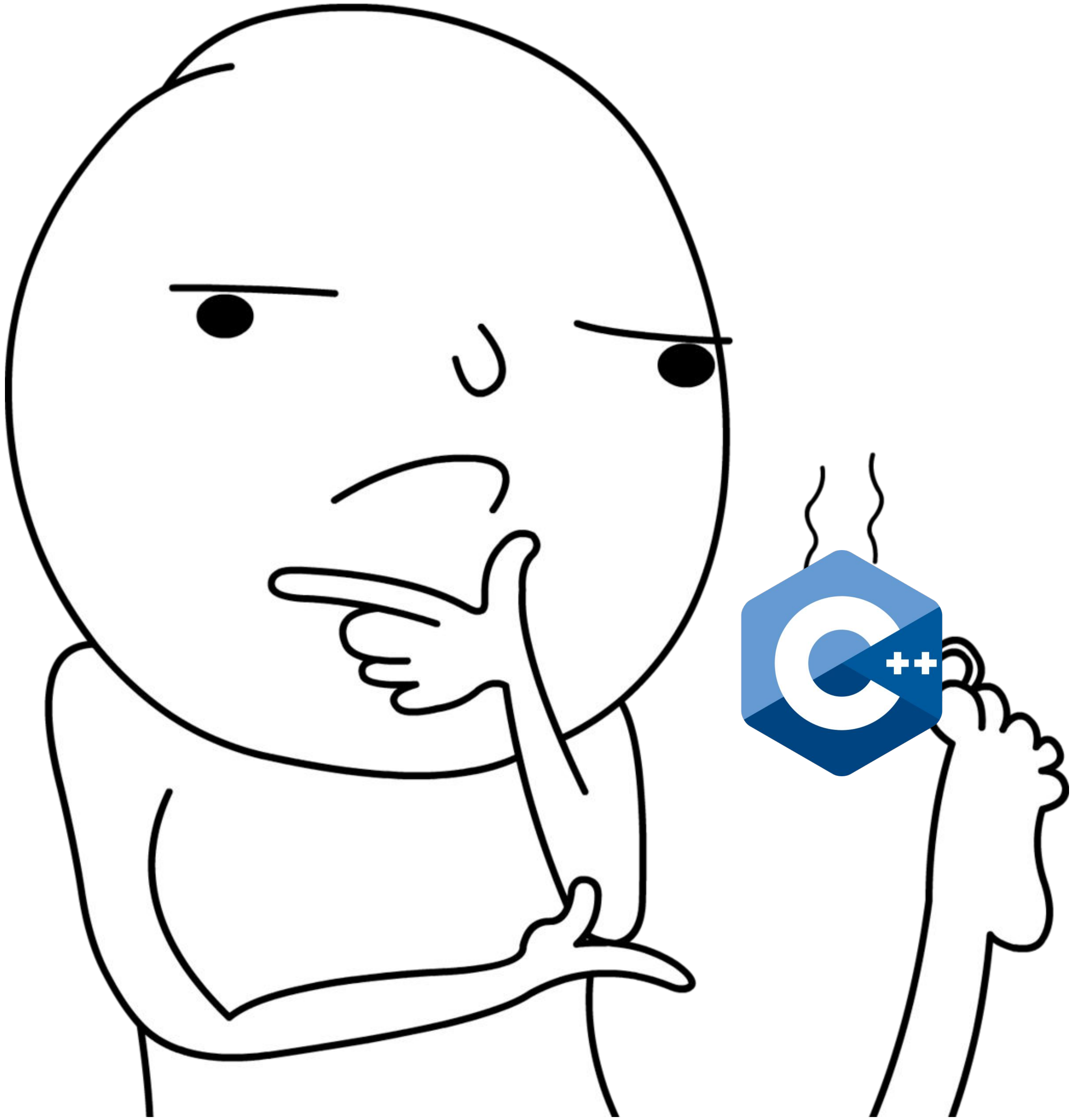
**ASIDE: If you’re interested in how computers are able to do multiple things at the same time take CS149!**

# Use ‘\n’!

```
std::cout << “Draaaakkkkeeeeeeeeee” << std::endl;
```

```
std::cout << “Draaaakkkkeeeeeeeeee” << ‘\n’;
```

# What questions do we have?



# Output File Streams

- Output file streams have a type: `std::ofstream`
- a way to write data to a file!
  - use the << insertion operator to ***send*** to the file
  - There are some methods for `std::ofstream` check them out
  - Here are some you should know:
    - `is_open()`
    - `open()`
    - `close()`
    - `fail()`

# Output File Streams

```
int main() {
  /// associating file on construction
  std::ofstream ofs(“hello.txt”)
  if (ofs.is_open()) {
    ofs << “Hello CS106L!” << ‘\n’;
  }
  ofs.close();
  ofs << “this will not get written”;

  ofs.open(“hello.txt”);
  ofs << “this will though! It’s open
again”;
  return 0;
}
```

# Output File Streams

```
int main() {
  /// associating file on construction
  std::ofstream ofs(“hello.txt”)
  if (ofs.is_open()) {
    ofs << “Hello CS106L!” << ‘\n’;
  }
  ofs.close();
  ofs << “this will not get written”;

  ofs.open(“hello.txt”);
  ofs << “this will though! It’s open
again”;
  return 0;
}
```

Creates an output file stream to the file “hello.txt”

# Output File Streams

```
int main() {
  /// associating file on construction
  std::ofstream ofs(“hello.txt”)
  if (ofs.is_open()) {
    ofs << “Hello CS106L!” << ‘\n’;
  }
  ofs.close();
  ofs << “this will not get written”;

  ofs.open(“hello.txt”);
  ofs << “this will though! It’s open
again”;
  return 0;
}
```

Checks if the file is open and if it is, then tries to write to it!

# Output File Streams

```
int main() {
  /// associating file on construction
  std::ofstream ofs(“hello.txt”)
  if (ofs.is_open()) {
    ofs << “Hello CS106L!” << ‘\n’;
  }
  ofs.close();
  ofs << “this will not get written”;

  ofs.open(“hello.txt”);
  ofs << “this will though! It’s open
again”;
  return 0;
}
```

This closes the output file stream to “hello.txt”

# Output File Streams

```
int main() {
  /// associating file on construction
  std::ofstream ofs(“hello.txt”)
  if (ofs.is_open()) {
    ofs << “Hello CS106L!” << ‘\n’;
  }
  ofs.close();
  ofs << “this will not get written”;

  ofs.open(“hello.txt”);
  ofs << “this will though! It’s open
again”;
  return 0;
}
```

Will silently fail

# Output File Streams

```
int main() {
  /// associating file on construction
  std::ofstream ofs(“hello.txt”)
  if (ofs.is_open()) {
    ofs << “Hello CS106L!” << ‘\n’;
  }
  ofs.close();
  ofs << “this will not get written”;

  ofs.open(“hello.txt”);
  ofs << “this will though! It’s open
again”;
  return 0;
}
```

Reopens the stream

# Output File Streams

```
int main() {
  /// associating file on construction
  std::ofstream ofs(“hello.txt”)
  if (ofs.is_open()) {
    ofs << “Hello CS106L!” << ‘\n’;
  }
  ofs.close();
  ofs << “this will not get written”;

  ofs.open(“hello.txt”);
  ofs << “this will though! It’s open
again”;
  return 0;
}
```

Successfully writes to stream

Let's checkout some code!

(My cue to go on Replit :) )

# Output File Streams

```
int main() {
  /// associating file on construction
  std::ofstream ofs(“hello.txt”)
  if (ofs.is_open()) {
    ofs << “Hello CS106L!” << ‘\n’;
  }
  ofs.close();
  ofs << “this will not get written”;

  ofs.open(“hello.txt”, std::ios::app);
  ofs << “this will though! It’s open
again”;
  return 0;
}
```

Flag specifies you want to append, not truncate!

# Input File Streams

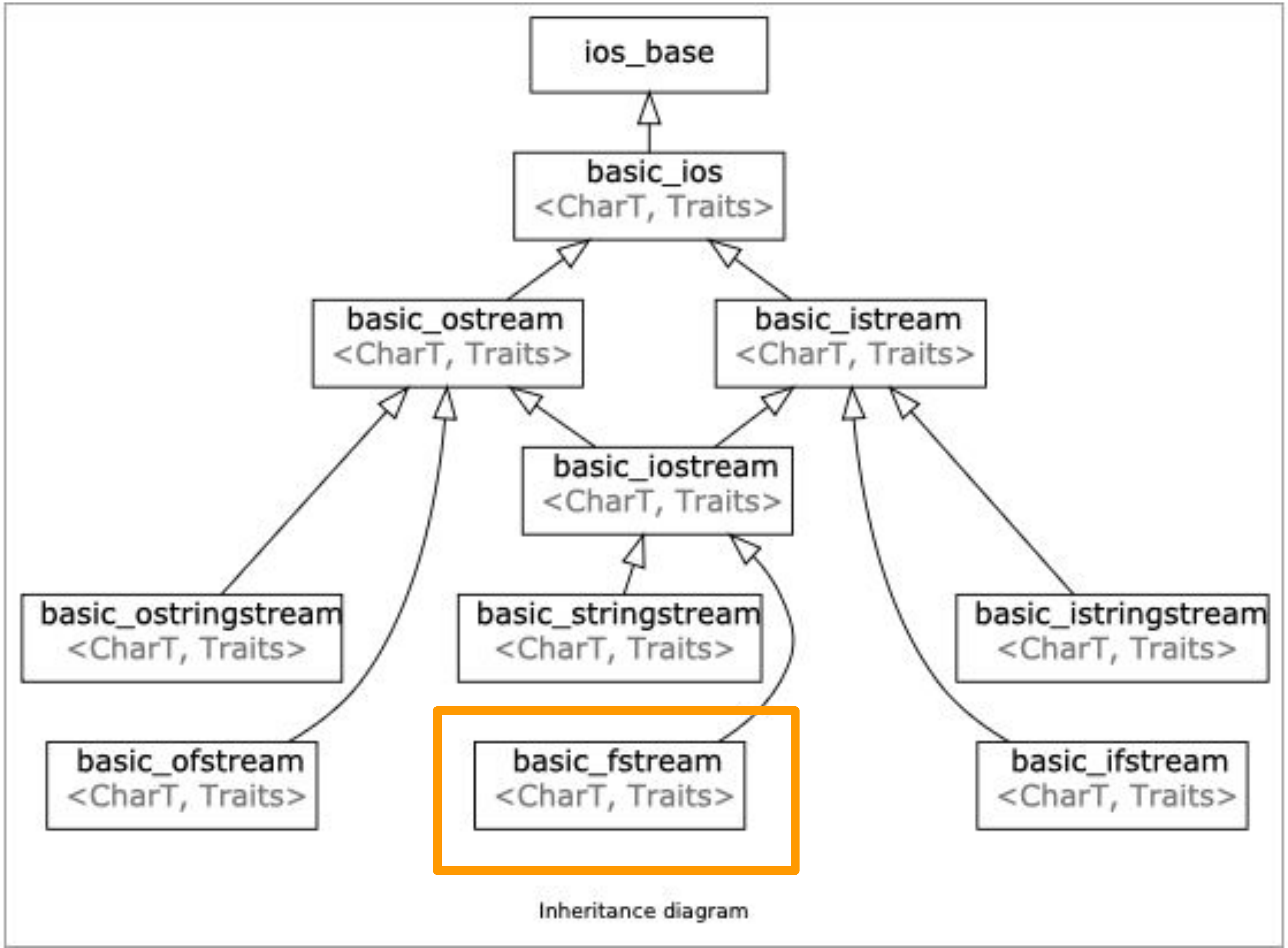
```
int inputFileStreamExample() {
  std::ifstream ifs(“append.txt”)
  if (ifs.is_open()) {
     std::string line;
     std::getline(ifs, line);
     std::cout << “Read from the file: “ << line << ‘\n’;
  }
  if (ifs.is_open()) {
     std::string lineTwo;
     std::getline(ifs, lineTwo);
     std::cout << “Read from the file: “ << lineTwo << ‘\n’;
  }
  return 0;
}
```

# Input File Streams

Input and output streams on the same source/destination type are complimentary!

```
int inputFileStreamExample() {
  std::ifstream ifs(“append.txt”)
  if (ifs.is_open()) {
      std::string line;
      std::getline(ifs, line);
      std::cout << “Read from the file: “ << line << ‘\n’;
  }
  if (ifs.is_open()) {
      std::string lineTwo;
      std::getline(ifs, lineTwo);
      std::cout << “Read from the file: “ << lineTwo << ‘\n’;
  }
  return 0;
}
```

# IO File Streams

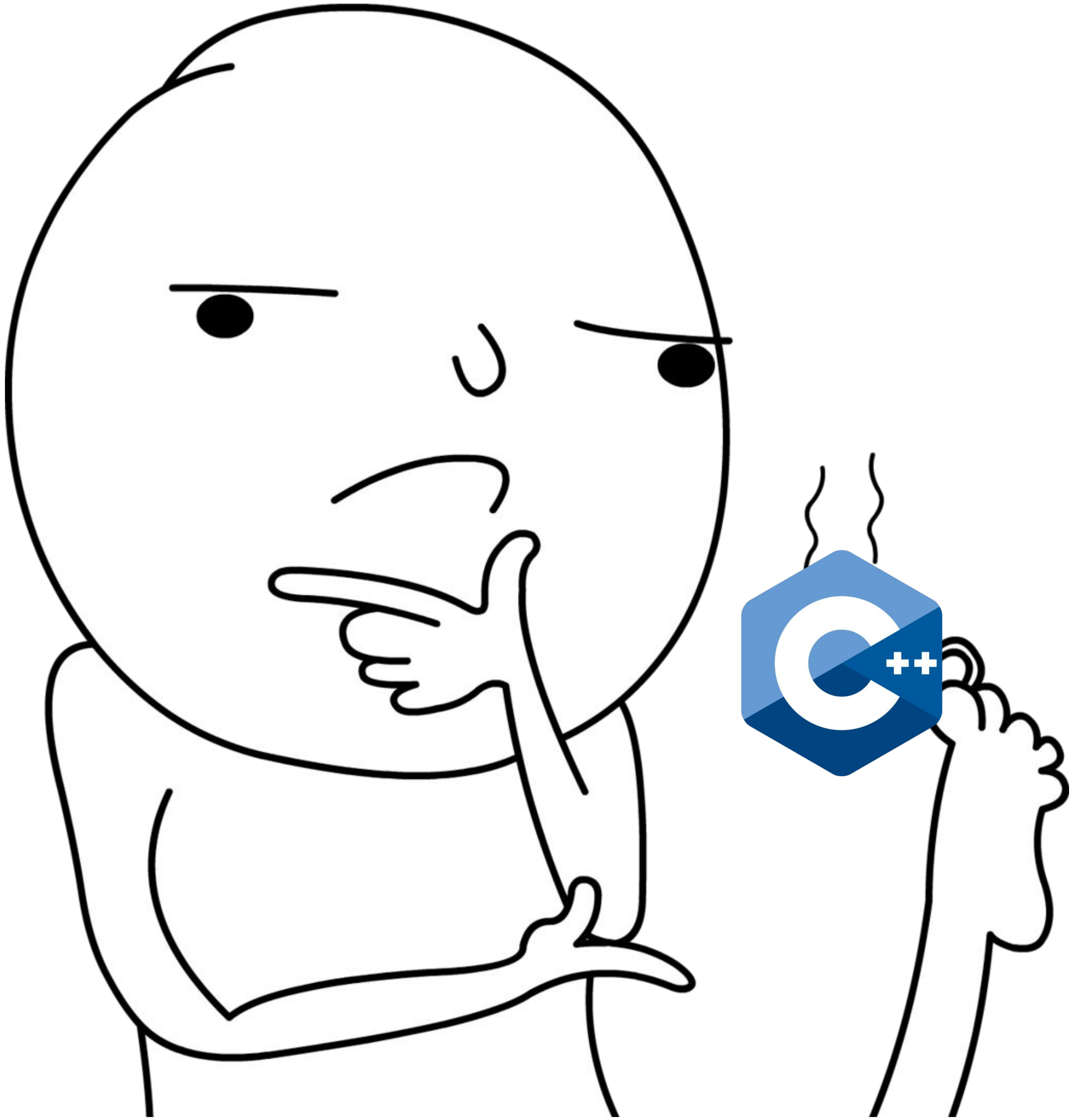

ios_base
basic_ios <CharT, Traits>
basic_ostream <CharT, Traits>
basic_istream <CharT, Traits>
basic_iostream <CharT, Traits>
basic_ostringstream <CharT, Traits>
basic_stringstream <CharT, Traits>
basic_istringstream <CharT, Traits>
basic_ofstream <CharT, Traits>
basic_fstream <CharT, Traits>
basic_ifstream <CharT, Traits>
Inheritance diagram

# Check out the Replit!

🤠Checkout the function **`testFstream()`**🤠

With your knowledge of how output and input streams independently work you can make great use of their combined implementation

# What questions do we have?



# Plan

1. ~~Quick recap~~
2. ~~What are streams??!!~~
3. ~~stringstreams~~
4. ~~Output streams~~
5. Input streams

# Input Streams

- Input streams have the type `std::istream`
- a way to read data from an destination/external source
  - use the `>>` extractor operator to ***read*** from the input stream
  - Remember the `std::cin` is the console input stream

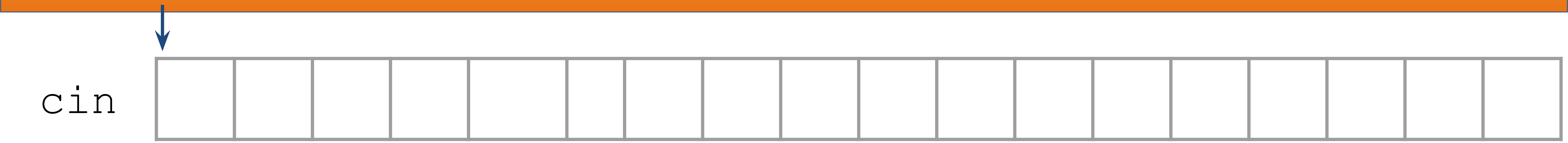
# std::cin

- `std::cin` is buffered
- Think of it as a place where a user can store some data and then read from it
- `std::cin` buffer stops at a whitespace

# std::cin

- std::cin is buffered
- Think of it as a place where a user can store some data and then read from it
- std::cin buffer stops at a whitespace
- Whitespace in C++ includes:
    - “ ” – a literal space
    - \n character
    - \t character

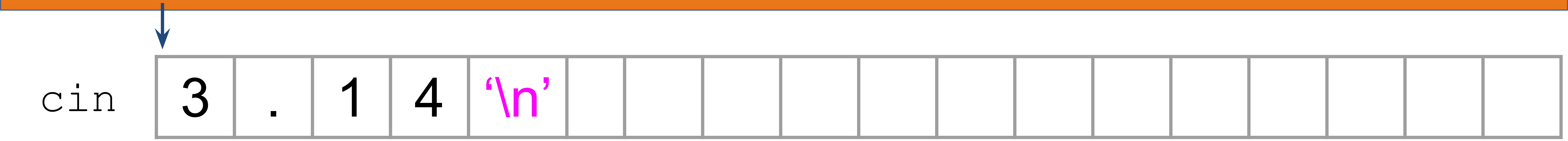
# std::cin



```
int main()
{
  double pi;
  std::cin; /// what does this do?
  std::cin >> pi;
  std::cout << “pi is: “ << pi << ‘\n’;
  return 0;
}
```

cin buffer is empty so prompts for input!

# std::cin

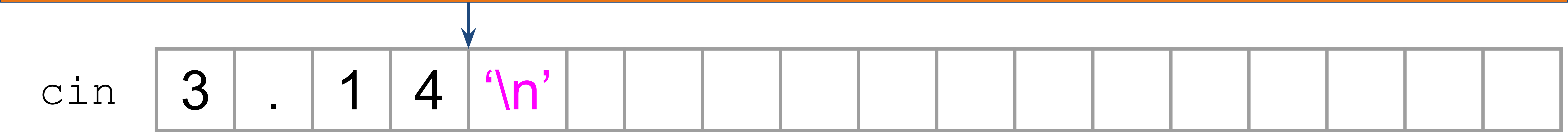


| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | ‘\n’ | | | | | | | | | | | | | |

```
int main()
{
  double pi;
  std::cin; /// what does this do?
  std::cin >> pi;
  std::cout << “pi is: “ << pi << ‘\n’;
  return 0;
}
```

3.14

# std::cin



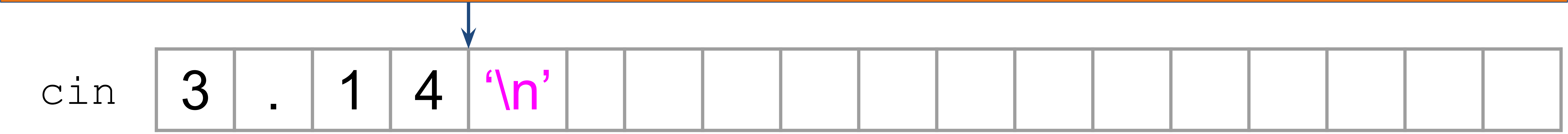
| cin | 3 | . | 1 | 4 | ‘\n’ | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

```
int main()
{
  double pi;
  std::cin; /// what does this do?
  std::cin >> pi;
  std::cout << “pi is: “ << pi << ‘\n’;
  return 0;
}
```

`cin` not empty so it reads up to white space and saves it to **`double pi`**

```
3.14
```

# std::cin

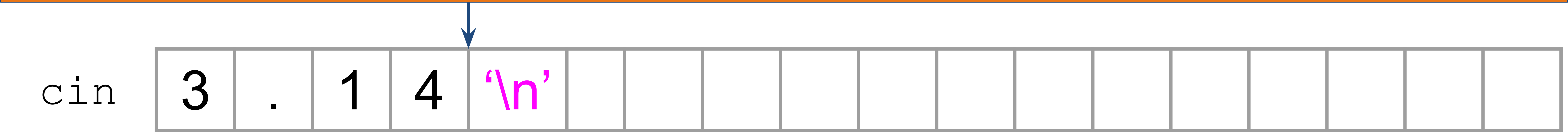


```
int main()
{
  double pi;
  std::cin; /// what does this do?
  std::cin >> pi;
  std::cout << “pi is: “ << pi << ‘\n’;
  return 0;
}
```

cout

```
“3.14”
“pi is: 3.14”
```

# Alternatively

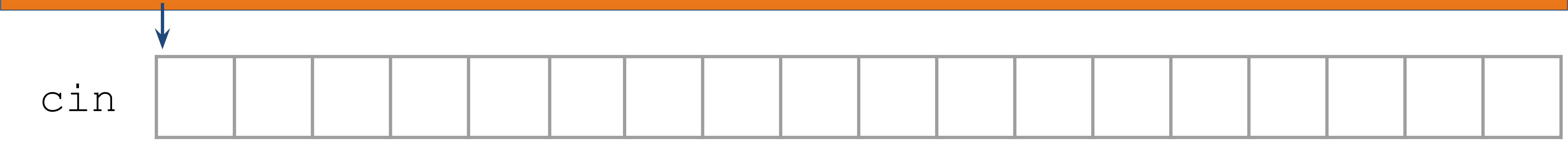


| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | ‘\n’ | | | | | | | | | | | | | |

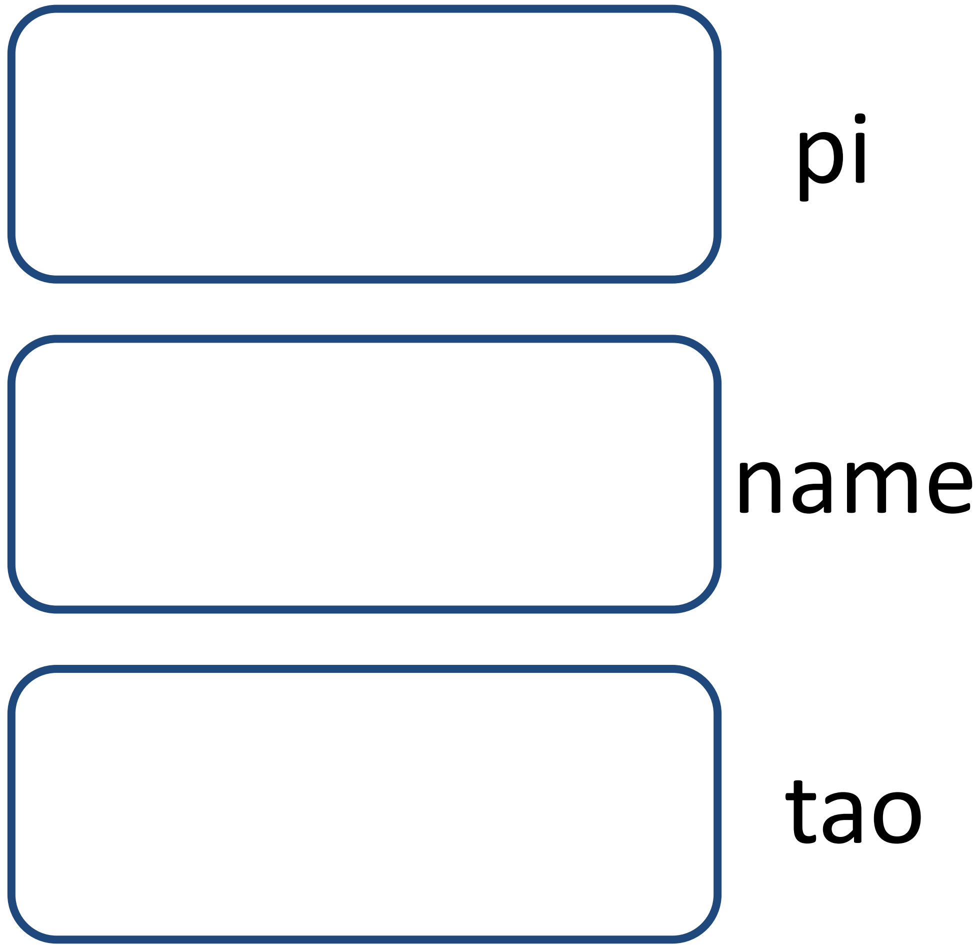
```
int main()
{
  double pi;
  std::cin >> pi; /// input directly!
  std::cout << “pi is: “ << pi << ‘\n’;
  return 0;
}
```

```
“3.14”
“pi is: 3.14”
```

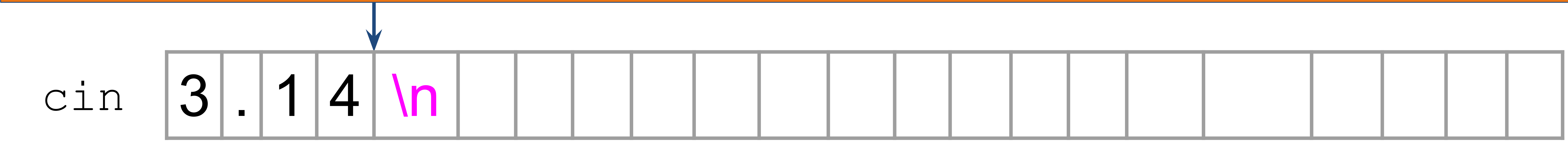
# When `std::cin` fails!



```
int main()
{
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::cin >> name;
  std::cin >> tao;
  std::cout << “my name is: “ << name <<
  “ tao is: “ << tao << “ pi is: “ << pi << ‘\n’;
  return 0;
}
```



# When std::cin fails!

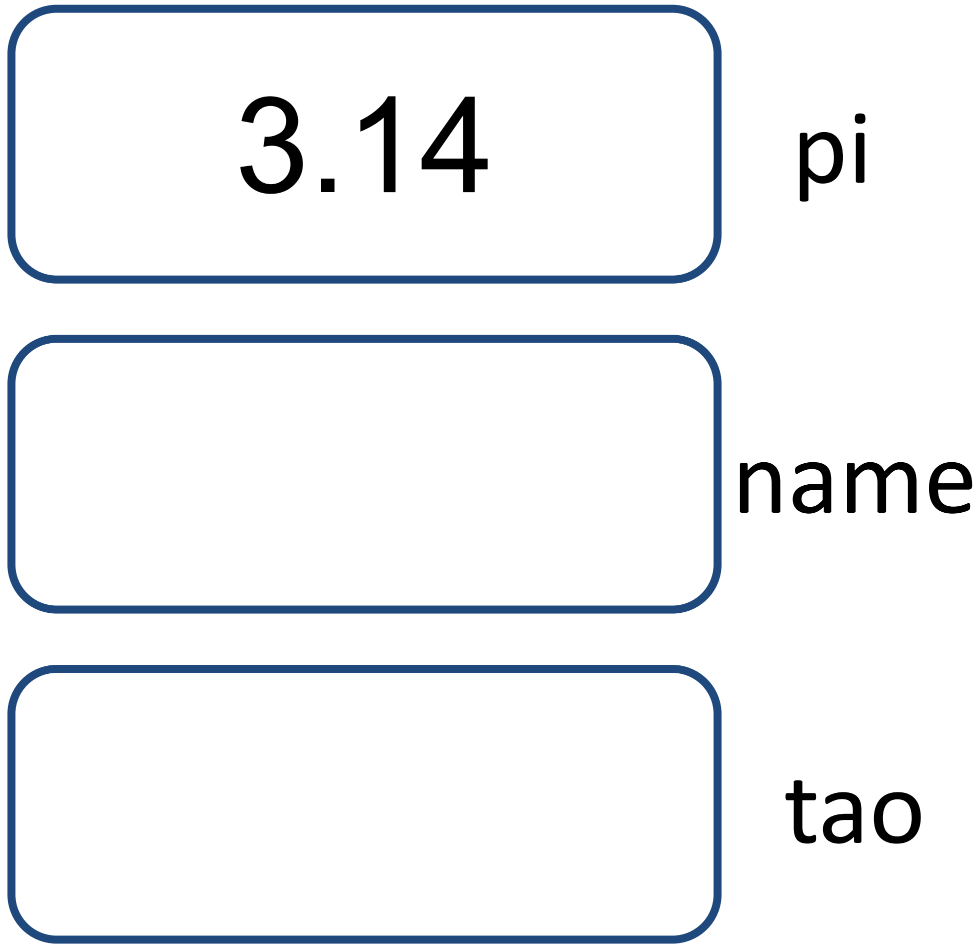


cin

| 3 | . | 1 | 4 | \n | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

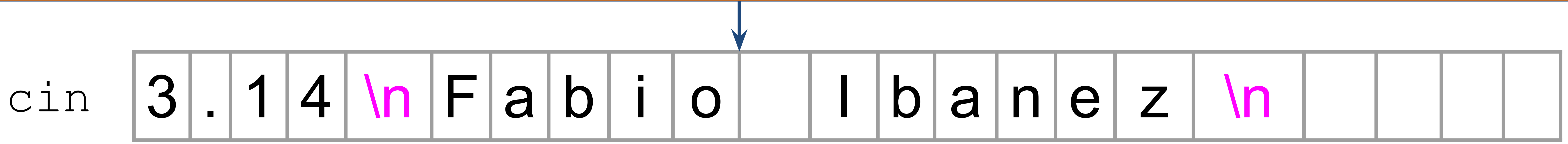
```
int main()
{
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::cin >> name;
  std::cin >> tao;
  std::cout << “my name is: “ << name <<
  “ tao is: “ << tao << “ pi is: “ << pi << ‘\n’;
  return 0;
}
```

**cin** prompts user to enter a value saved in **pi**



| | |
|---|---|
| 3.14 | pi |
| | name |
| | tao |

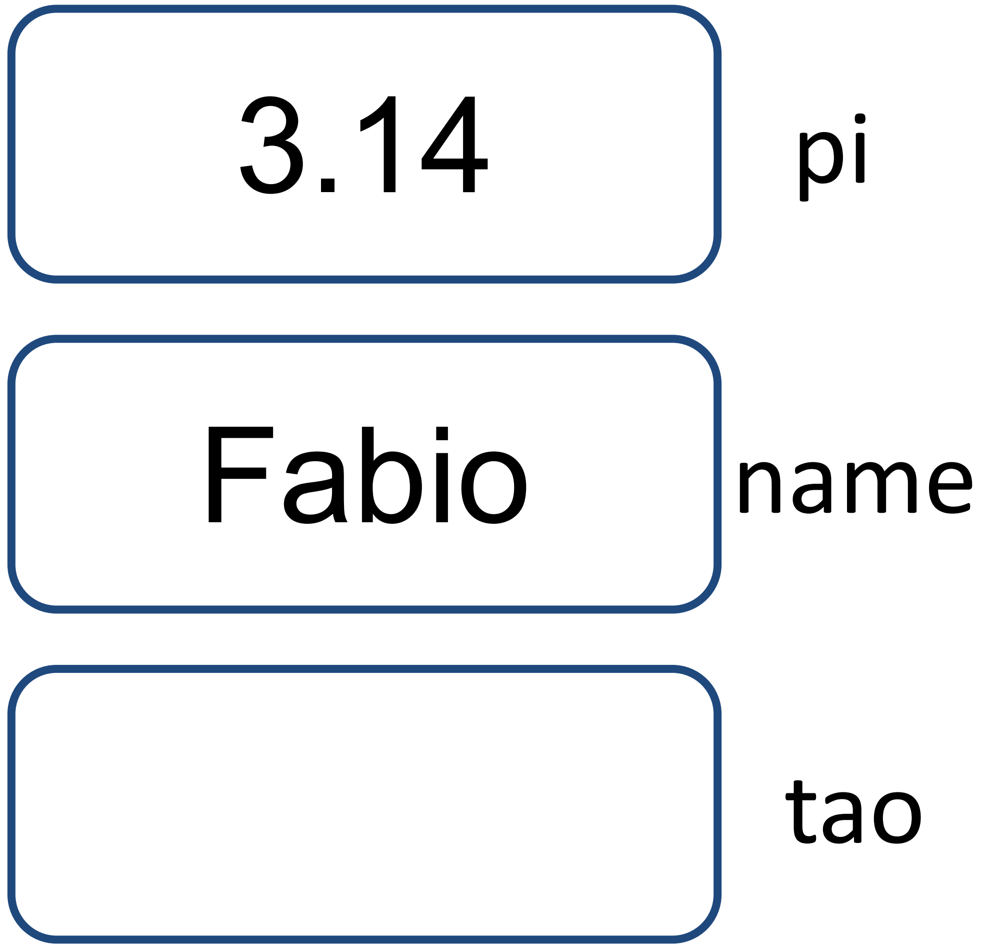
# When std::cin fails!



| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | | |

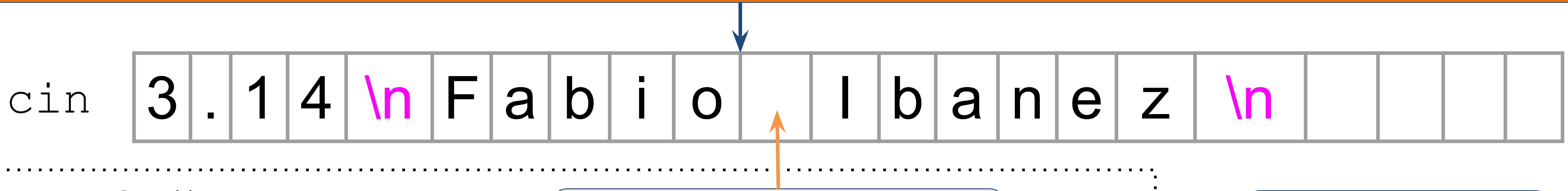
```
int main()
{
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::cin >> name;
  std::cin >> tao;
  std::cout << “my name is: “ << name <<
  “ tao is: “ << tao << “ pi is: “ << pi << ‘\n’;
  return 0;
}
```

**cin** prompts user to enter a value saved in **name**



| | |
|---|---|
| 3.14 | pi |
| Fabio | name |
| | tao |

# When std::cin fails!

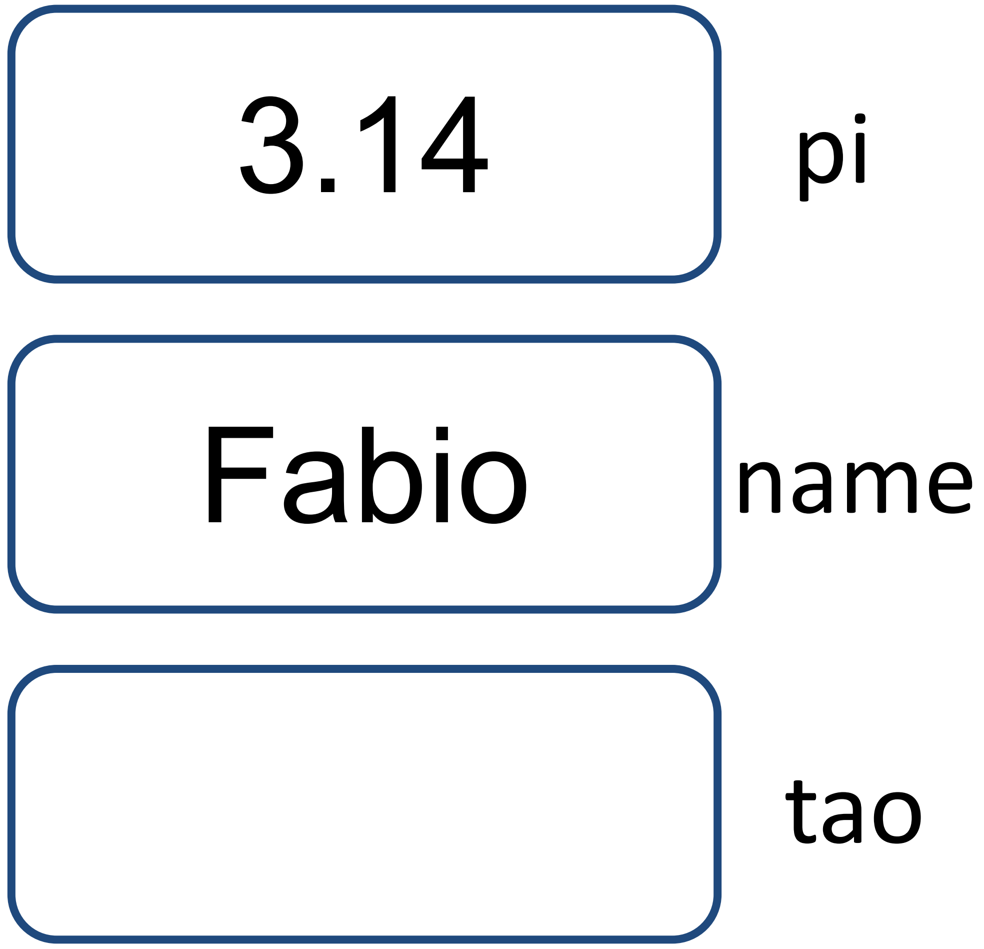


| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | | |

```
int main()
{
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::cin >> name;
  std::cin >> tao;
  std::cout << “my name is: “ << name <<
  “ tao is: “ << tao << “ pi is: “ << pi << ‘\n’;
  return 0;
}
```

Notice that cin ***only*** reads until the next whitespace

**cin** prompts user to enter a value saved in **name**



| | |
|---|---|
| 3.14 | pi |
| Fabio | name |
| | tao |

# When `std::cin` fails!

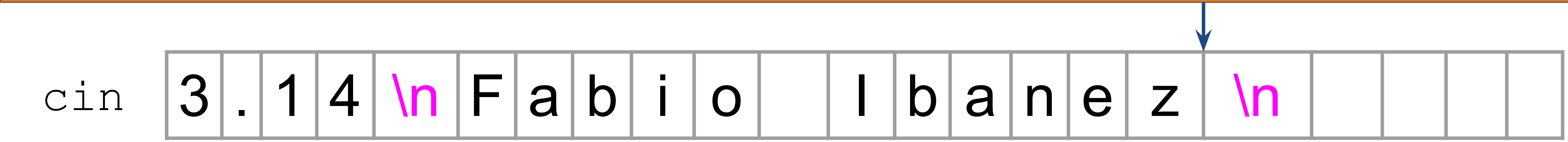
| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | | |

```
int main()
{
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::cin >> name;
  std::cin >> tao;
  std::cout << “my name is: “
  “ tao is: “ << tao << “ pi is: “ << pi << ‘\n’;
  return 0;
}
```

`cin` buffer is not empty, so it reads until the next whitespace

| | |
|---|---|
| 3.14 | pi |
| Fabio | name |
| ? | tao |

# When std::cin fails!



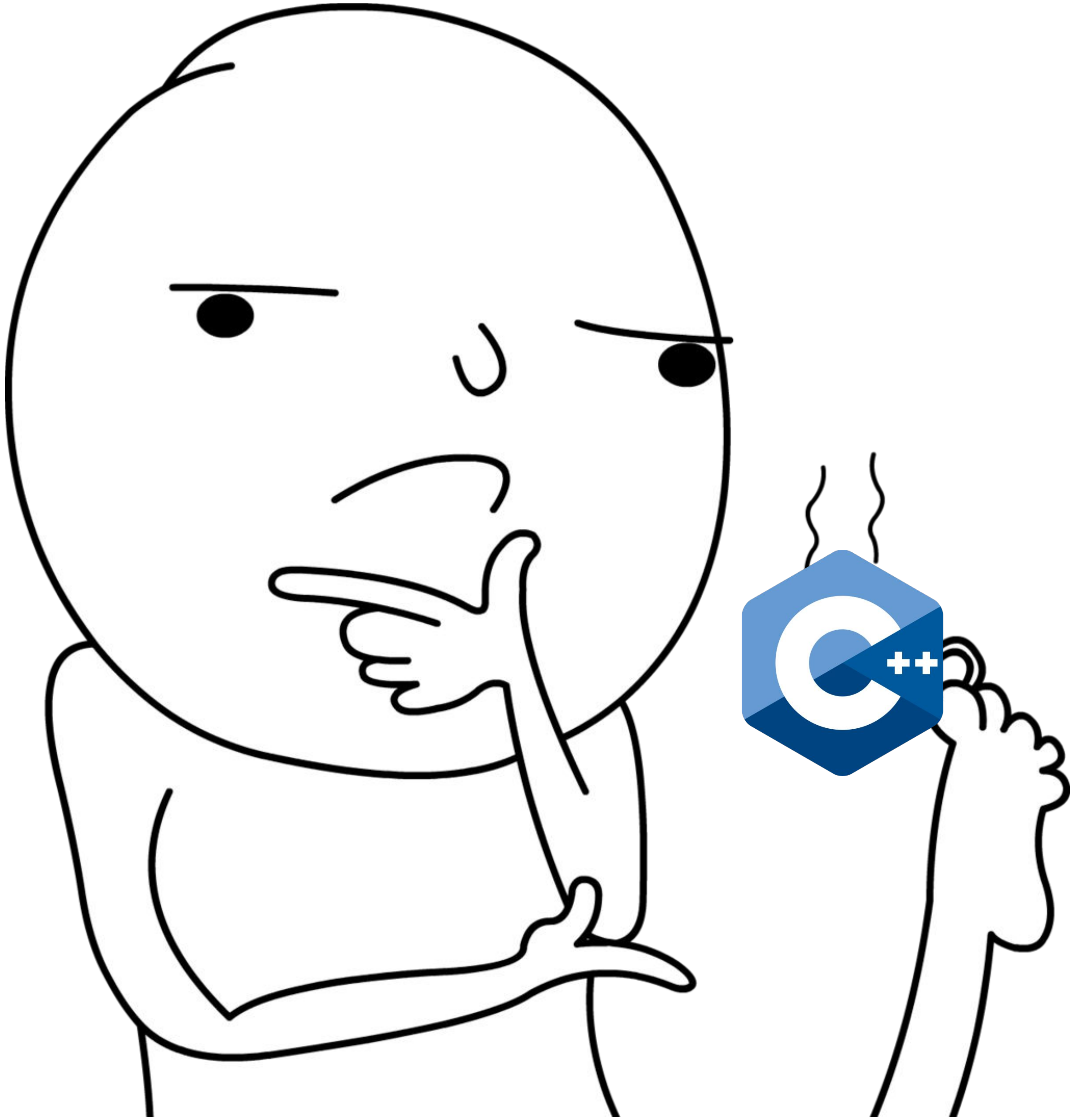
| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o |  | I | b | a | n | e | z | \n |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

```
void cinFailure() // replit name
{
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::cin >> name;
  std::cin >> tao;
  std::cout << “my name is: “
  “ tao is: “ << tao << “ pi is: “ << pi << ‘\n’;
}
```

**cin** buffer is not empty, so it reads until the next whitespace

|  |  |
|---|---|
| 3.14 | pi |
| Fabio | name |
| 0 | tao |

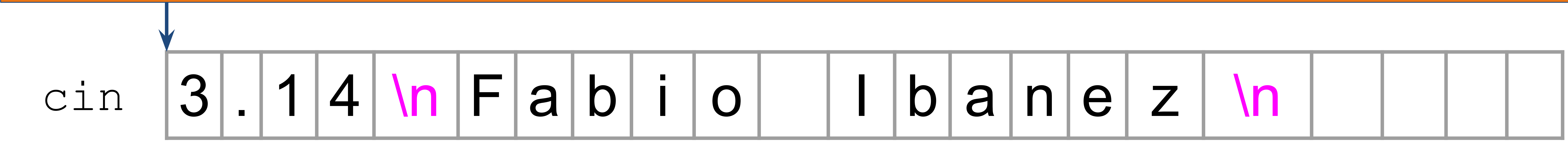
# What questions do we have?



# How do we fix this?

**Anyone want to take a guess?**

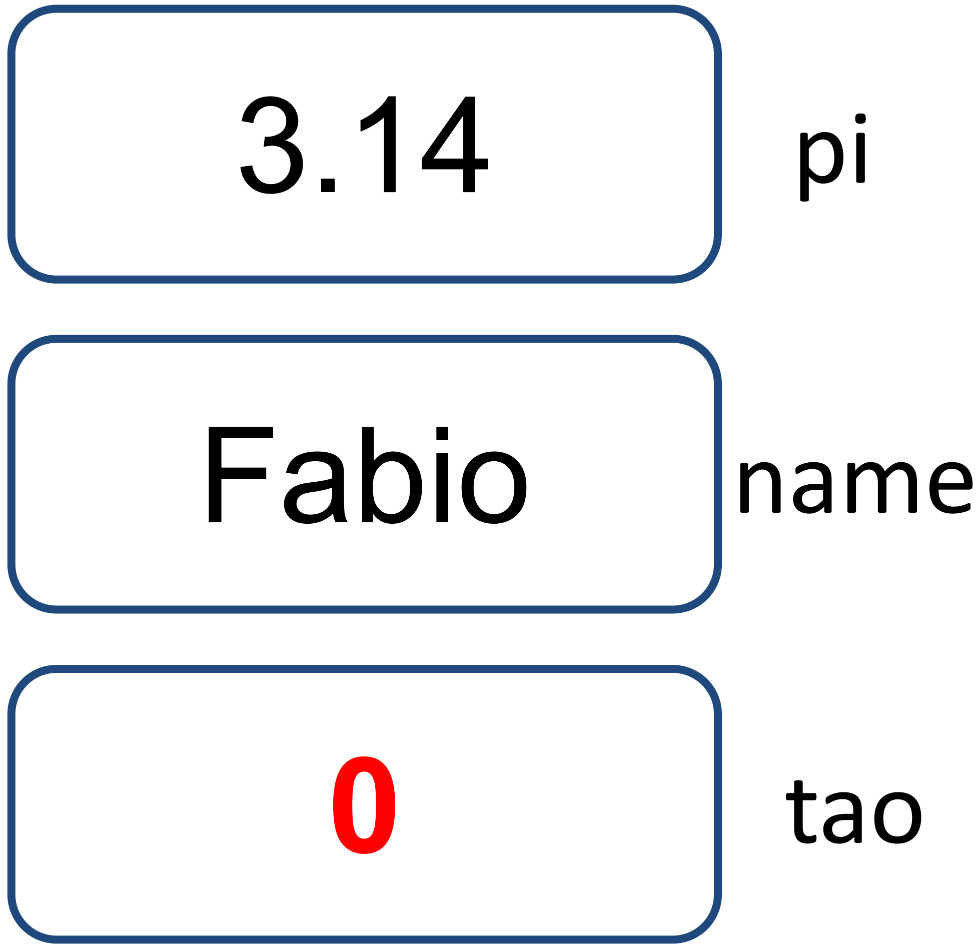
# Fix?



cin

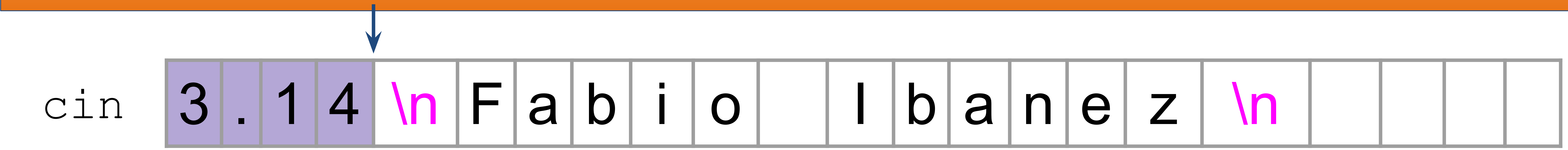
| 3 | . | 1 | 4 | \n | F | a | b | i | o |  | I | b | a | n | e | z | \n |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is :
" << tao
            << " pi is : " << pi << '\n';
}
```



| | |
|---|---|
| 3.14 | pi |
| Fabio | name |
| **0** | tao |

# Fix?

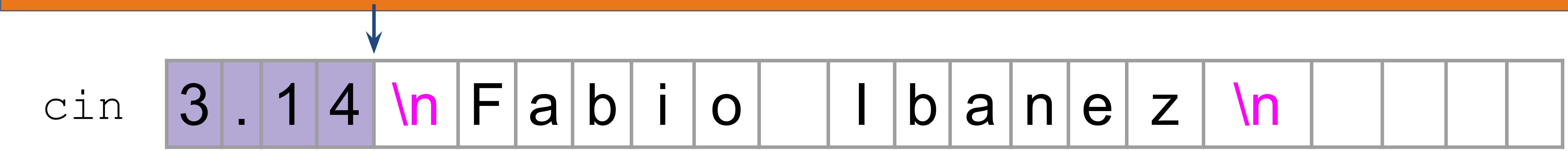


| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | | |

```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is : 
" << tao
            << " pi is : " << pi << '\n';
}
```

| | |
|---|---|
| 3.14 | pi |
| Fabio | name |
| 0 | tao |

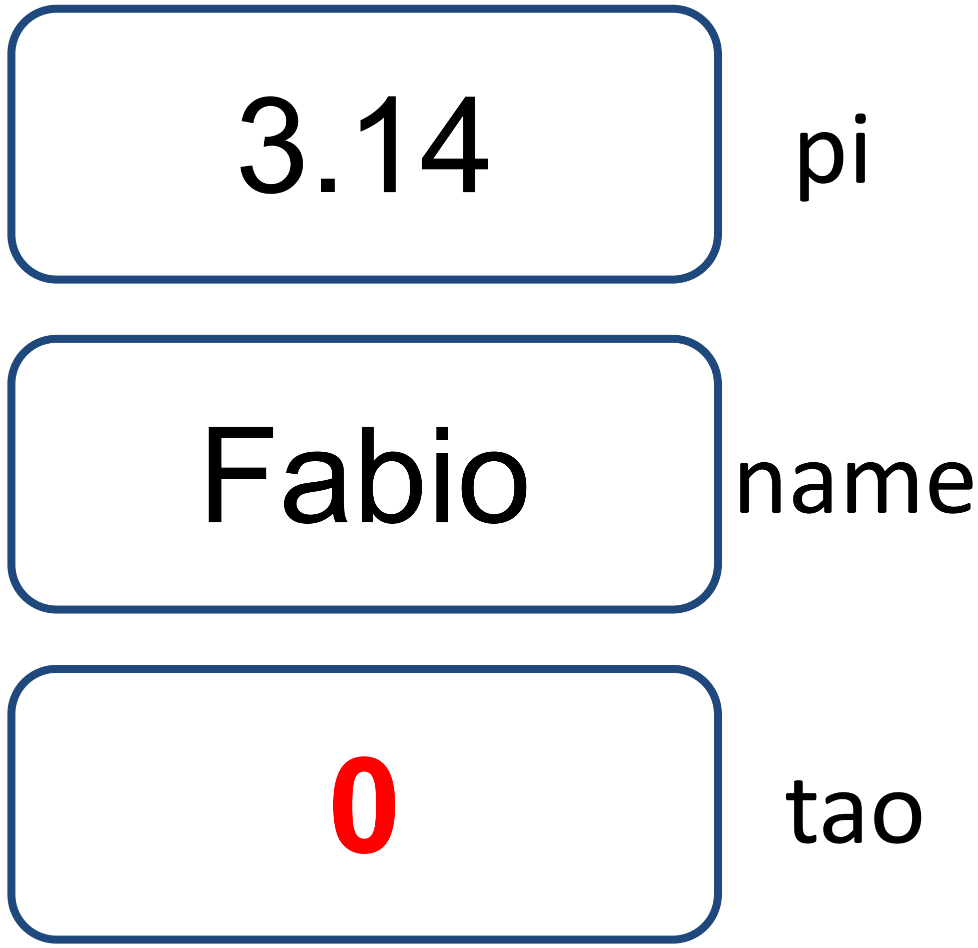
# Fix?



| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | | |

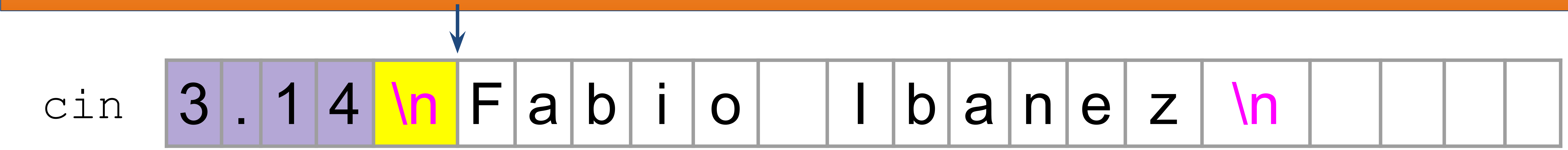
```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is :
" << tao
            << " pi is : " << pi << '\n';
}
```

Any guesses for what happens here?



| | |
|---|---|
| 3.14 | pi |
| Fabio | name |
| 0 | tao |

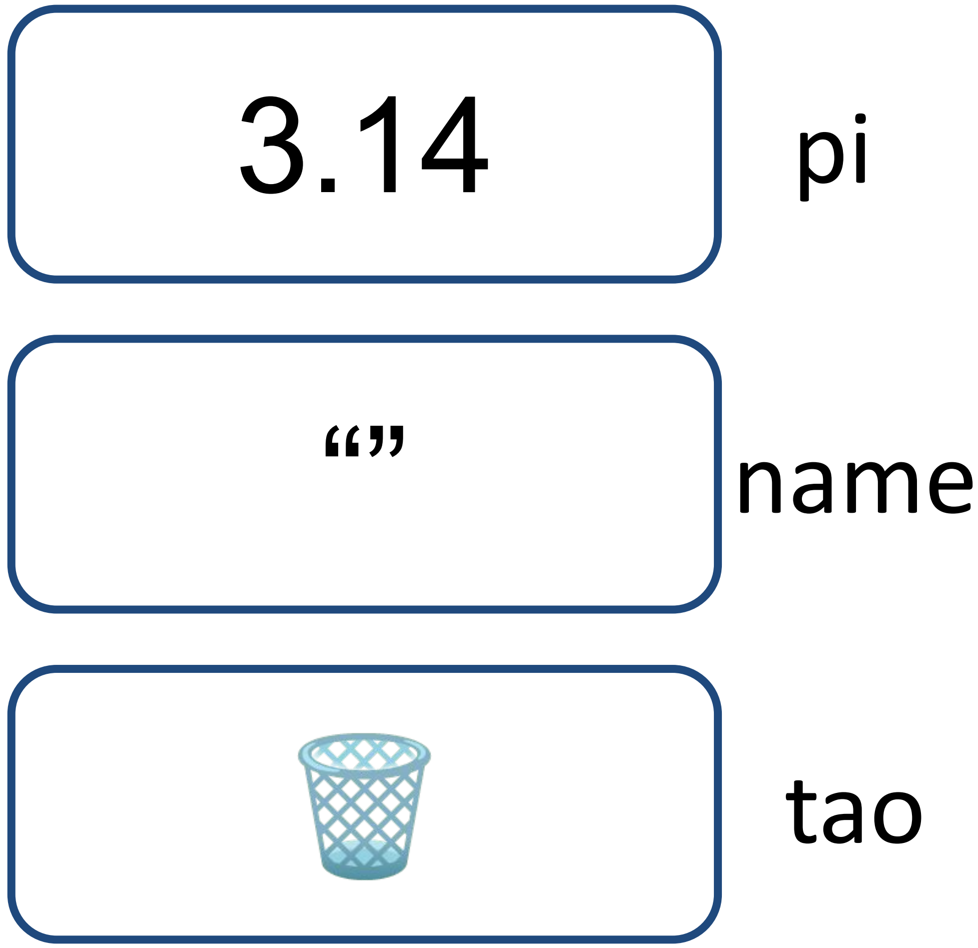
# Fix?



| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | | |

```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is :
" << tao
            << " pi is : " << pi << '\n';
}
```

**getline** consumes the newline character



| | |
|---|---|
| 3.14 | pi |
| “” | name |
| 🗑️ | tao |

# Fix?

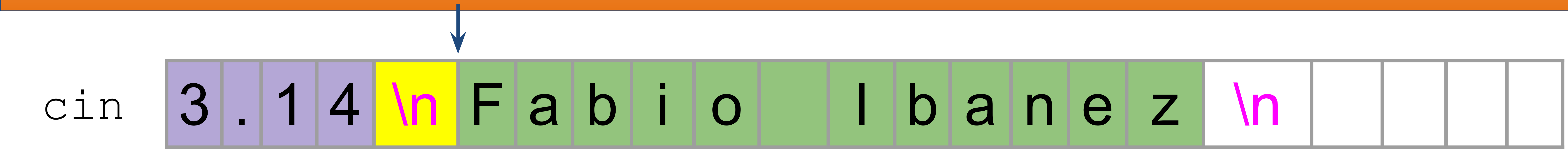
| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | | |

```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << na
" << tao
            << " pi is : " << pi << '\n';
}
```

| | |
|---|---|
| 3.14 | pi |
| “” | name |
| 🗑️ | tao |

Tao is going to be garbage because the buffer is not empty

# Fix?



| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | |

```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << na
" << tao
                << " pi is : " << pi << '\n';
}
```

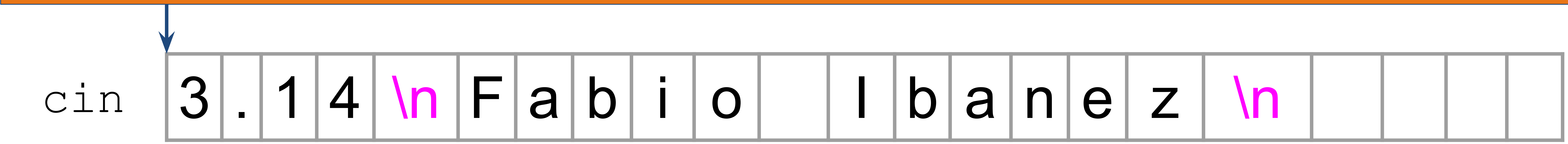
It’s going to try to read the green stuff (name). But tao is a **double**!

| | |
|---|---|
| 3.14 | pi |
| “” | name |
| 🗑️ | tao |

# How do we fix this?

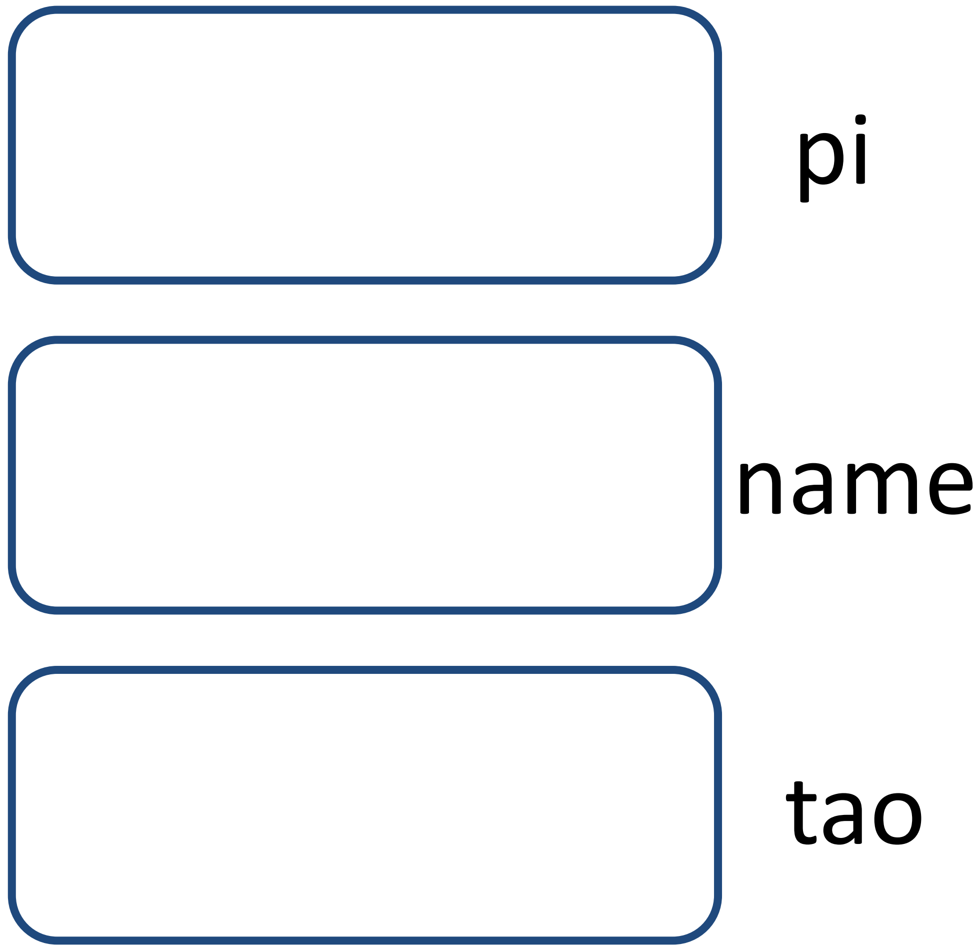
**Anyone want to take another guess?**

# Fix?

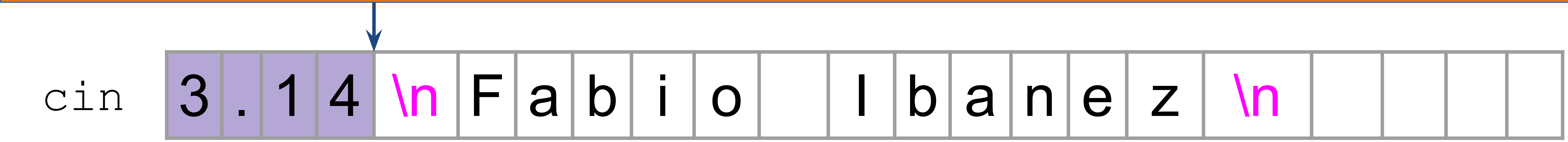


| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | | |

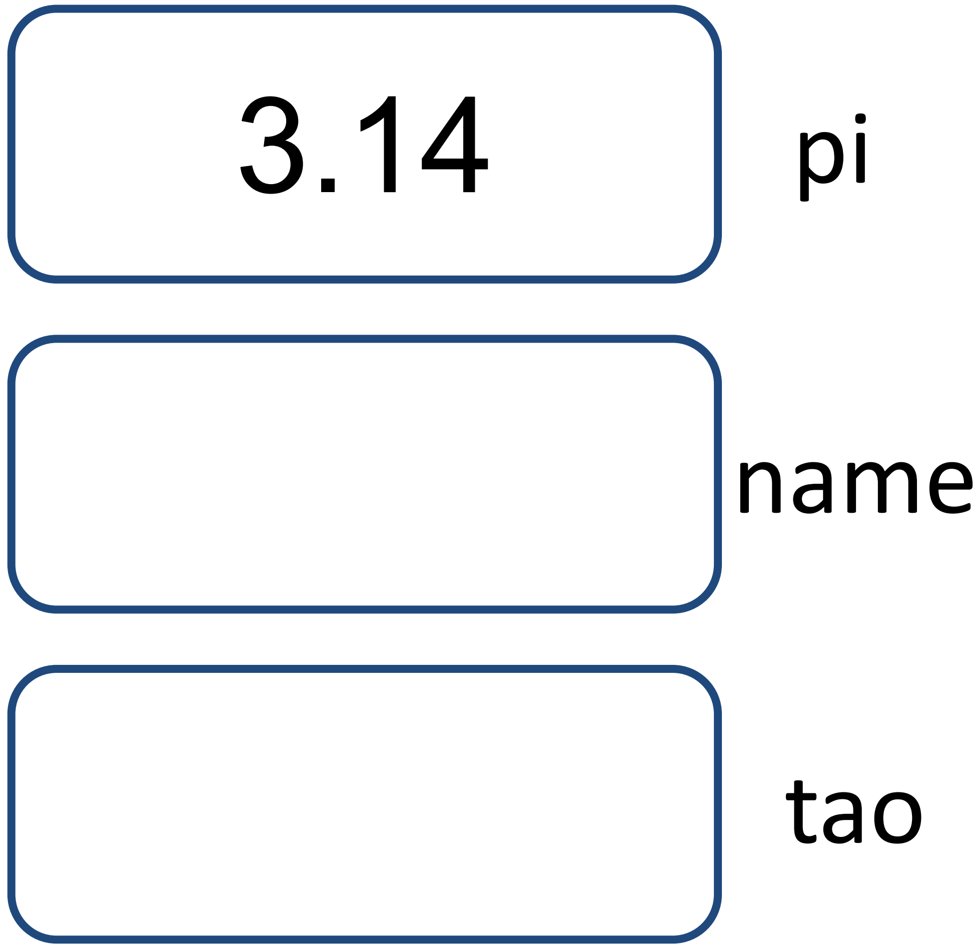
```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is :
" << tao << " pi is : " << pi << '\n';
}
```



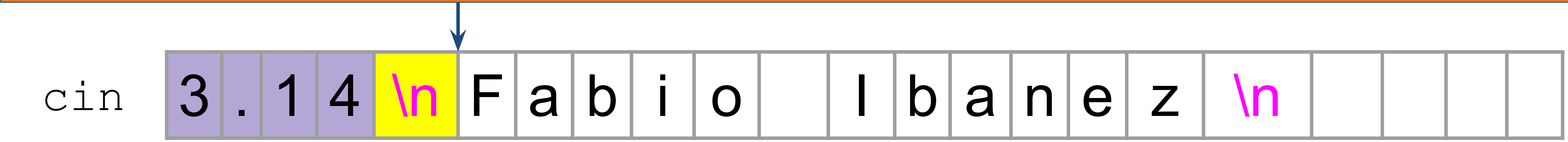
# Fix?



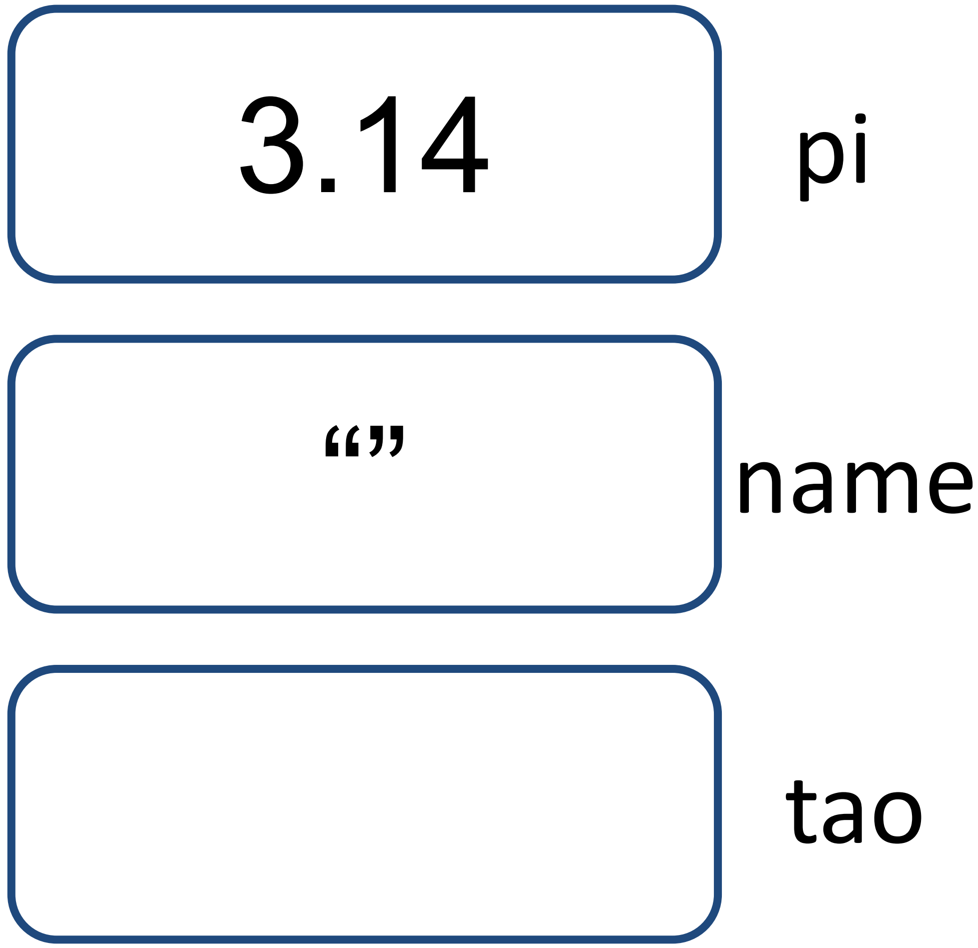
```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is :
" << tao << " pi is : " << pi << '\n';
}
```



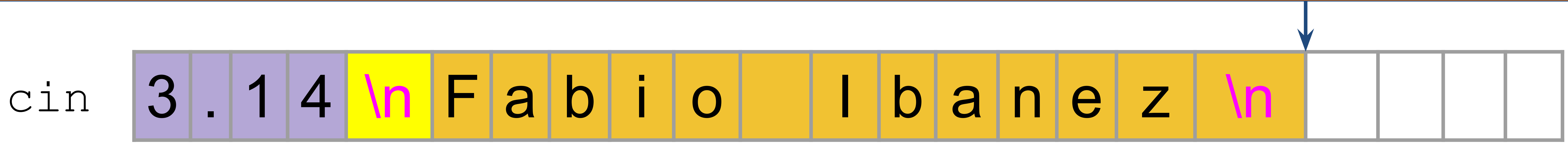
# Fix✅



```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is :
" << tao << " pi is : " << pi << '\n';
}
```



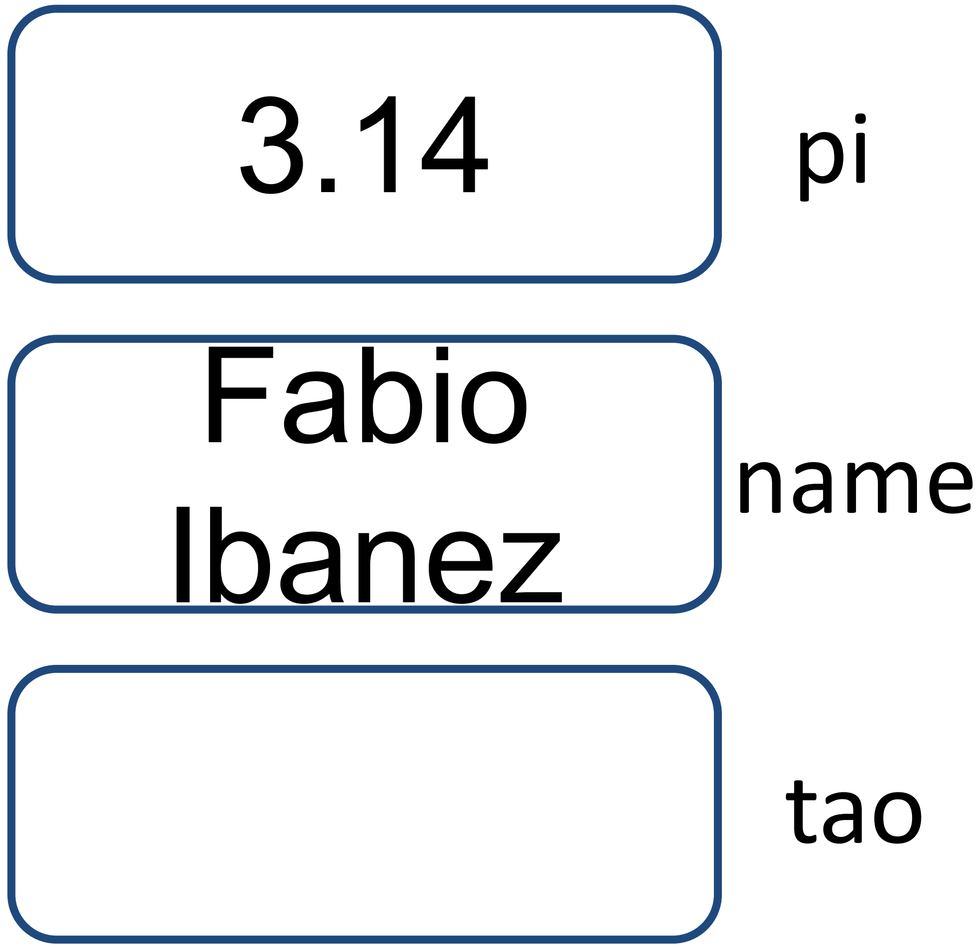
# Fix✅



cin

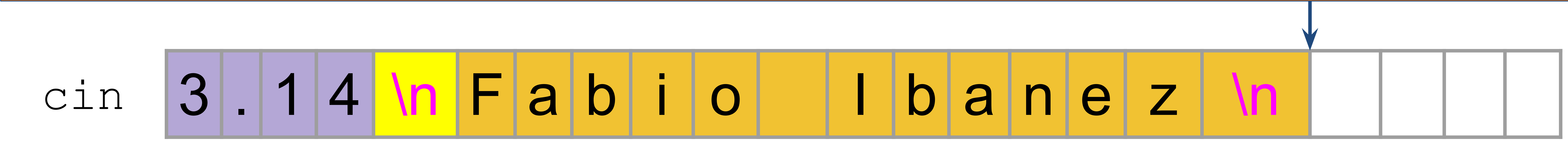
| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | . | 1 | 4 | \n | F | a | b | i | o | | I | b | a | n | e | z | \n | | | | |

```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is : 
" << tao << " pi is : " << pi << '\n';
}
```



| | |
|---|---|
| 3.14 | pi |
| Fabio Ibanez | name |
| | tao |

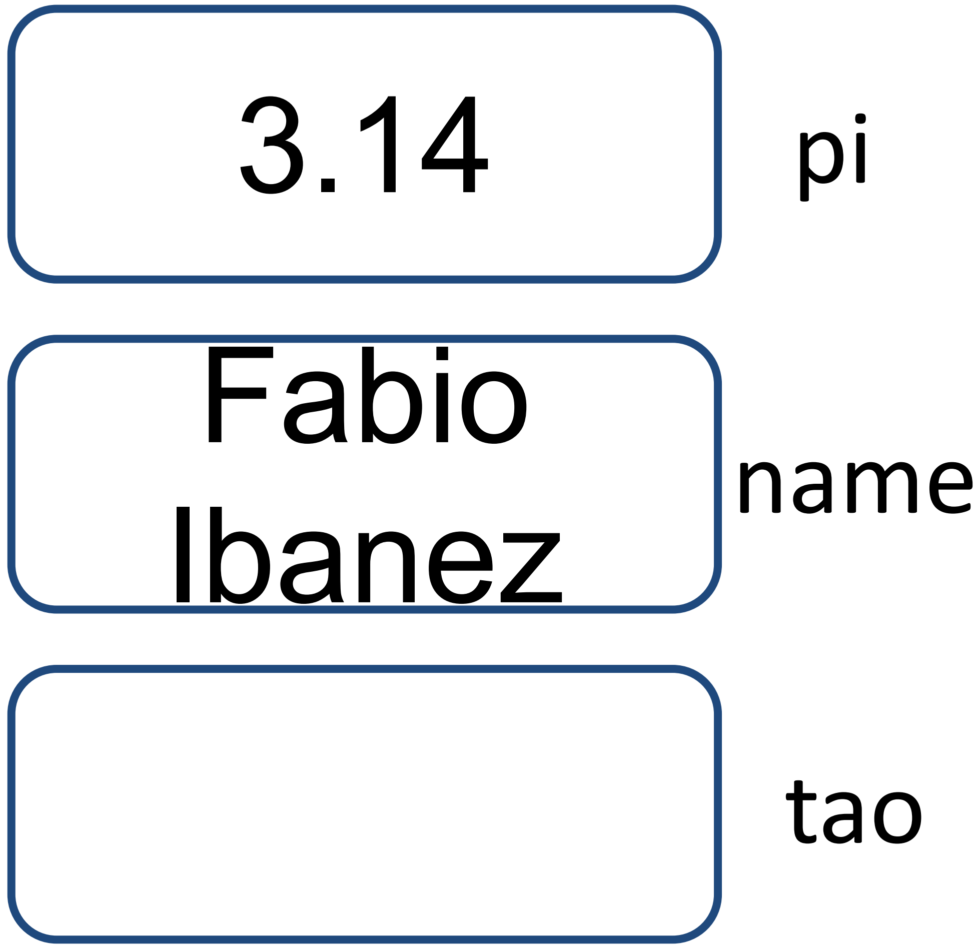
# Fix✅



| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o |  | I | b | a | n | e | z | \n |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

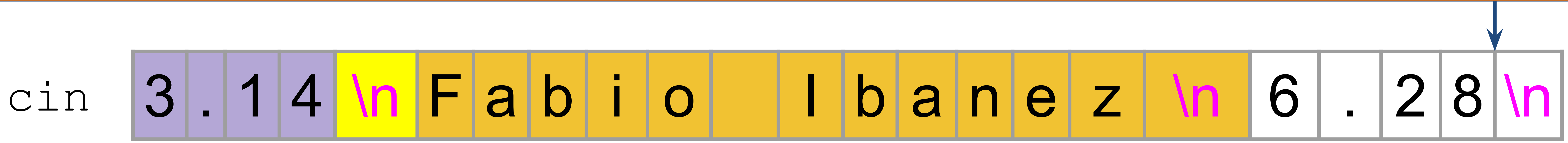
```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is :
" << tao << " pi is : " << pi << '\n';
}
```

The stream is empty! So it is going to prompt a user for input



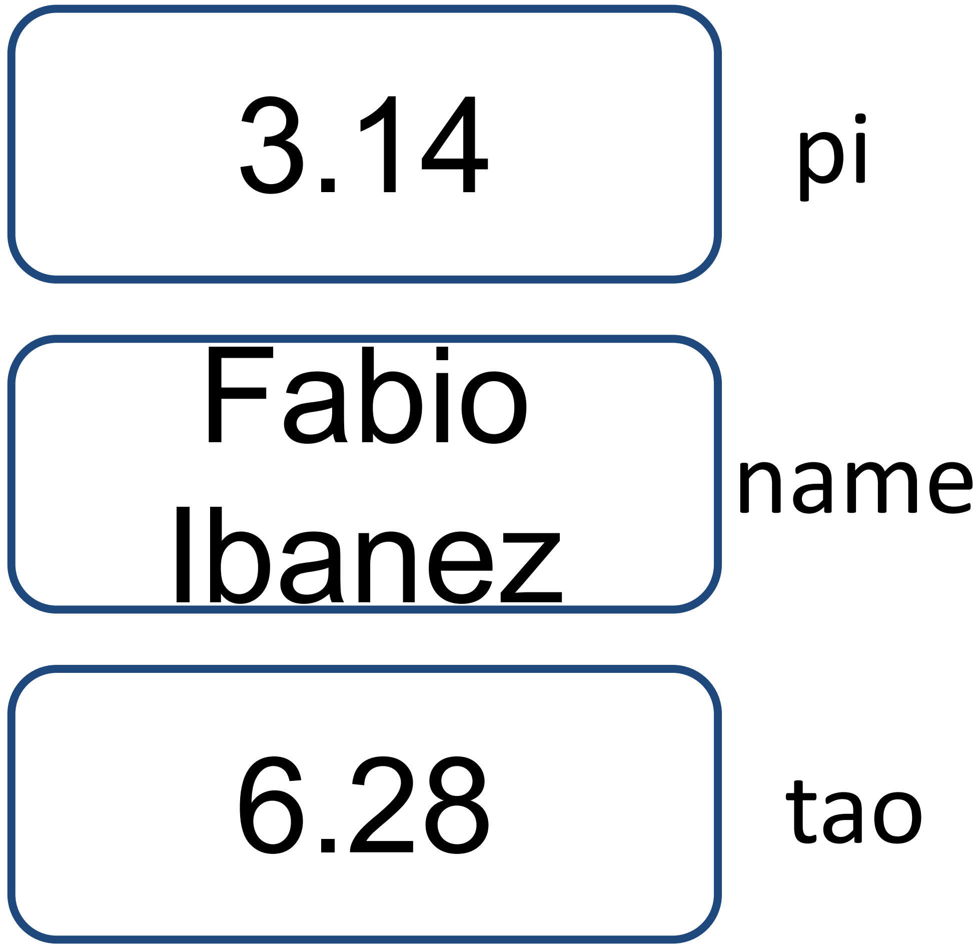
| | |
|---|---|
| 3.14 | pi |
| Fabio Ibanez | name |
|  | tao |

# Fix✅



| cin | 3 | . | 1 | 4 | \n | F | a | b | i | o |  | I | b | a | n | e | z | \n | 6 | . | 2 | 8 | \n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

```
void cinGetlineBug() {
  double pi;
  double tao;
  std::string name;
  std::cin >> pi;
  std::getline(std::cin, name);
  std::getline(std::cin, name);
  std::cin >> tao;
  std::cout << "my name is : " << name << " tao is : " << tao << " pi is : " << pi << '\n';
}
```



| | |
|---|---|
| 3.14 | pi |
| Fabio Ibanez | name |
| 6.28 | tao |

# That being said

You actually ***<u>shouldn’t</u>*** use `getline()` and `std::cin()` together because of the difference in how they parse data.

If you really do need to though, it *is* possible, but not recommended.

# Whew that was a lot!

## To conclude (Main takeaways):

1. Streams are a general interface to read and write data in programs
2. Input and output streams on the same source/destination type compliment each other!
3. Don't use `getline()` and `std::cin()` together, unless you *really really* have to!

# Acknowledgements

Credit to **Avery Wang's** streams lecture which I took a lot of inspiration from, particularly for formatting and flow.

Thank you Aolin Zhang for pointing out the nuance about buffering!