TDDE18 & 726G77

Course Introduction

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Department of Computer and information science

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Course Information

Personnel

- Examiner: Klas Arvidsson
- Course leader: Christoffer Holm
- Course assistant: Dag Jönsson
- Assistant: Tobias Elfstrand (Group A)
- Assistant: Marcus Dean Grattan (Group A)
- Assistant: Wiktor Liew (Group A)
- Assistant: Malte Nilsson (Group B)
- Assistant: Jacob Slunga (Group B)
- Assistant: Malte Hammar (Group B)

Course Information

Aim (syllabus)

- Prerequisites: Skills in one programming language
- C++
- Usage of standard Linux/UNIX systems
- Problem solving

Course Information

Content

- Basic constructs
- Pointers and memory
- Object-oriented programming
- Inheritance and polymorphism
- Standard library

Course Information

Examination

- Labs
- Exam

Course Information

Examination

- Labs
  - 5 lab assignments
  - Soft deadlines (1 per lab)
  - Demonstrate your work to the assistant
  - Complementary work
  - Bonus for exam
- Exam

Course Information

Examination

- Labs
- Exam
  - To be determined

Course Information

Organization

- Lectures
- Lab sessions
- Teaching session
- Programming workshop

Course Information

Online resources

- http://ida.liu.se/~TDDE18
- http://cppreference.com
- The library part of cppreference will be available during the exam!

Course Information

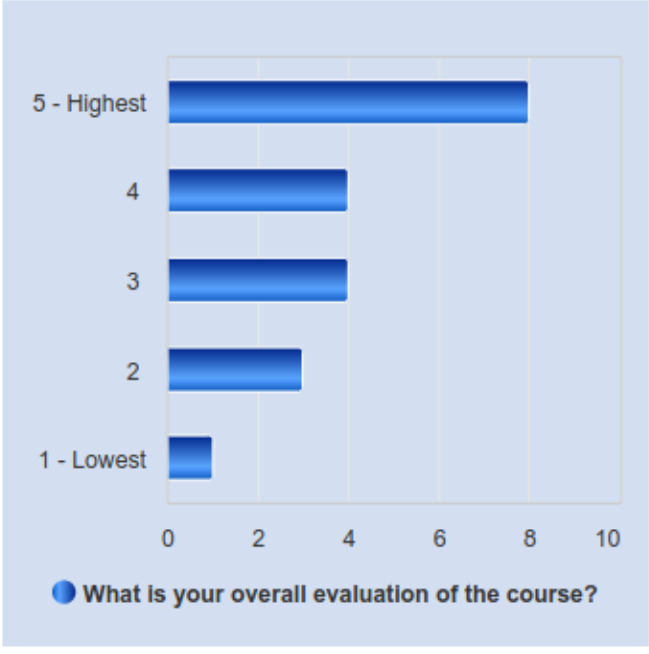
Evaluation & Improvements based on last year

20 out of 105 answered

Overall score: 3.75 out of 5

Changes since then:

- Added warmup excercises
- Moved around deadlines
- Updated material and slides
- New (not yet determined) exam due to policy changes



Course Information

Register to the lab

Register to the labs on WebReg:

https://www.ida.liu.se/webreg-beta/TDDE18-2024-1/LAB1

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C++ basics

What is C++?

- Programming language
- Is based on C
- Defined by a committee

C++ basics

What is C++?

- Gives programmer control

C++ basics

What is C++?

- Gives programmer control
- Broad application area

C++ basics

What is C++?

- Gives programmer control
- Broad application area
- Highly optimized

C++ basics

What is C++?

- C++ is **not** a specific set of programs
- C++ is **not** an editor
- C++ is **not** a compiler
- It is simply a language that can be passed to a compiler

C++ basics

When is C++ used?

- C++ is primarily used when performance matters.
  - Operating system
  - Videogames
  - Databases
  - Banking software
  - ... And many more!
- C++ works as both a high-level and low-level language.

C++ basics

When is C++ used?

- C++ is primarily used when performance matters.
- C++ works as both a high-level and low-level language.
  - You can program close to the hardware...
  - But there are tools for strong abstractions as well!

C++ basics

A first program

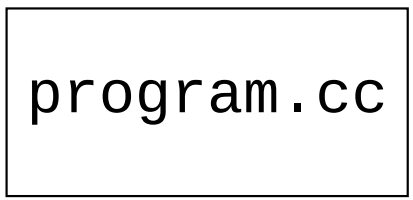
program.cc

```
#include <iostream>
using namespace std;

int main()
{
  cout << "A C++ program" << endl;
  return 0;
}
```

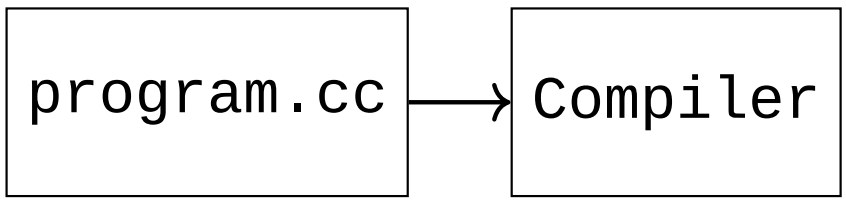
C++ basics

Compiling



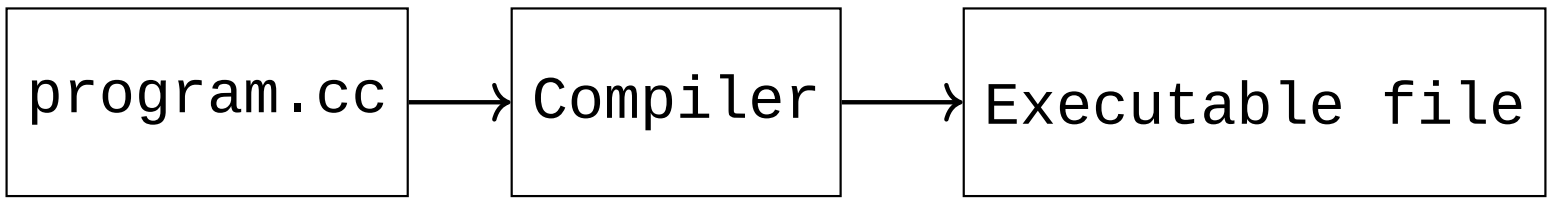
C++ basics

Compiling



C++ basics

Compiling



C++ basics

Compiling

```
$ ls
```

C++ basics

Compiling

```
$ ls
program.cc
```

C++ basics

Compiling

```
$ ls
program.cc
$ g++ program.cc
```

C++ basics

Compiling

```
$ ls
program.cc
$ g++ program.cc
$
```

C++ basics

Compiling

```
$ ls
program.cc
$ g++ program.cc
$ ls
```

C++ basics

Compiling

```
$ ls
program.cc
$ g++ program.cc
$ ls
a.out  program.cc
```

C++ basics

Compiling

```
$ ls
program.cc
$ g++ program.cc
$ ls
a.out  program.cc
$ ./a.out
```

C++ basics

Compiling

```
$ ls
program.cc
$ g++ program.cc
$ ls
a.out  program.cc
$ ./a.out
A C++ program
```

C++ basics

Compiler flags

```
g++ -Wall -Wextra -Wpedantic -std=c++17 program.cc
```

C++ basics

Creating alias

```
echo "alias w++17='g++ -std=c++17 -Wall -Wextra -Wpedantic'" >> ~/.bashrc
```

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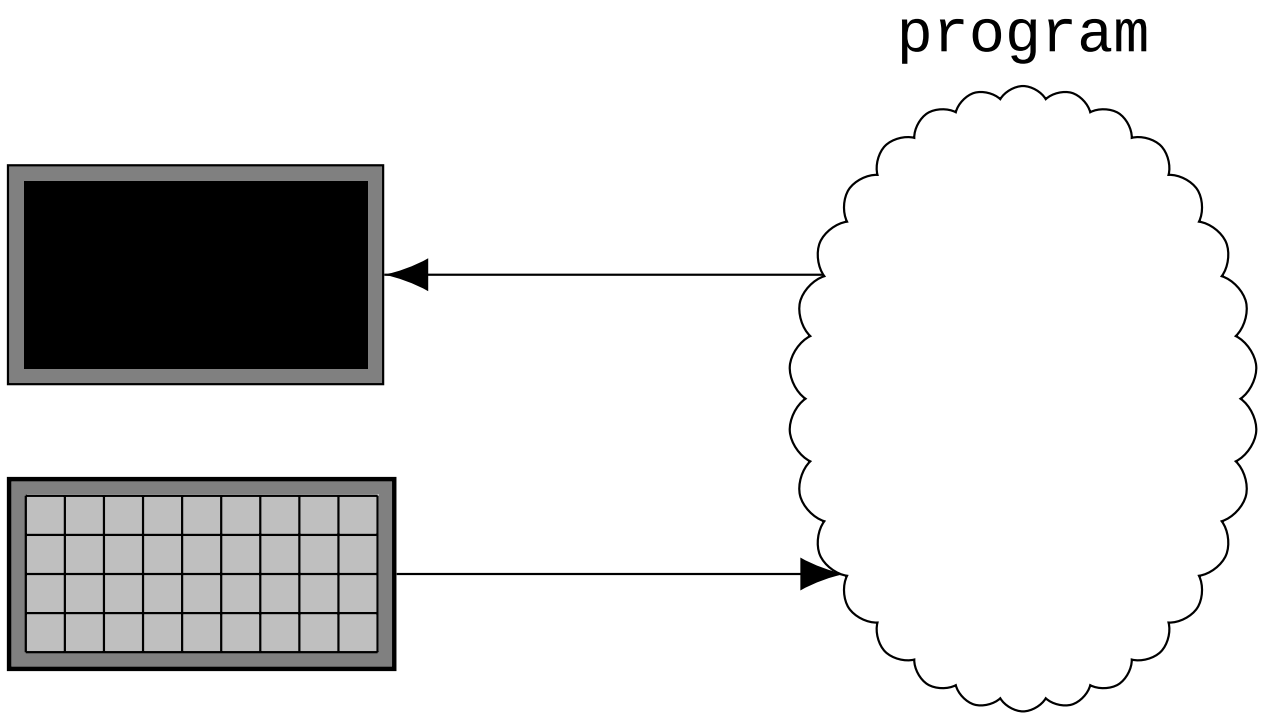
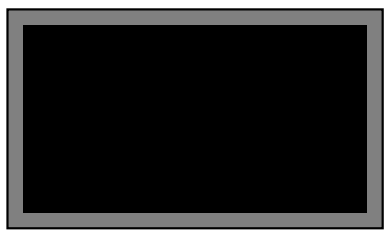
IO

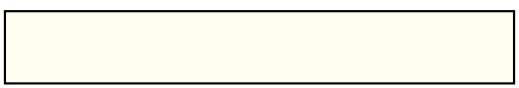
Idea



IO

Printing





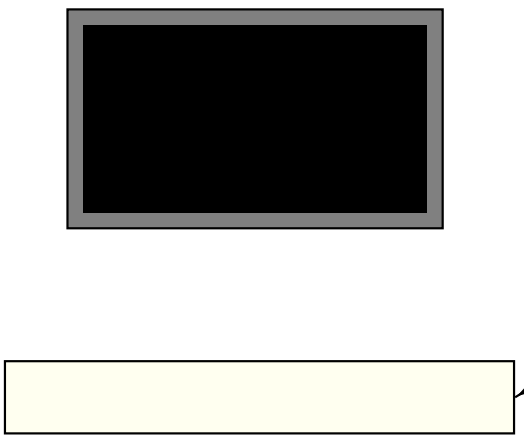
program.cc

```
#include <iostream>
using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```

IO

Printing



program.cc

```
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using namespace std;

int main()
{
  cout << "Text!" << endl;
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  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```
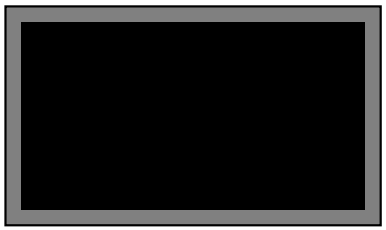

IO

Printing



```
Text!\n
```

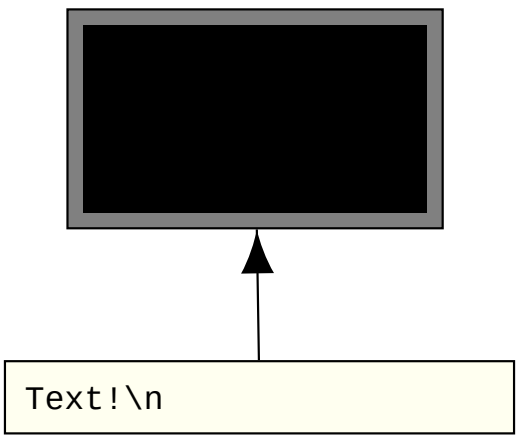
program.cc

```cpp
#include <iostream>
using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```

IO

Printing



program.cc

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  cout << "Text!" << endl;
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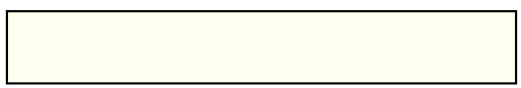
}
```

IO

Printing



program.cc

```
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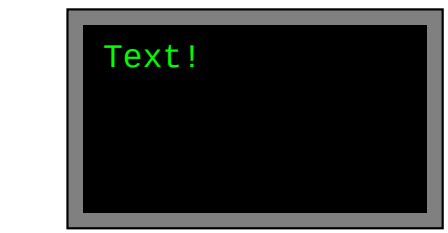
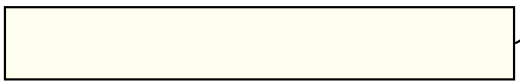
int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```

IO

Printing





program.cc

```
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using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```

IO

Printing


```
Some
```

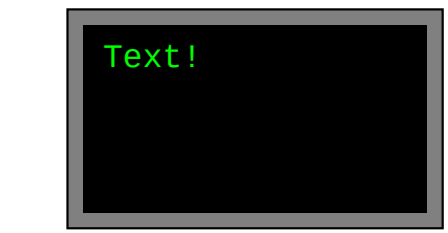
program.cc

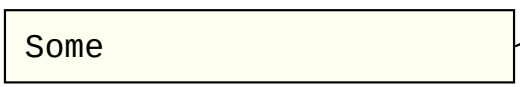
```cpp
#include <iostream>
using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```

IO

Printing





program.cc

```
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using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```

IO

Printing


```
Some text!\n
```

program.cc

```
#include <iostream>
using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
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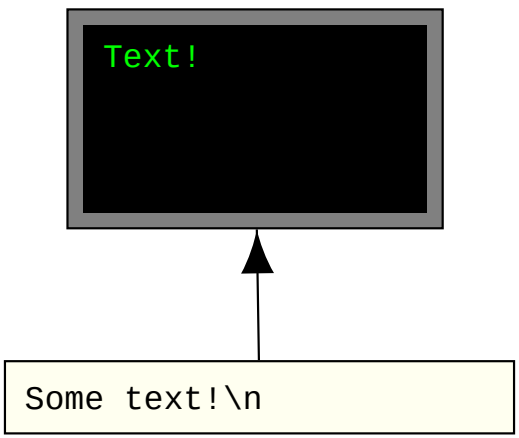
}
```

IO

Printing



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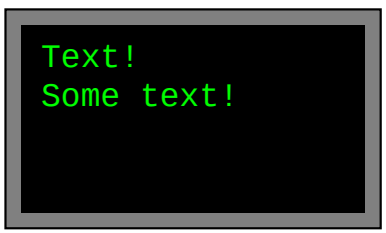
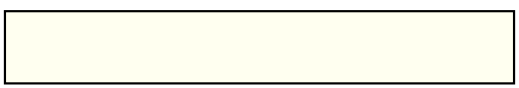
```

IO

Printing





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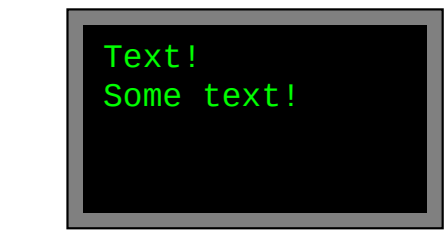
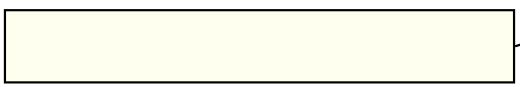
IO

Printing





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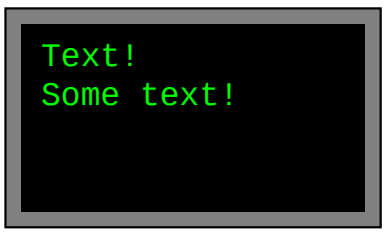
}
```

IO

Printing




```
The
```

program.cc

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{
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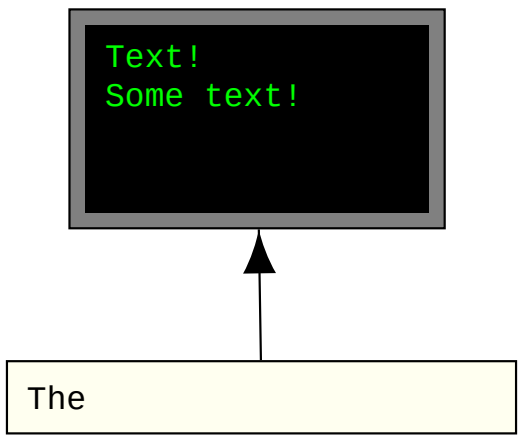
IO

Printing



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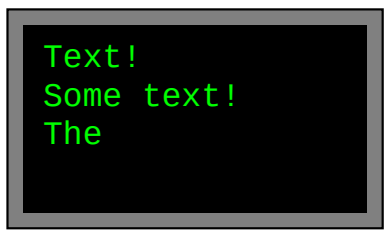
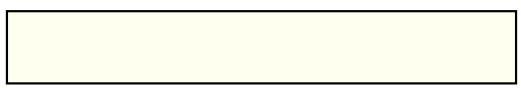
IO

Printing





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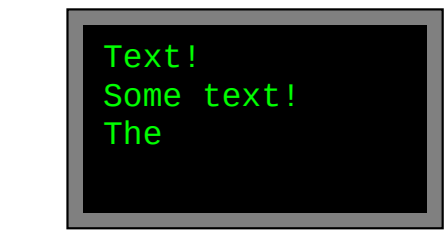
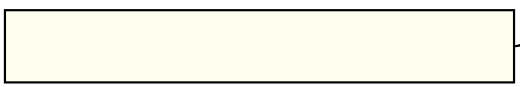
}
```

IO

Printing





program.cc

```
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using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```

IO

Printing

```
Text!
Some text!
The
```

```
End!\n
```

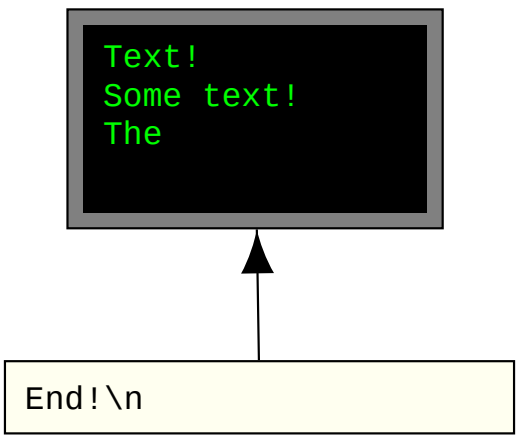
program.cc

```cpp
#include <iostream>
using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```

IO

Printing



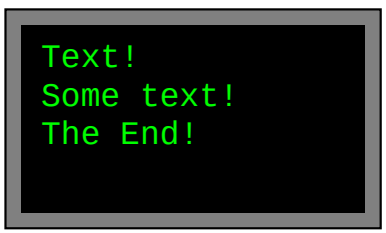
program.cc

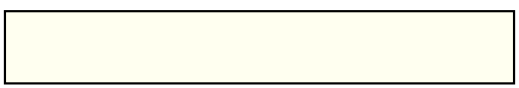
```
#include <iostream>
using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```

IO

Printing





program.cc

```
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using namespace std;

int main()
{
  cout << "Text!" << endl;
  cout << "Some ";
  cout << "text!" << endl;
  cout << "The " << flush;
  cout << "End!" << endl;
}
```
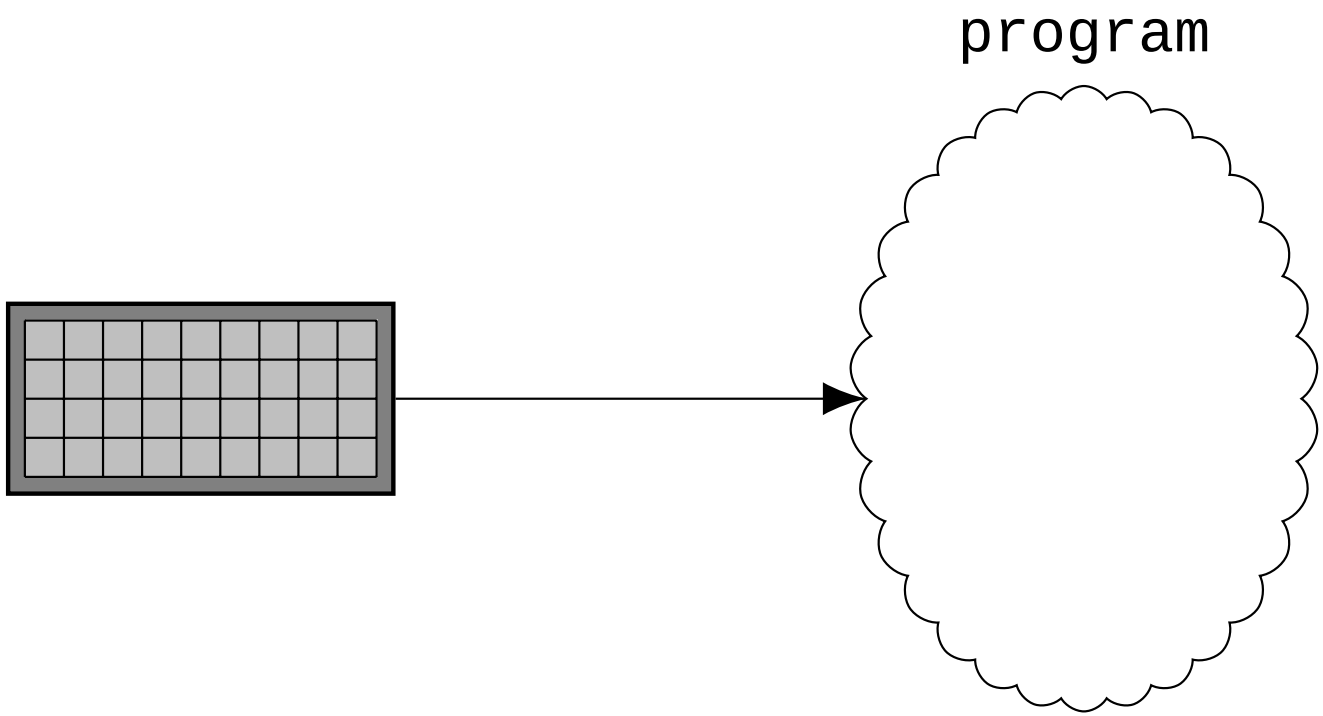

IO

What about reading?



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Variables

Basics

```
int main()
{
  int x{3};
  double y{3.14};
  char z{'c'};
}
```

Variables

Basics

```
int main()
{
  int x{3};
  double y{3.14};
  char z{'c'};
}
```

```
int main()
{
  int x{3};
  cout << "x = "
       << x << endl;
}
```

Variables

`string`

```
#include <iostream>
#include <string>

using namespace std;
int main()
{
  string str {"hello"};
  cout << str << endl
       << str.size() << endl
       << str.front() << endl;
}
```

Variables

string

```
#include <iostream>
#include <string>

using namespace std;
int main()
{
  string str {"hello"};
  cout << str << endl
       << str.size() << endl
       << str.front() << endl;
}
```

```
$ ./a.out
hello
5
h
```

Variables

`const`

```
int x{5};
x = 7;

int const y{7};
y = 9; // will not compile

const int z{9};
```

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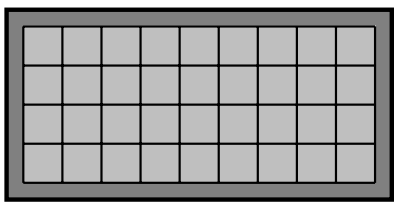
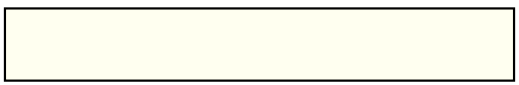
More IO

Reading

```
word = ""
number = 0
letter = '\0'
```





program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```

More IO

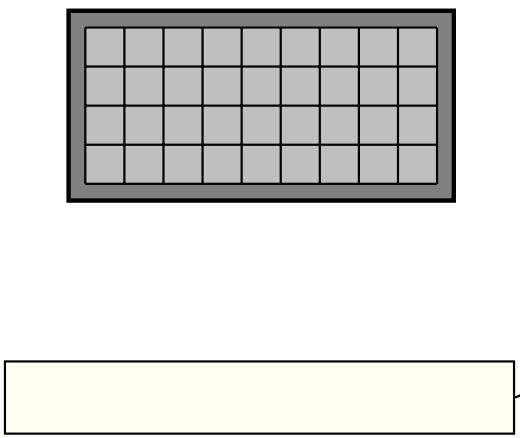
Reading

```
word = ""
number = 0
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



More IO

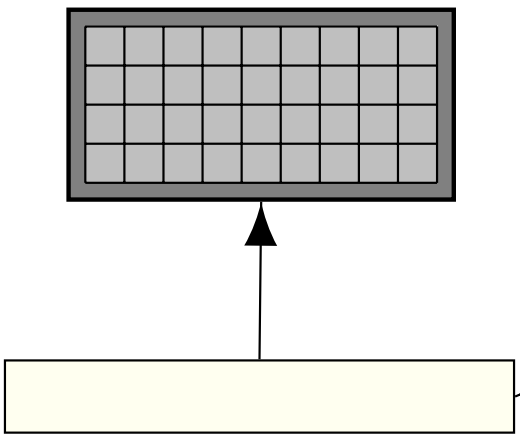
Reading

```
word = ""
number = 0
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



More IO

Reading

```
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number = 0
letter = '\0'
```
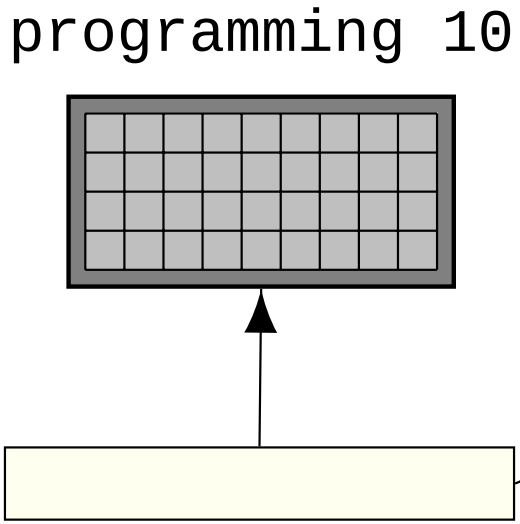

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



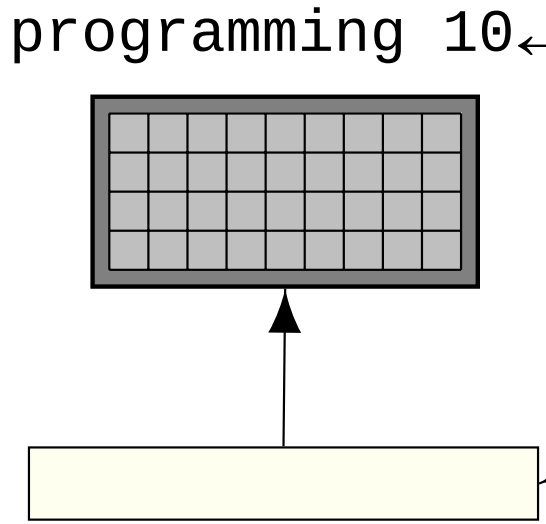
More IO

Reading

```
word = ""
number = 0
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



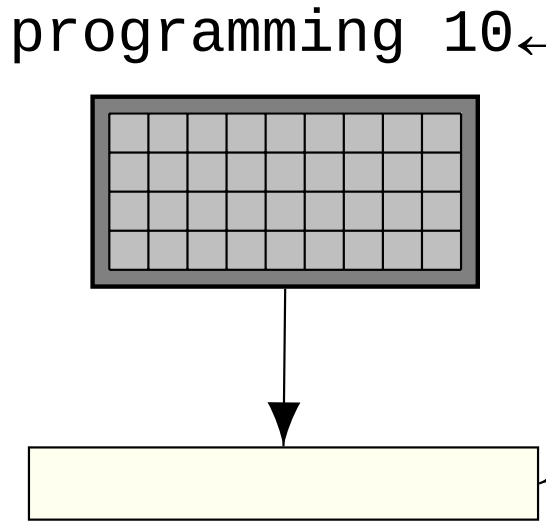
More IO

Reading

```
word = ""
number = 0
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



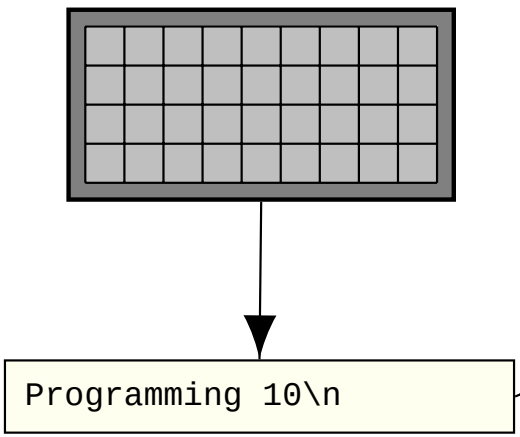
More IO

Reading

```
word = ""
number = 0
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



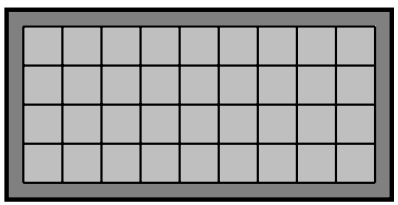
More IO

Reading

```
word = ""
number = 0
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



```
Programming 10\n
```

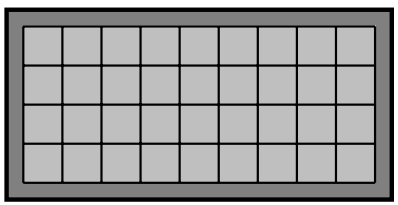
More IO

Reading

```
word = "programming"
number = 0
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```

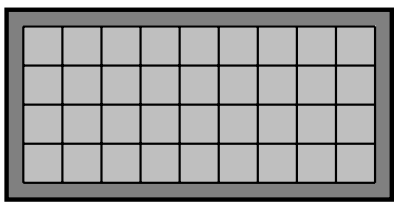


```
10\n
```

More IO

Reading

```
word = "programming"
number = 0
letter = '\0'
```



```
10\n
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```

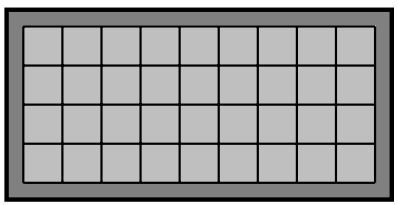
More IO

Reading

```
word = "programming"
number = 0
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



```
10\n
```

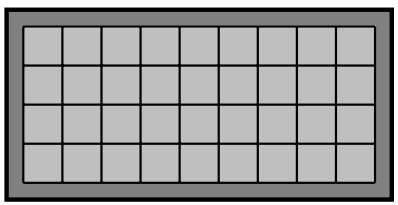
More IO

Reading

```
word = "programming"
number = 0
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



```
10\n
```

More IO

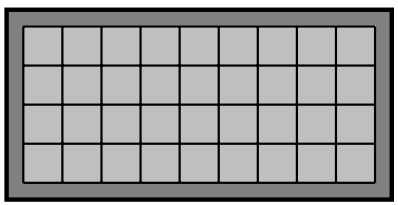
Reading

```
word = "programming"
number = 10
letter = '\0'
```

program.cc

```cpp
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```

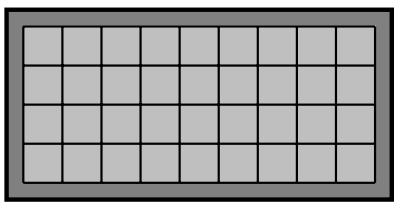


\n

More IO

Reading

```
word = "programming"
number = 10
letter = '\0'
```



```
\n
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
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More IO

Reading

```
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program.cc

```
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#include <string>
using namespace std;

int main()
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  string word{};
  int number{};
  char letter{};
  cin >> word;
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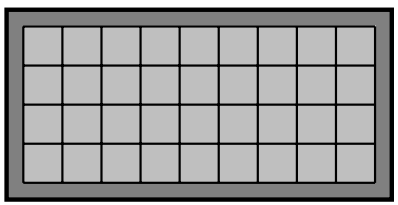

\n

More IO

Reading

```
word = "programming"
number = 10
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
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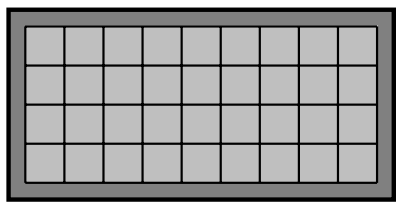

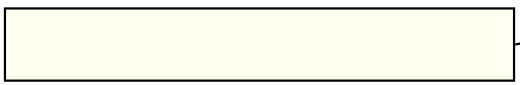

More IO

Reading

```
word = "programming"
number = 10
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
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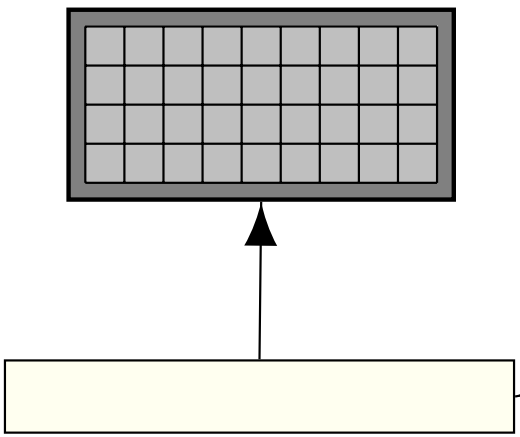
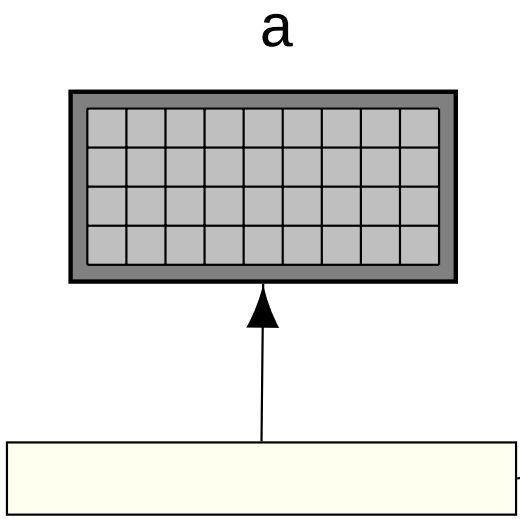


More IO

Reading

```
word = "programming"
number = 10
letter = '\0'
```



program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
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```

More IO

Reading

```
word = "programming"
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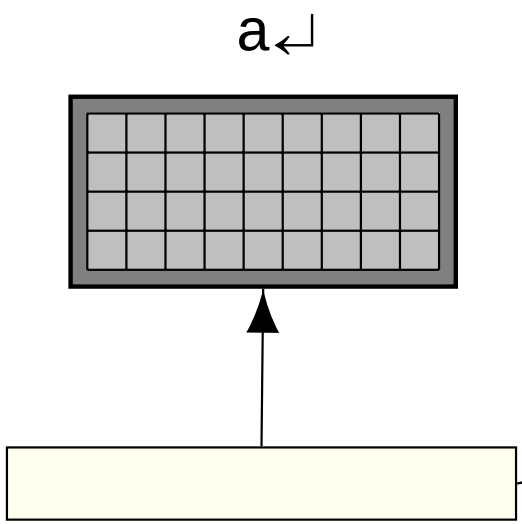
program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



More IO

Reading

```
word = "programming"
number = 10
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
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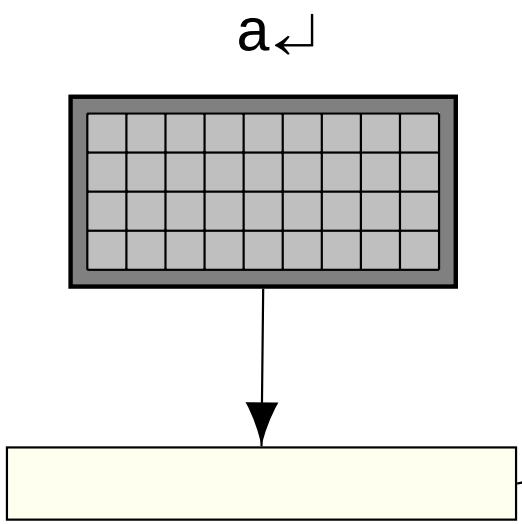

More IO

Reading

```
word = "programming"
number = 10
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
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  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
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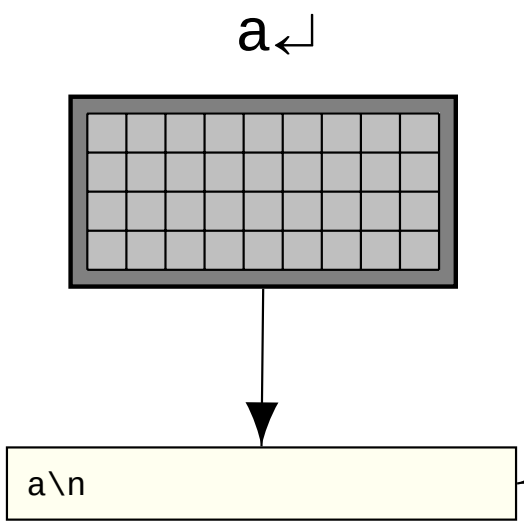

More IO

Reading

```
word = "programming"
number = 10
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
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  cin >> letter;
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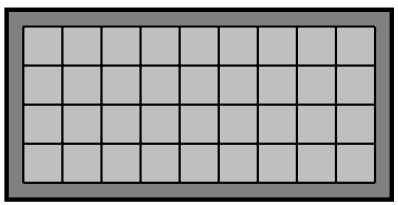


```
a\n
```

More IO

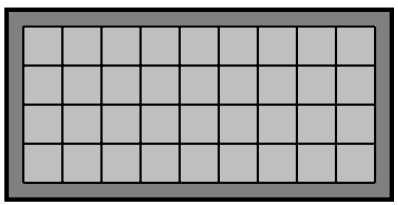
Reading

```
word = "programming"
number = 10
letter = '\0'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```



```
a\n
```

More IO

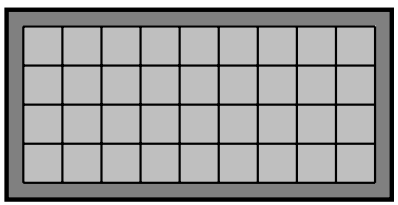
Reading

```
word = "programming"
number = 10
letter = 'a'
```

program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```

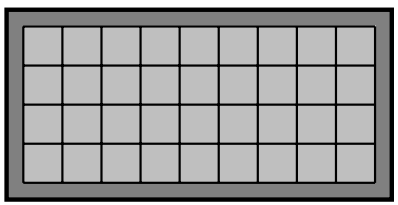


\n

More IO

Reading

```
word = "programming"
number = 10
letter = 'a'
```



```
\n
```

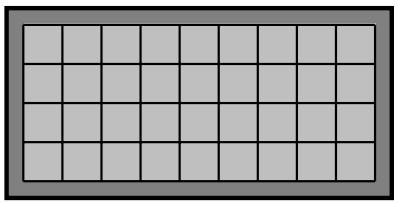
program.cc

```
#include <iostream>
#include <string>
using namespace std;

int main()
{
  cout << "Enter a word and number: ";
  string word{};
  int number{};
  char letter{};
  cin >> word;
  cin >> number;
  cin >> letter;
}
```

More IO

getline



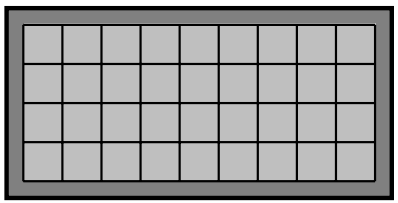
```
This is a line\nAnother line\n
```

line = ""

```
string line;
getline(cin, line);
cin.ignore(1000, '\n');
```

More IO

getline



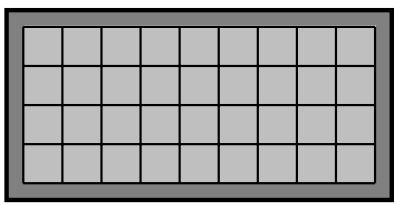
```
line = ""
```

```
string line;
getline(cin, line);
cin.ignore(1000, '\n');
```

```
This is a line\nAnother line\n
```

More IO

getline



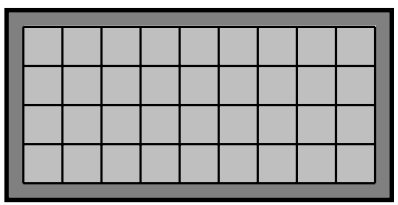
```
This is a line\nAnother line\n
```

line = ""

```
string line;
getline(cin, line);
cin.ignore(1000, '\n');
```

More IO

getline



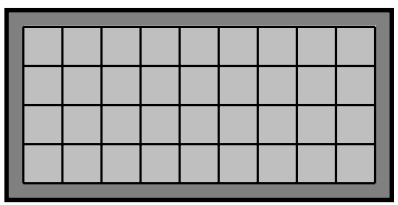
```
\nAnother line\n
```

```
line = "this is a line"
```

```
string line;
getline(cin, line);
cin.ignore(1000, '\n');
```

More IO

getline



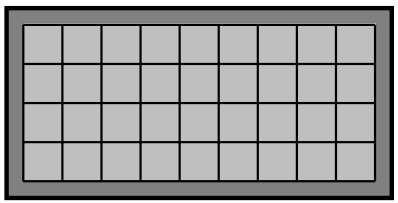
```
Another line\n
```

```
line = "this is a line"
```

```
string line;
getline(cin, line);
cin.ignore(1000, '\n');
```

More IO

getline



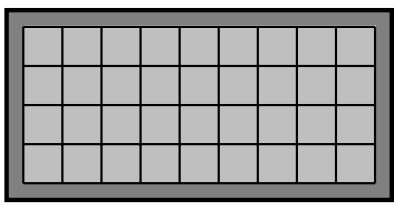
```
Another line\n
```

line = "this is a line"

```
string line;
getline(cin, line);
cin.ignore(1000, '\n');
```

More IO

getline



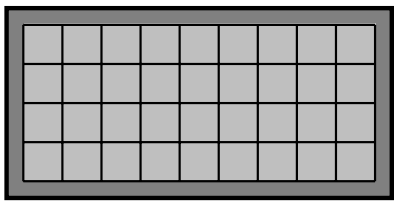
```
line = "this is a line"
```

```
string line;
getline(cin, line);
cin.ignore(1000, '\n');
```

```
Another line\n
```

More IO

getline



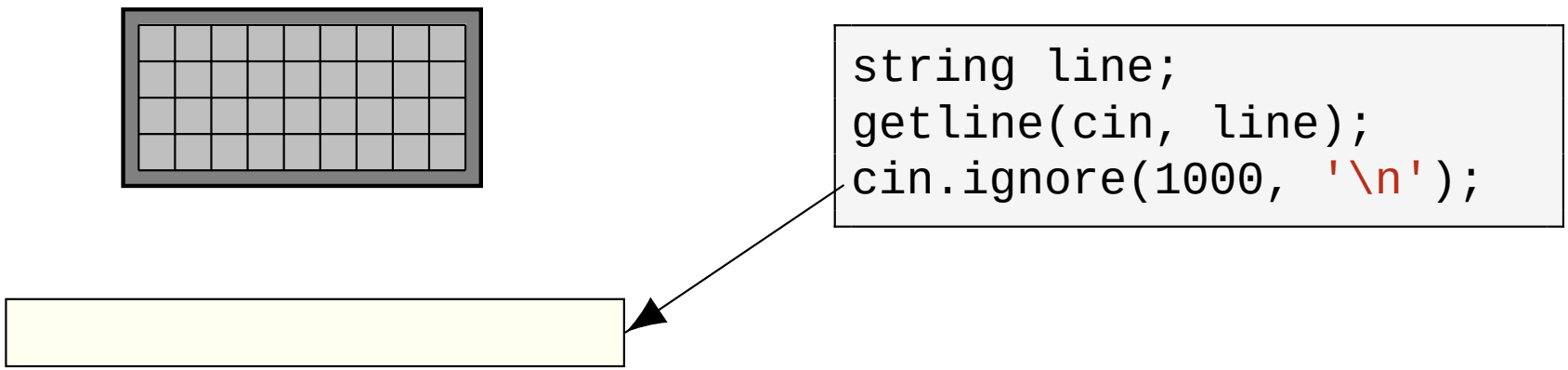
line = "this is a line"

```
string line;
getline(cin, line);
cin.ignore(1000, '\n');
```

\n

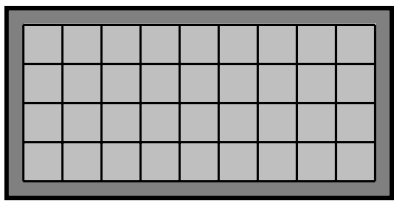
More IO

`getline`



More IO

`getline`



line = "this is a line"

```
string line;
getline(cin, line);
cin.ignore(1000, '\n');
```

More IO

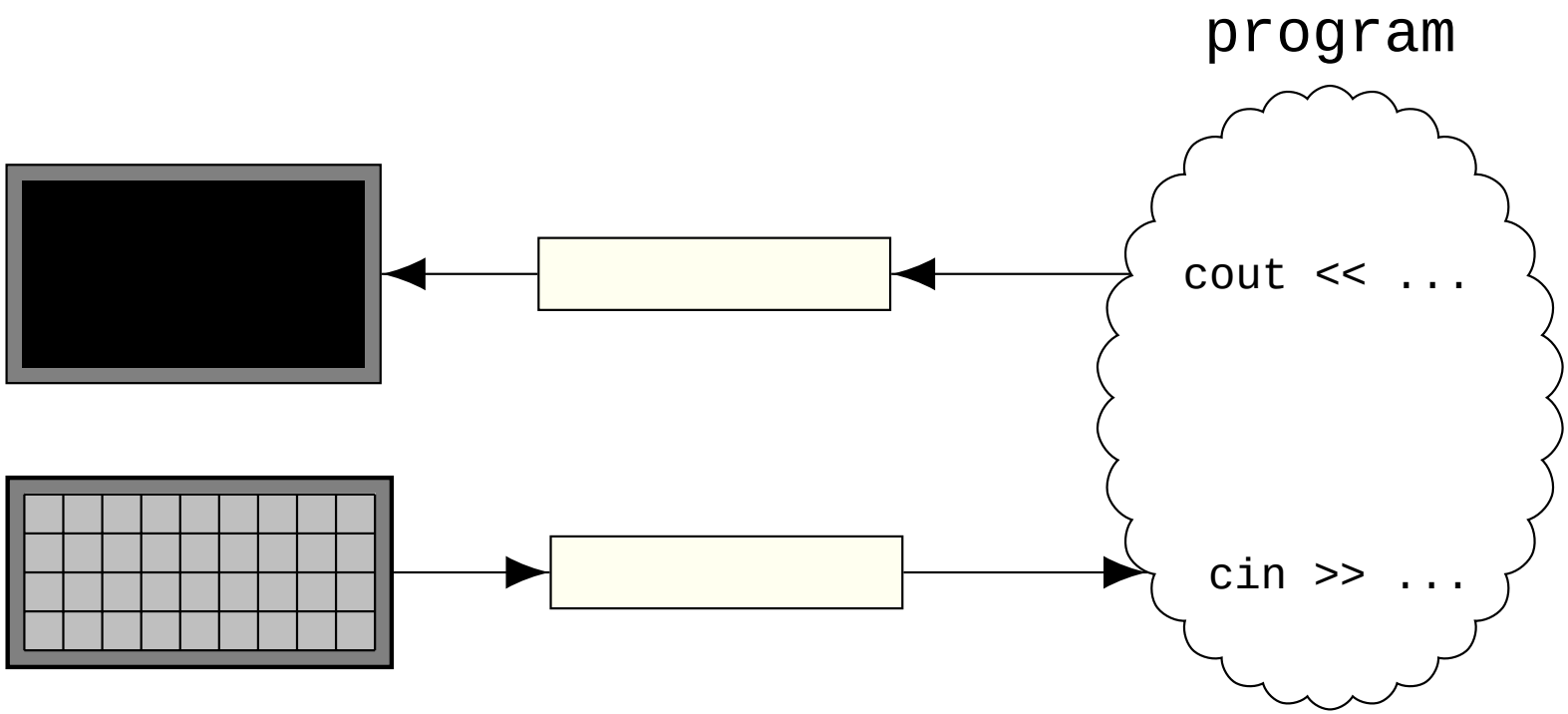
`getline`

```
#include <iostream>
#include <string>

using namespace std;
int main()
{
  string line;
  cout << "Enter a line: ";
  getline(cin, line);
  cout << "Your line was: "
       << line << endl;
}
```

More IO

The complete picture



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Streams

Reading from files

```
#include <fstream>
#include <string>
using namespace std;

int main()
{
  ifstream in{"data.txt"};
  string line;
  int x;
  in >> x;
  getline(in, line);
  in.ignore(1000, '\n');
}
```

Streams

Formatting output streams

```
#include <iostream>
#include <iomanip>
using namespace std;
int main()
{
  cout << setw(10) << "hello"
       << '|' << right
       << setw(10) << "world"
       << endl;
  cout << setfill('-')
       << setw(21) << "The end!"
       << endl;
}
```

```
$ ./a.out
hello     |     world
----------The end!
```

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Files

Reading all of a file

```
ifstream ifs{"data.txt"};
string s{};
while (...)
{
   ...
}
```

Files

Reading all of a file

```
ifstream ifs{"data.txt"};
string s{};
while (ifs >> s)
{
   ...
}
```

Files

Reading all of a file

```
ifstream ifs{"data.txt"};
string line{};
while (getline(ifs, line))
{
   ...
}
```

Files

UNIX console

- `cd` to change directory
- `mkdir` to create a directory
- `ls` view files in current directory
- `rm` remove a file
- `rm -r` remove a directory
- `mv` to rename a file or directory
- `cp` to copy a file

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Basic constructs

Conditional statements

```
if (some logical statement)
{
  // do this
}
else if (some other logical statement)
{
  // do this instead
}
else
{
  // when all else fails, do this
}
```

Basic constructs

`bool`

```
int main()
{
  bool statement{false};
  if (statement)
  {
    // will not run
  }
  else
  {
    // will run
  }
}
```

Basic constructs

`bool`

```
int main()
{
  bool statement{false};
  if (!statement)
  {
    // will run
  }
  else
  {
    // will not run
  }
}
```

Basic constructs

Comparison and logical operators

- `a == b`
- `a != b`
- `a < b`
- `a <= b`
- `a > b`
- `a >= b`

Basic constructs

Comparison and logical operators

- `a == b`
- `a != b`
- `a < b`
- `a <= b`
- `a > b`
- `a >= b`

- `a == b and c != b`
- `a == b or a == c`

Basic constructs

Comparison and logical operators

- `a == b`
- `a != b`
- `a < b`
- `a <= b`
- `a > b`
- `a >= b`

- `a == b && c != b`
- `a == b || a == c`

Basic constructs

Loops

```
#include <iostream>
using namespace std;
int main()
{
  int x{};
  cout << "Enter number (1-10): ";
  cin >> x;
  while (x < 1 || x > 10)
  {
    cout << "Enter number (1-10): ";
    cin >> x;
  }
}
```

Basic constructs

Loops

```
#include <iostream>
using namespace std;
int main()
{
  int x{};
  do
  {
    cout << "Enter number (1-10): ";
    cin >> x;
  }
  while (x < 1 || x > 10);
}
```

Basic constructs

`for`-loop

```
#include <iostream>
using namespace std;
int main()
{
  for (int i{0}; i < 10; ++i)
  {
    cout << "Iteration #" << i << endl;
  }
}
```

Basic constructs

Arithmetic operations

- `a + b` (addition)
- `a - b` (subtraction)
- `a * b` (multiplication)
- `a / b` (division)
- `a % b` (modulus)

Basic constructs

Arithmetic operations

- `a + b` (addition)
- `a - b` (subtraction)
- `a * b` (multiplication)
- `a / b` (division)
- `a % b` (modulus)

- `-a` (negation)
- `++a` (prefix increment)
- `a++` (postfix increment)
- `--a` (prefix decrement)
- `a--` (postfix decrement)

Basic constructs

Prefix vs. Postfix

```
int a{0};

a += 2; // a = a + 2
++a;    // a = a + 1
a++;    // a = a + 1

int b{++a};
int c{a++};

// what is a, b and c?
```

Basic constructs

Type casting

- `3 / 2 = 1`

Basic constructs

Type casting

- `3 / 2 = 1`
- `3 / 2.0 = 1.5`

Basic constructs

Type casting

- `3 / 2 = 1`
- `3 / 2.0 = 1.5`
- `3.0 / 2 = 1.5`

Basic constructs

Type casting

- `3 / 2 = 1`
- `3 / 2.0 = 1.5`
- `3.0 / 2 = 1.5`
- `3.0 / 2.0 = 1.5`

Basic constructs

Type casting

```
int a{3};
int b{2};

cout << a / b << endl;
// will output 1

cout << static_cast<double>(a) / b << endl;
// will output 1.5
```

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