Streams

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How can we convert between string-represented data and the real thing?

Recap

- Everything with a name in your program has a **type**
- **Strong type systems** prevent errors before your code runs!
- **Structs** are a way to bundle a bunch of variables of many types
- **std::pair** is a type of struct that had been defined for you and is in the STL
- So you access it through the **std:: namespace** (std::pair)
- **auto** is a keyword that tells the compiler to deduce the type of a variable, it should be used when the type is obvious or very cumbersome to write out

Today

- Streams!
    - Input streams
    - Output streams
    - File streams and string streams!

Definition

stream: an abstraction for input/output. Streams convert between *data* and the *string representation of data.*

A stream you’ve used: cout

```
std::cout << 5 << std::endl; // prints 5
// use a stream to print any primitive type!
std::cout << "Frankie" << std::endl;
```

A stream you've used: cout

```cpp
std::cout << 5 << std::endl; // prints 5
// use a stream to print any primitive type!
std::cout << "Frankie" << std::endl;
// Mix types!
std::cout << "Frankie is " << 21 << std::endl;
```

A stream you've used: cout

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std::cout << 5 << std::endl; // prints 5
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std::cout << "Frankie" << std::endl;
// Mix types!
std::cout << "Frankie is " << 21 << std::endl;
// structs?
Student s = {"Frankie", "MN", 21};
std::cout << s << std::endl;
```

A stream you’ve used: cout

```
std::cout << 5 << std::endl; // prints 5
// use a stream to print any primitive type!
std::cout << "Frankie" << std::endl;
// Mix types!
std::cout << "Frankie is " << 21 << std::endl;
// structs?
Student s = {"Frankie", "MN", 21};
~~std::cout << s << std::endl;~~
```

A stream you've used: cout

```
std::cout << 5 << std::endl; // prints 5
// use a stream to print any primitive type!
std::cout << "Frankie" << std::endl;
// Mix types!
std::cout << "Frankie is " << 21 << std::endl;
// structs?
Student s = {"Frankie", "MN", 21};
std::cout << s.name << s.age << std::endl;
```

A stream you’ve used: cout

```
std::cout << 5 << std::endl; // prints 5
// use a stream to print any primitive type!
std::cout << "Frankie" << std::endl;
// Mix types!
std::cout << "Frankie is " << 21 << std::endl;
// Any primitive type + most from the STL work!
// For other types, you will have to write the
            << operator yourself!
```

`std::cout` is an *output stream*. It has type `std::ostream`

Output Streams

- Have type `std::ostream`
- Can only ***send*** data using the `<<` operator
  - Converts any type into string and ***sends*** it to the stream

Output Streams

- Have type `std::ostream`
- Can only ***send*** data using the `<<` operator
  - Converts any type into string and ***sends*** it to the stream
- `std::cout` is the output stream that goes to the console

```
std::cout << 5 << std::endl;
// converts int value 5 to string “5”
// sends “5” to the console output stream
```

Output File Streams

- Have type `std::ofstream`
- Only ***send*** data using the `<<` operator
  - Converts data of any type into a string and sends it to the **file stream**

Output File Streams

- Have type `std::ofstream`
- Only ***send*** data using the `<<` operator
  - Converts data of any type into a string and sends it to the **file stream**

- Must initialize your own `ofstream` object linked to your file

```
std::ofstream out(“out.txt”);
// out is now an ofstream that outputs to out.txt
out << 5 << std::endl; // out.txt contains 5
```

`std::cout` is a *global constant object* that you get from `#include <iostream>`

`std::cout` is a *global constant object* that you get from `#include <iostream>`

To use any other output stream, you must first initialize it!

Code Demo: ostreams

Input Streams!

What does this code do?

```
int x;
std::cin >> x;
```

What does this code do?

```
int x;
std::cin >> x;
// what happens if input is 5 ?
// how about 51375 ?
// how about 5 1 3 7 5?
```

`std::cin` is an *input stream.* It has type `std::istream`

Intput Streams

- Have type `std::istream`
- Can only ***receive*** strings using the `>>` operator
  - ***Receives*** a string from the stream and converts it to data

Input Streams

- Have type `std::istream`
- Can only ***receive*** strings using the `>>` operator
    - ***Receives*** a string from the stream and converts it to data

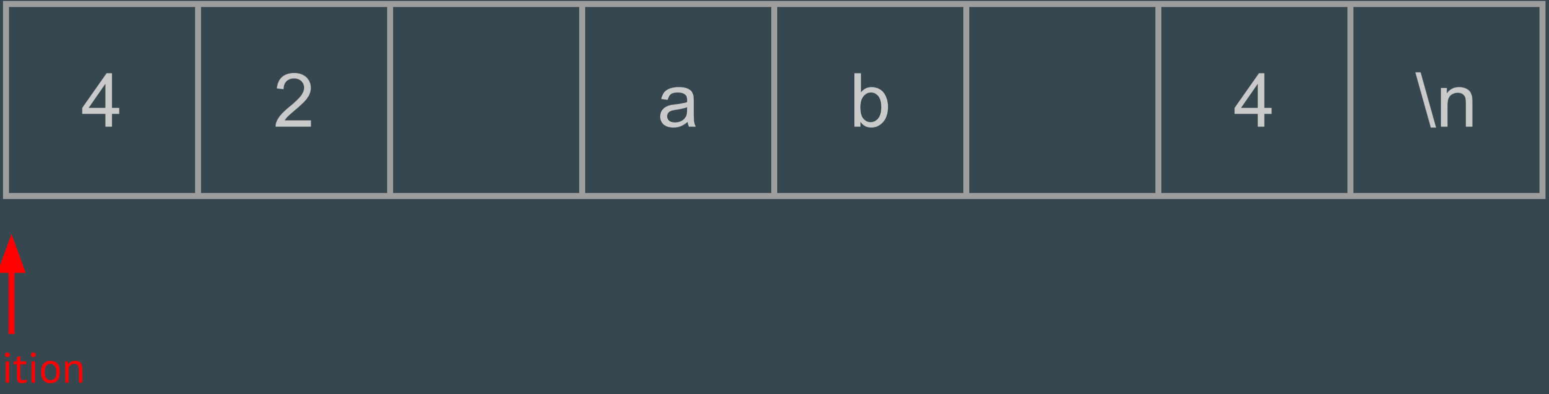
- `std::cin` is the input stream that gets input from the console

```
int x;
string str;
std::cin >> x >> str;
//reads exactly one int then 1 string from console
```

Nitty Gritty Details: `std::cin`

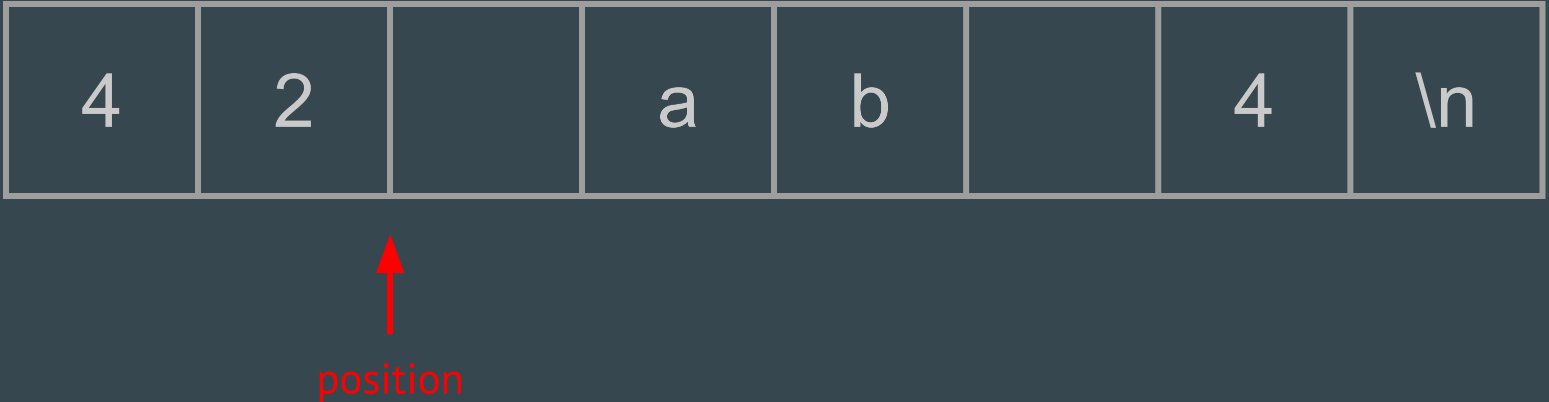
- First call to `std::cin >>` creates a command line prompt that allows the user to type until they hit enter
- Each `>>` ONLY reads until the next *whitespace*
  - Whitespace = tab, space, newline
- Everything after the first whitespace gets saved and used the next time `std::cin >>` is called
  - The place its saved is called a **buffer**!
- If there is nothing waiting in the buffer, `std::cin >>` creates a new command line prompt
- Whitespace is eaten: it won’t show up in output

Think of a `std::istream` as a sequence of characters



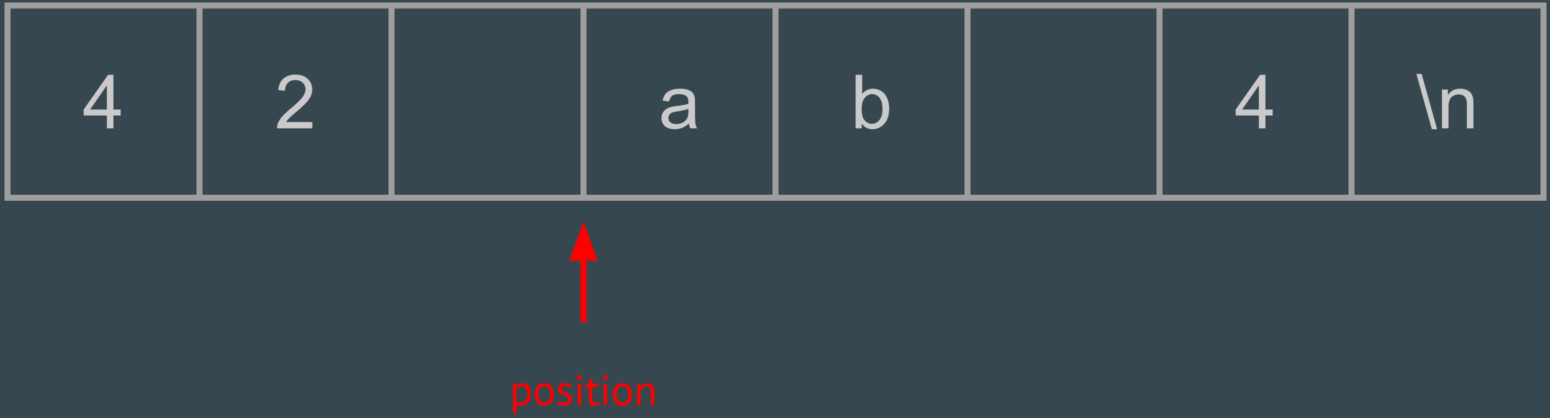
```
int x; string y; int z;
cin >> x;
cin >> y;
cin >> z;
```

Think of a `std::istream` as a sequence of characters



```
int x; string y; int z;
cin >> x; //42 put into x
cin >> y;
cin >> z;
```

Think of a `std::istream` as a **sequence** of characters



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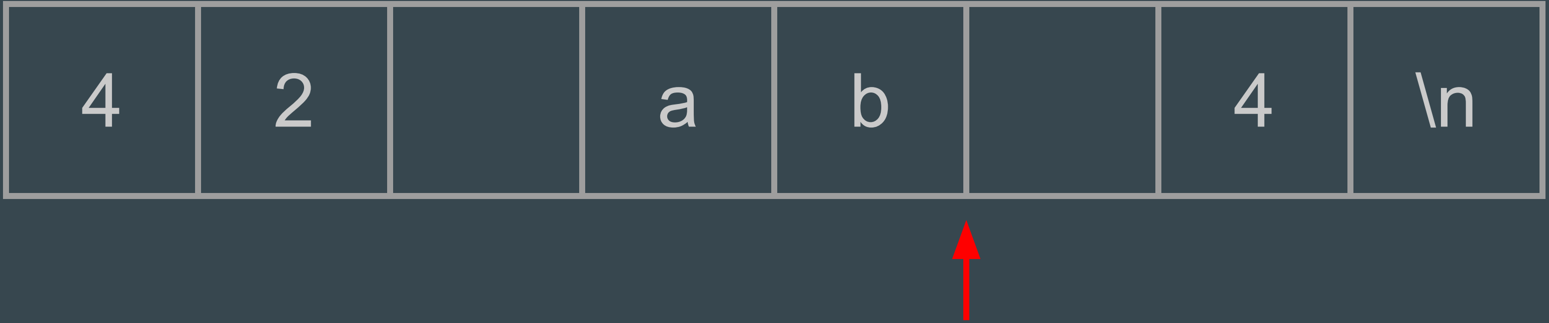

```
int x; string y; int z;
cin >> x;
cin >> y; //ab put into y
cin >> z;
```

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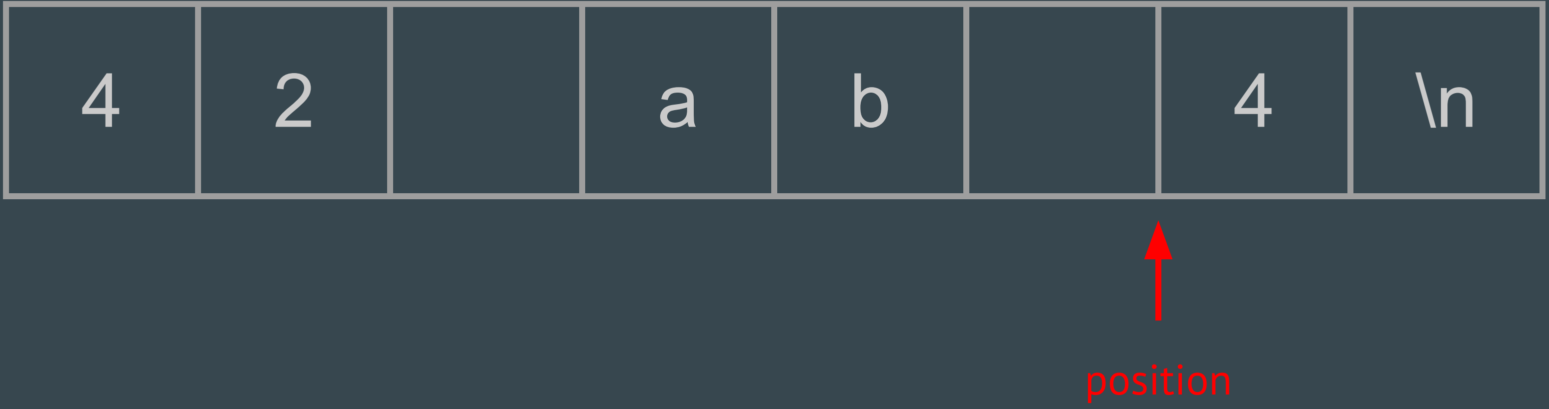

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cin >> x;
cin >> y; //ab put into y
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```

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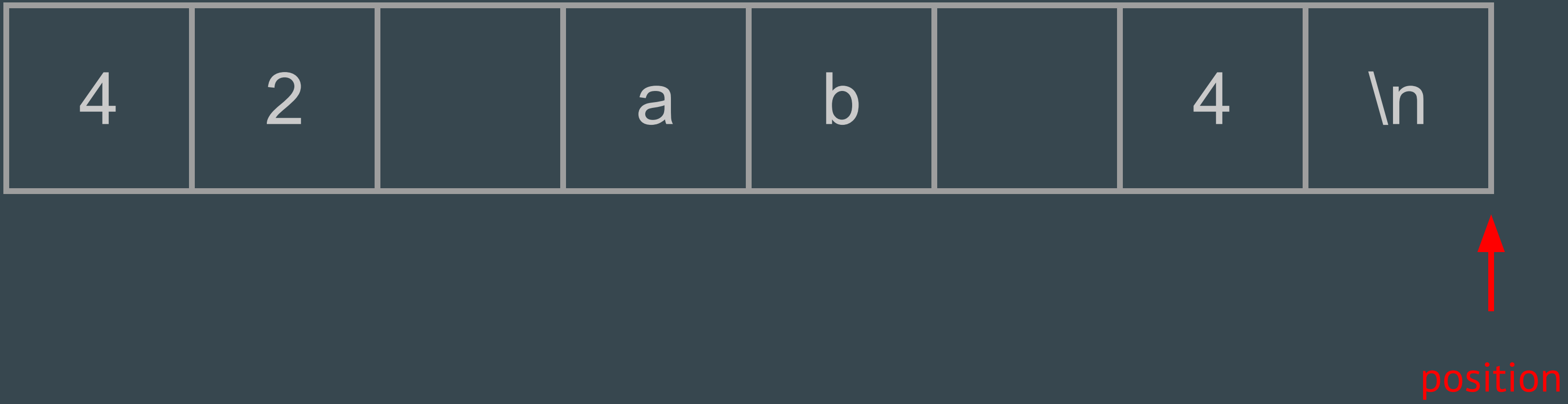
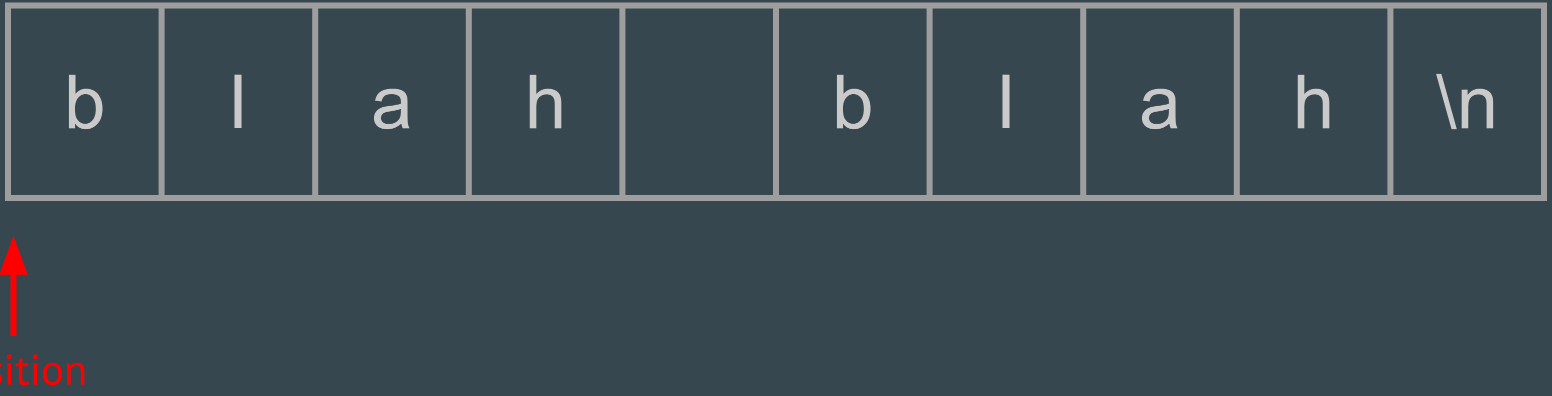


```
int x; string y; int z;
cin >> x;
cin >> y;
cin >> z; //4 put into z
```

Input Streams: When things go wrong

```
string str;
int x;
std::cin >> str >> x;
//what happens if input is blah blah?
std::cout << str << x;
```

Think of a `std::istream` as a **sequence** of characters



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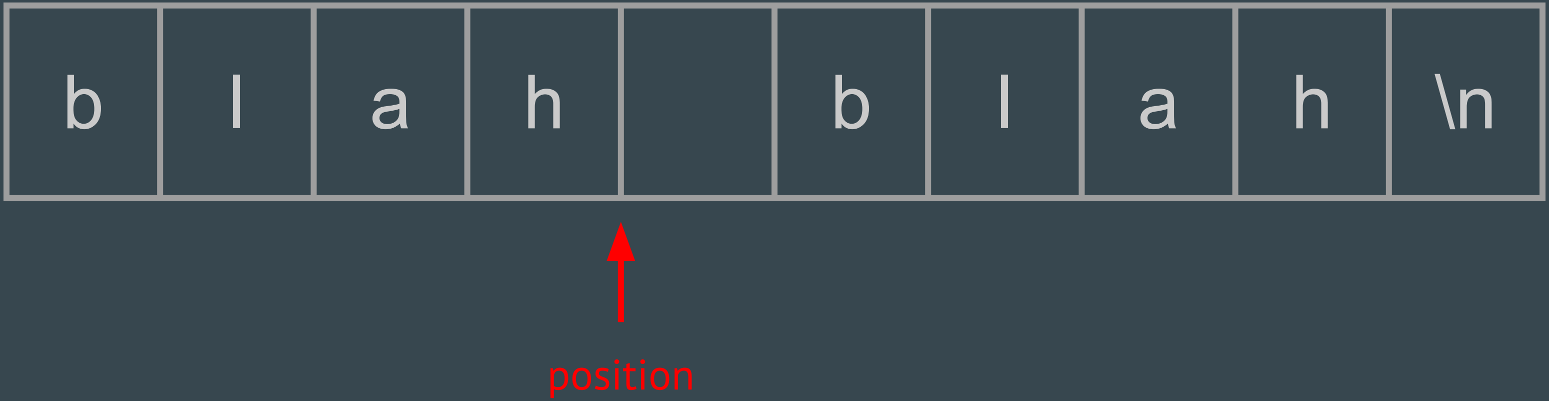
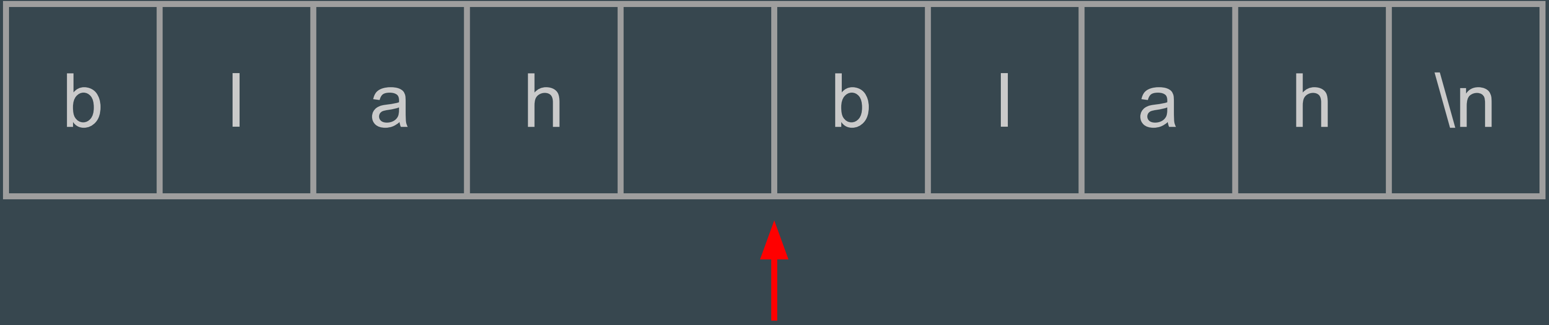
string str; int x;
std::cin >> str >> x;
```

Think of a `std::istream` as a sequence of characters



```
string str; int x;
std::cin >> str >> x;
```

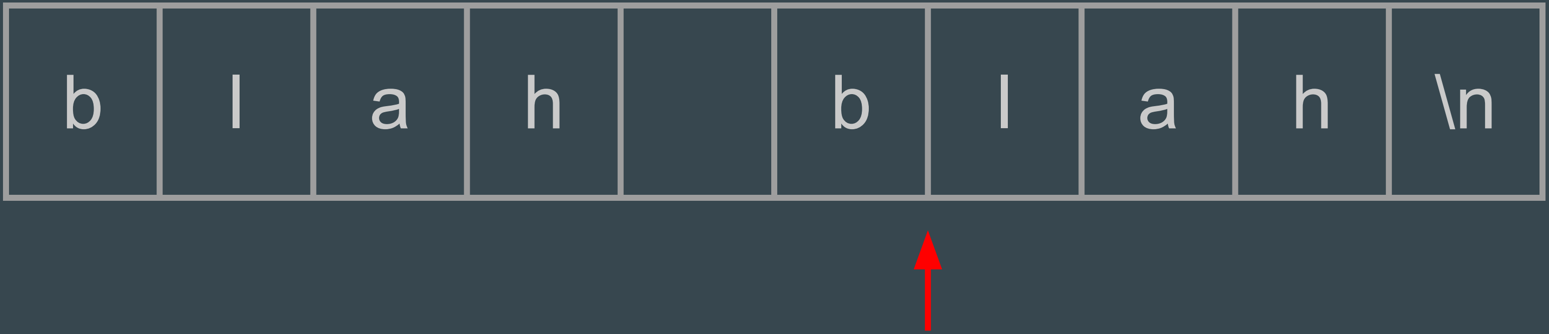
Think of a `std::istream` as a sequence of characters



position

```
string str; int x;
std::cin >> str >> x;
```

Think of a `std::istream` as a sequence of characters



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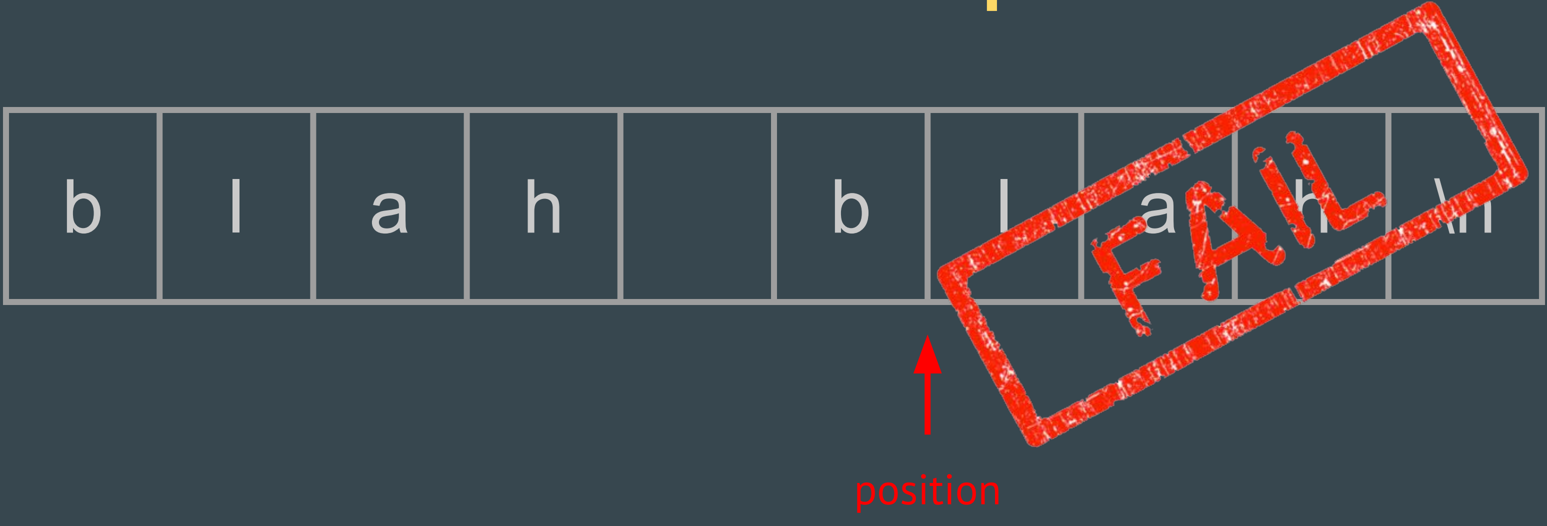
Think of a `std::istream` as a sequence of characters



```
string str; int x;
std::cin >> str >> x;
```

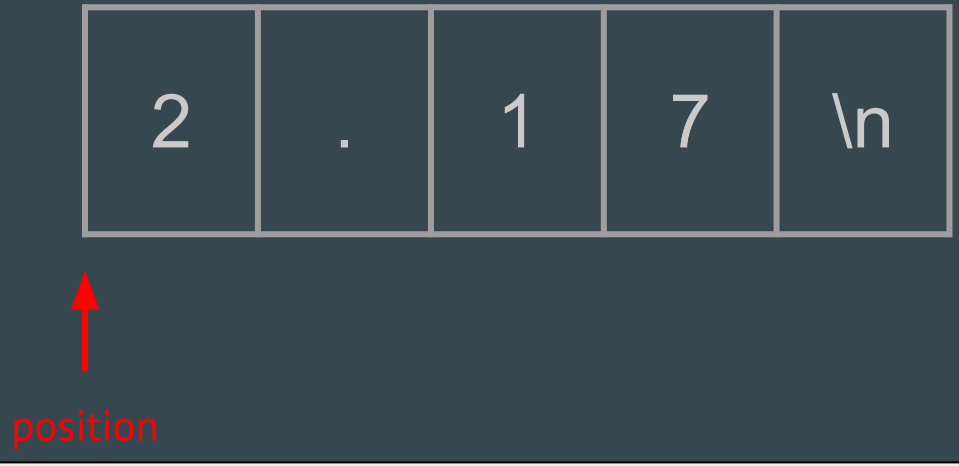
Input Streams: When things go wrong

```
string str;
int x;
std::cin >> str >> x;
//what happens if input is blah blah?
std::cout << str << x;
//once an error is detected, the input stream's
//fail bit is set, and it will no longer accept
//input
```

Input Streams: When things go wrong

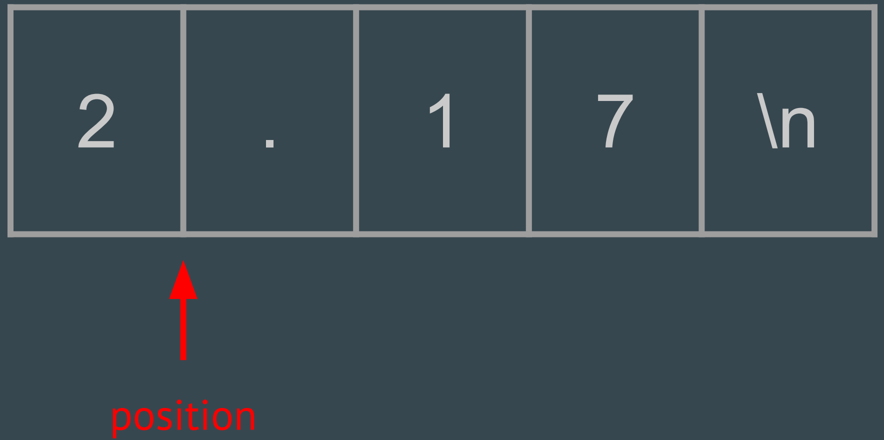
```
int age; double hourlyWage;
cout << "Please enter your age: ";
cin >> age;
cout << "Please enter your hourly wage: ";
cin >> hourlyWage;
//what happens if first input is 2.17?
```

Think of a `std::istream` as a sequence of characters



```
cin >> age;
cout << "Wage: ";
cin >> hourlyWage;
```

Think of a `std::istream` as a sequence of characters



```
cin >> age;
cout << "Wage: ";
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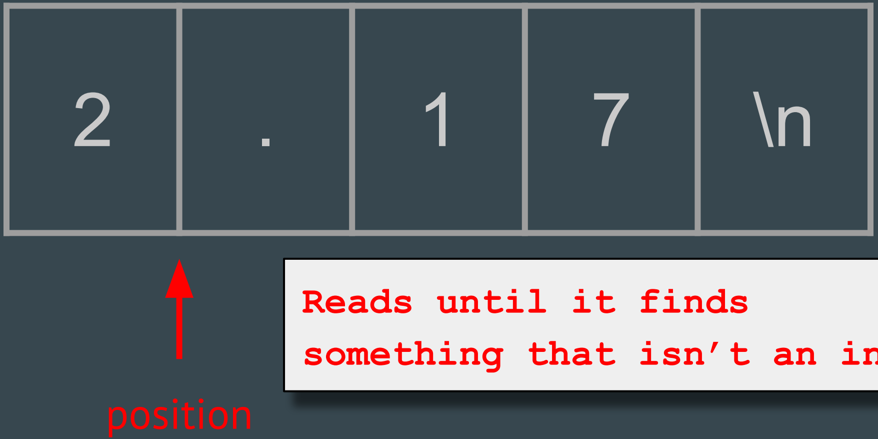
```

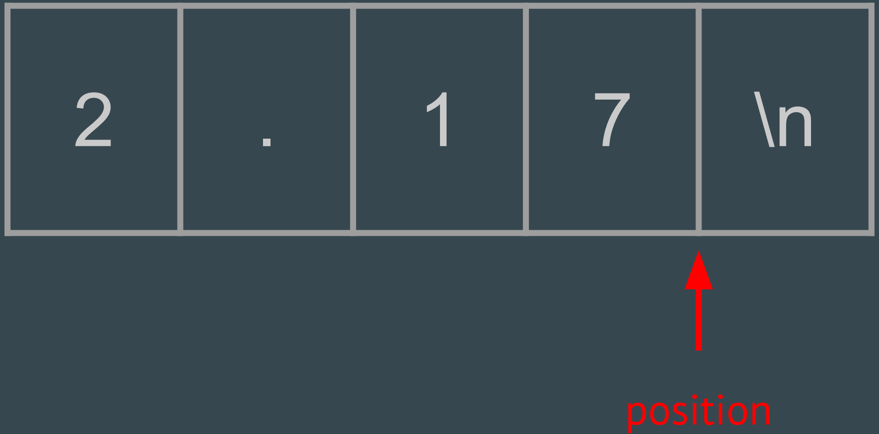
Think of a `std::istream` as a sequence of characters



Reads until it finds something that isn't an int!

```
cin >> age; // age = 2
cout << "Wage: ";
cin >> hourlyWage;
```

Think of a `std::istream` as a sequence of characters



```
cin >> age;
cout << "Wage: ";
cin >> hourlyWage;// =.17
```

Playground (istreams.cpp)

`std::cin` is dangerous to use on its own!

Reading using >> extracts a single “word” or type

including for strings

To read a whole line, use

```
std::getline(istream& stream, string& line);
```

How to use getline

- Notice `getline(istream& stream, string& line)` takes in both parameters by reference!

```
std::string line;
std::getline(cin, line); //now line has changed!
//say the user entered "Hello World 42!"
std::cout << line << std::endl;
//should print out"Hello World 42!"
```

Don’t mix >> with getline!

- **>>** reads up to the next whitespace character and *does not* go past that whitespace character.
- **getline** reads up to the next delimiter (by default, ‘\n’), and *does* go past that delimiter.
- Don’t mix the two or bad things will happen!

📝 **Note for 106B:** Don’t use >> with Stanford libraries, they use getline.

Input File Streams

- Have type `std::ifstream`
- Only receives strings using the `>>` operator
  - Receives strings from a file and converts it to data of any type

Input File Streams

- Have type `std::ifstream`
- Only receives strings using the `>>` operator
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- Must initialize your own `ofstream` object linked to your file

```
std::ifstream in(“out.txt”);
// in is now an ifstream that reads from out.txt
string str;
in >> str; // first word in out.txt goes into str
```

`std::cin` is a *global constant object* that you get from `#include <iostream>`

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To use any other input stream, you must first initialize it!

Code Demo: istreams

Stringstreams

Stringstreams

- Input stream: std::istringstream
  - Give any data type to the istringstream, it'll store it as a string!
- Output stream: std::ostringstream
  - Make an ostringstream out of a string, read from it word/type by word/type!
- The same as the other i/ostreams you've seen!

ostringstreams

```
string judgementCall(int age, string name,
                                                                        bool lovesCpp)
{
     std::ostringstream formatter;
     formatter << name <<", age " << age;
     if(lovesCpp) formatter << ", rocks.";
     else formatter << " could be better";
     return formatter.str();
}
```

istringstreams

```
Student reverseJudgementCall(string judgement)
{ //input: “Frankie age 22, rocks”
    std::istringstream converter;
    string fluff; int age; bool lovesCpp; string name;
    converter >> name;
    converter >> fluff;
    converter >> age;
    converter >> fluff;
    string cool;
    converter >> cool;
    if(cool == "rocks") return Student{name, age, "bliss"};
    else return Student{name, age, "misery"};
}// returns:
```

istringstreams

```
Student reverseJudgementCall(string judgement)
{ //input: “Frankie age 22, rocks”
    std::istringstream converter;
    string fluff; int age; bool lovesCpp; string name;
    converter >> name;
    converter >> fluff;
    converter >> age;
    converter >> fluff;
    string cool;
    converter >> cool;
    if(cool == "rocks") return Student{name, age, "bliss"};
    else return Student{name, age, "misery"};
}// returns: {“Frankie”, 22, “bliss”}
```

Lets write getInteger!

Recap

- Streams convert between data of any type and the string representation of that data
- Streams have an endpoint: console for cin/cout, files for i/o fstreams, string variables for i/o streams where they read in a string from or output a string to.
- To send data (in string form) to a stream, use `stream_name << data`
- To extract data from a stream, use `stream_name >> data`, and the stream will try to convert a string to whatever type `data` is