Introduction to Computer Science and Programming in Java

Arrays

Holds a specific number of elements

All elements must be of the same type

Zero-Indexed

Stored in contiguous section of memory

Pop Quiz!

What's wrong in these mini-programs?

```
int[] arr;
arr[0] = 6;
```

```
int[] arr = new int[5];
arr[5] = 6;
```

```
int[] arr = new int[5];
arr[-1] = 6;
```

```
int[] arr = new int[5];
6 = arr[0];
```

ArrayList

Resizable

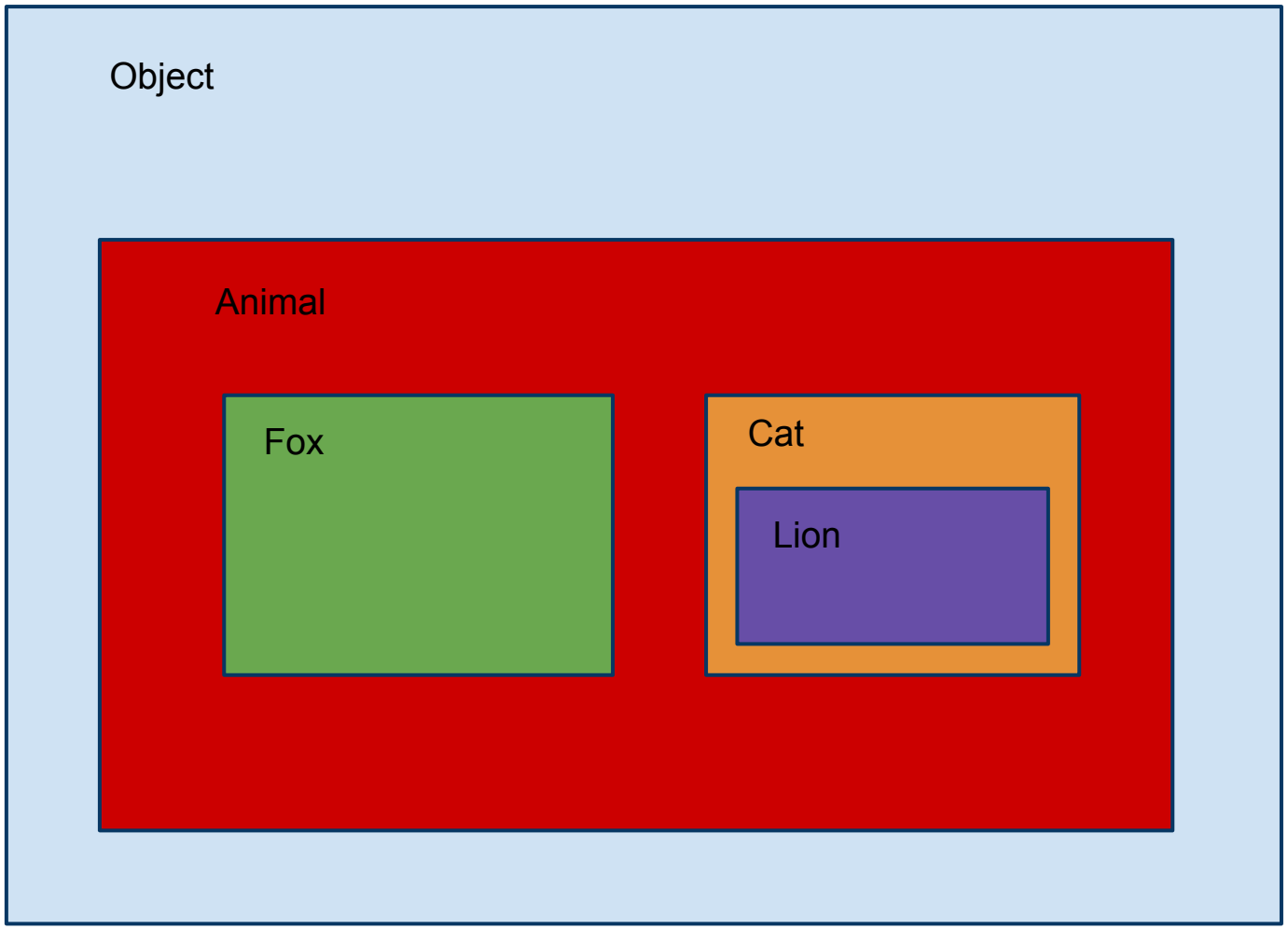
All elements are of same type

Slower than Array

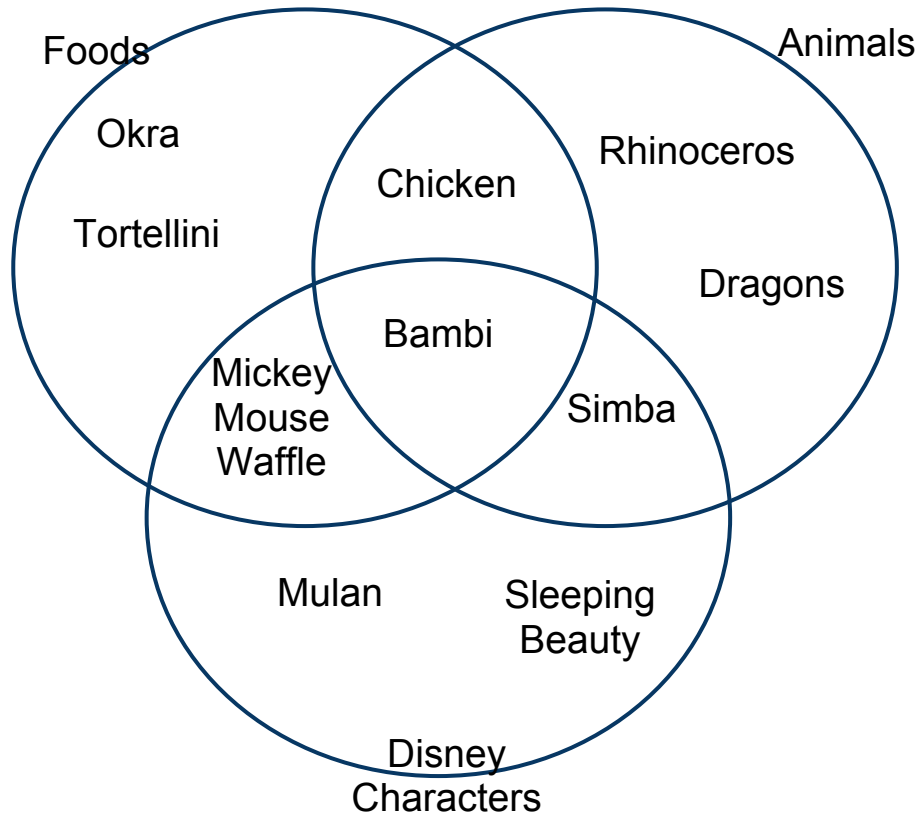
When do you want an ArrayList versus an Array?

Classes and OOP

Inheritance: "extends"



Interface: "implements"



Polymorphism: Selecting one method among many of the same name based on the actual type of the implicit parameter.

```
Animal animal1;
Animal animal2;

animal1 = new Dog();
animal2 = new Cat();

animal1.makeNoise();
animal2.makeNoise();
```

Static Things

Static/"Class" Method: does not belong to an object
    Ex: Integer.parseInt(x)

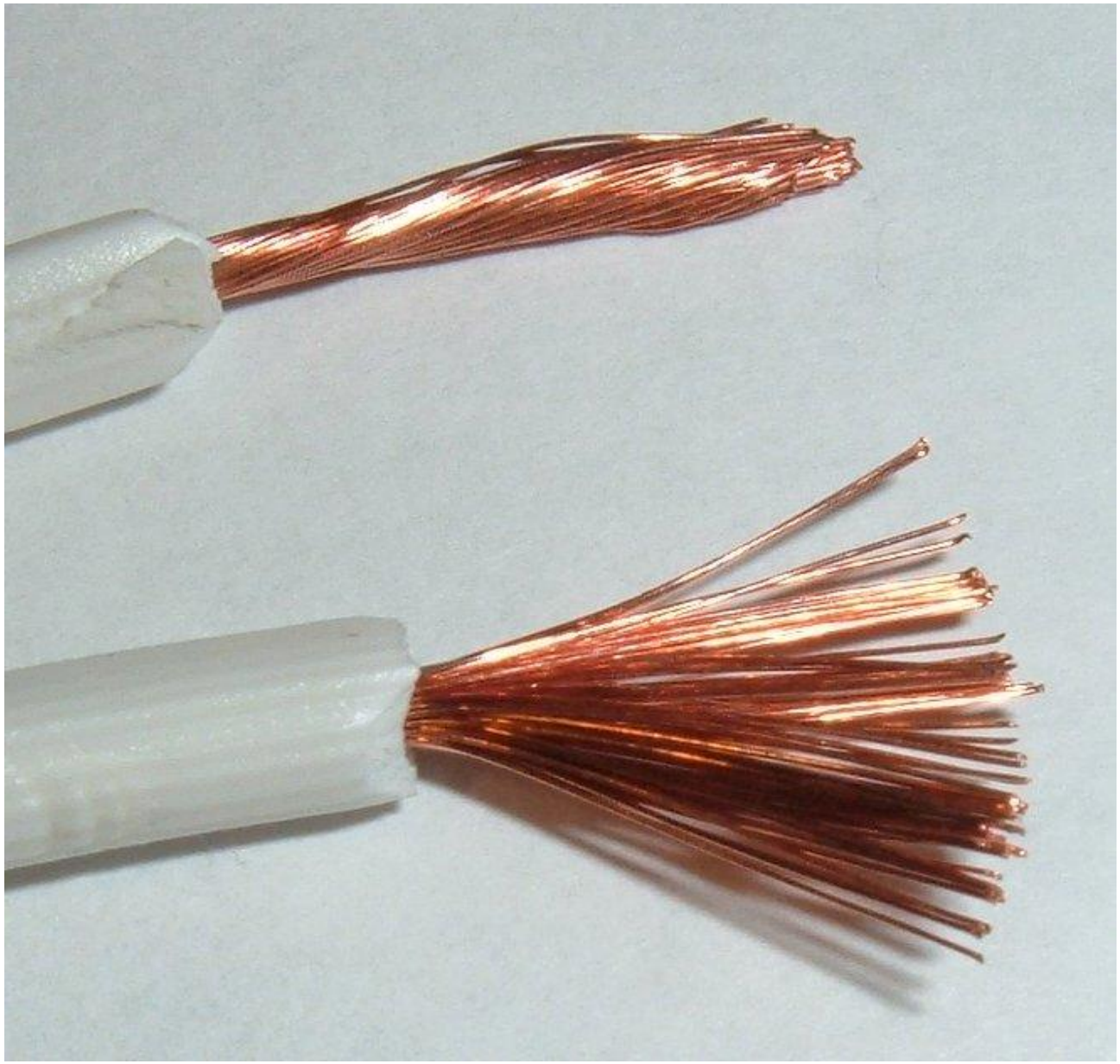
Static Variable: shared across a class
    Ex: BankAccount identifier

Networks

Networks

Layers
Physical
Data-Link
Network
Transport
Application

Physical Layer

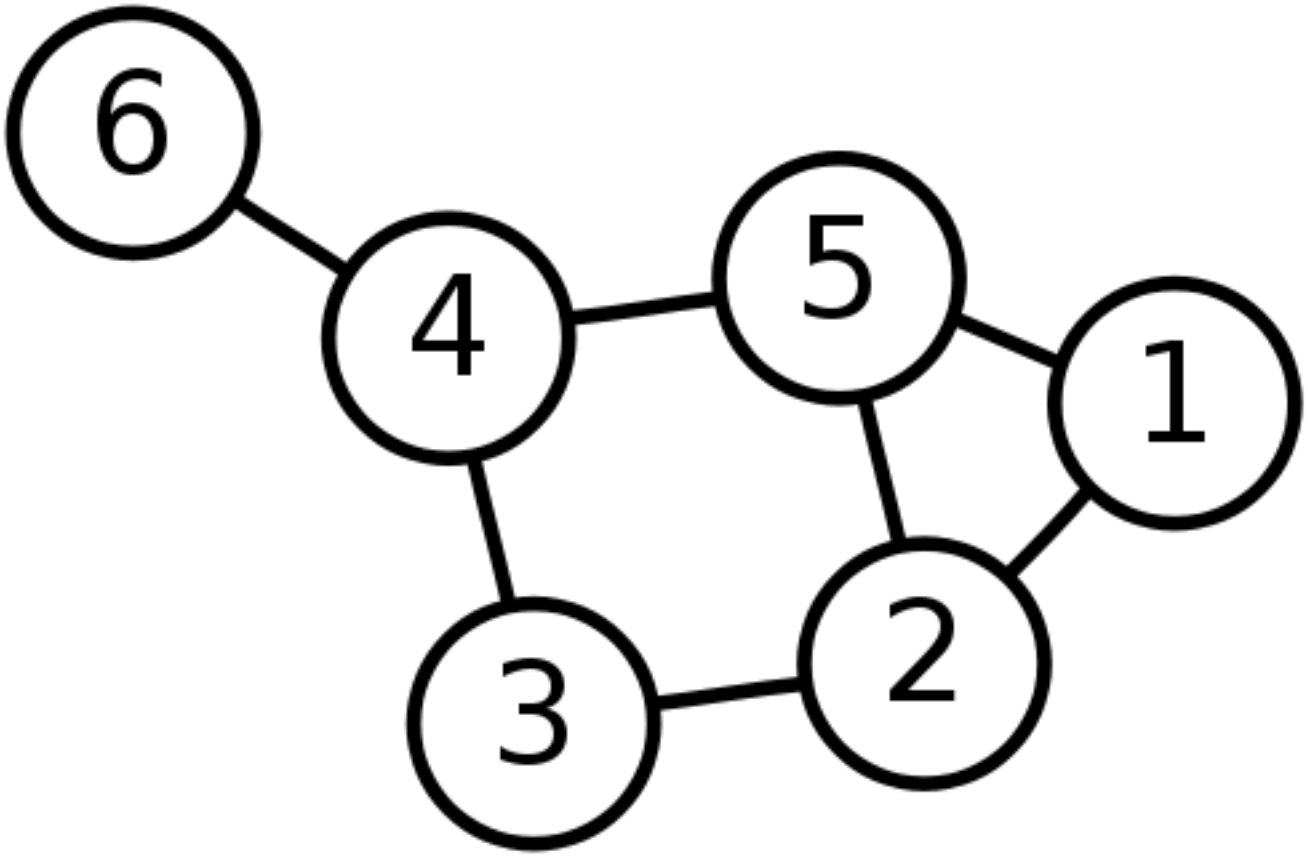


Data-Link Layer

Creates a Bit Pipe
Collision Handling
ARQ algorithm

Network Layer

How to get from point A to point B
DNS: every node has an absolute address
IP protocol

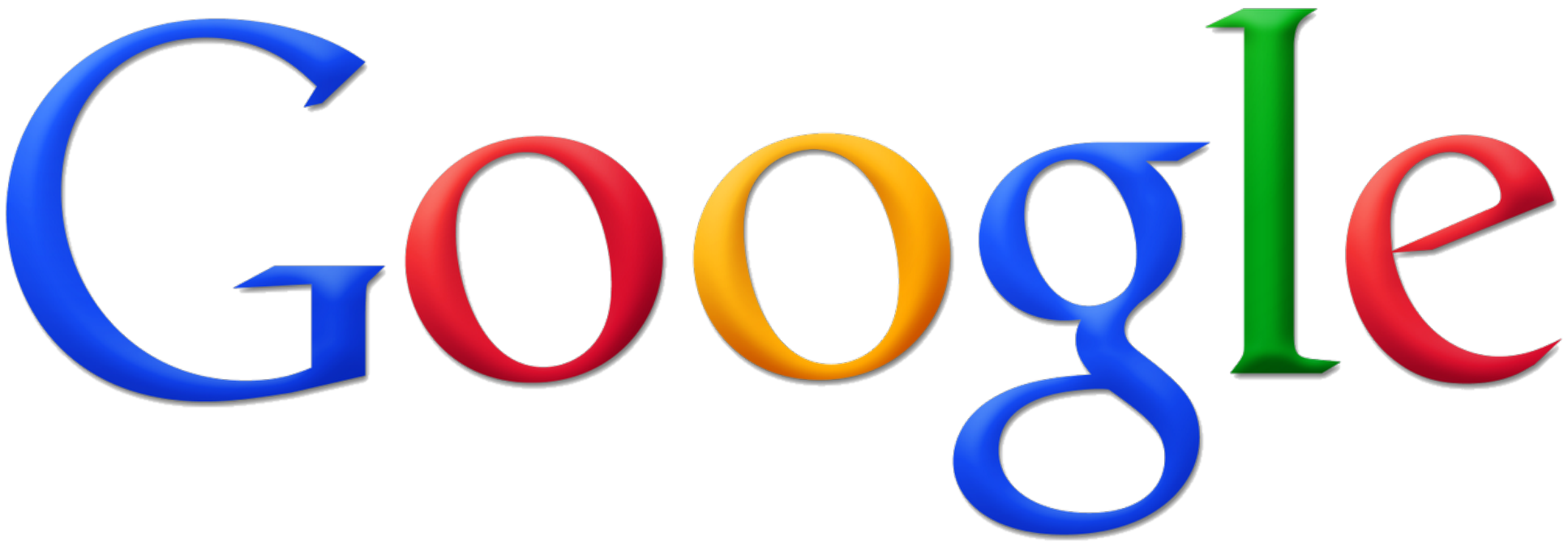


Transport Layer

Program-to-Program (Ports)
Reliability
TCP or UDP

Application Layer

Necessary for building applications for consumers on networks (ie Facebook)
HTTP



Pop Quiz!

What's the difference between the transport and network layers?

How does an ACK work?

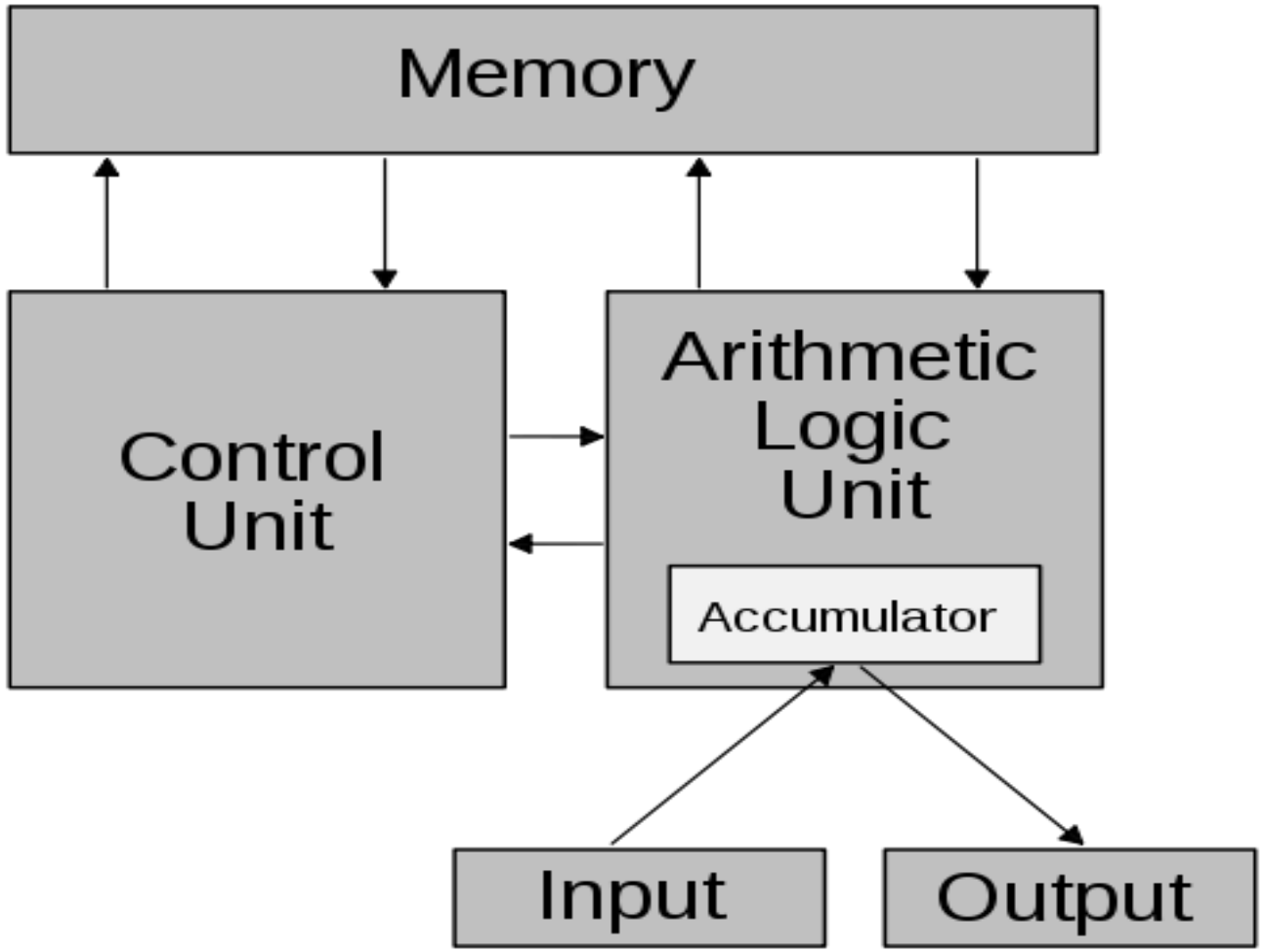
Which layer is the GET request at?

TCP Protocol?

Voltage levels for wires?

Von Neumann Architecture

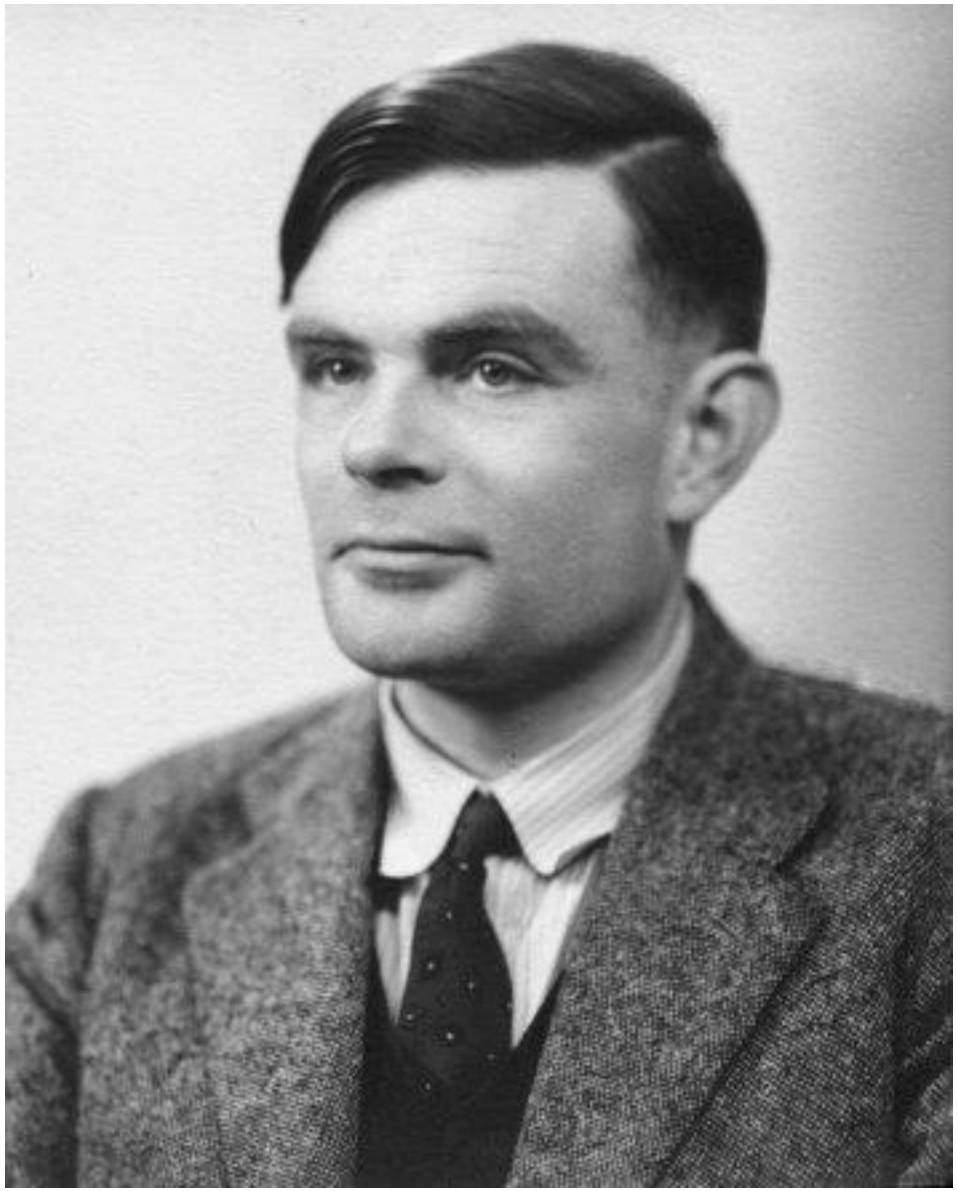
Von Neumann Architecture



Computability

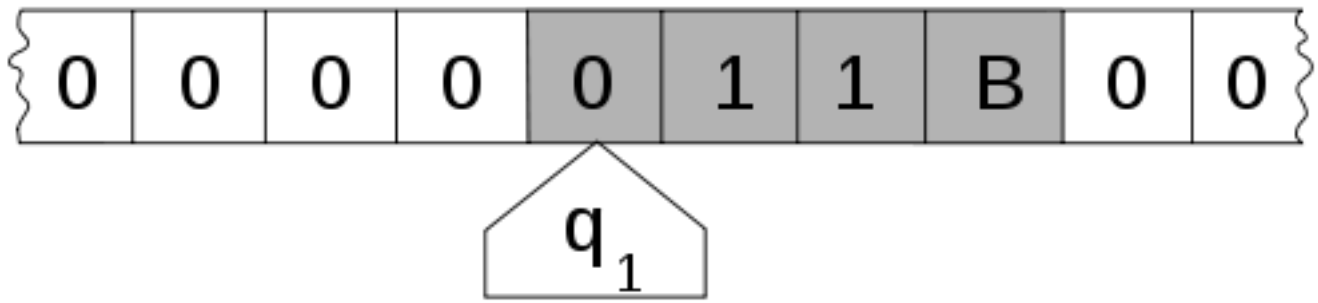
Turing Machines etc

Alan Turing



Turing Machine

Infinite number of cells
Finite number of tape symbols
Finite number of states
Next state, symbol to write, and tape head movement are defined by state and current tape symbol.



Church-Turing Thesis

Everything algorithmically computable is computable by a Turing machine

The Halting Problem

TM H: Given a TM M and input x, will M halt when given input x?

TM D: Given a TM T, run H as input on T, using T as both M and x. If H accepts, reject (output 0). If H rejects, accept (output 1).

Run D on itself.

D<D> accepts if D<D> rejects, and rejects if D<D> accepts --> contradiction!

There is no Turing Machine that solves the halting problem.

What is the significance of this?

Pop Quiz!

If your input is a bitstring of 0s and 1s, how would you check if a binary number is even?

What is the time-complexity of checking whether a number is even? (Use Big-Oh Notation!)

If your input is a string of 0s and 1s, how would you increment it?

Bonus: What is the time complexity of decrementing a binary number to 0?

Boolean Algebra & Logic Gates

Truth Tables describe how specific boolean operators work

Construct using AND, OR, NOT

p	q	p ∧ q
T	T	T
T	F	F
F	T	F
F	F	F

Number Systems

Binary: Base 2

$0110 = (0 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (0 \times 2^0) = 6$

Hexadecimal: Base 16

0-9 represent values 0-9

A-F represent 10-15

$2AF3 = (2 \times 16^3) + (10 \times 16^2) + (15 \times 16^1) + (3 \times 16^0)$

$= 10{,}995.$

Convert between the two using groups of four!

Exceptions: Introductory Questions

What are exceptions?

Why are they useful?

Exceptions: Syntax

```
try {
  //dangerous stuff here
} catch (ArrayIndexOutOfBoundsException e) {
  //handle
} catch (IOException e) {
  //handle
} finally {
  //do something that always needs to happen
}
```

Exceptions: Follow-up Questions

What might you want to put in a finally block?

What's the difference between `throw` and `throws`?

What's the difference between a checked and unchecked exception?

Djikstra's Algorithm

Make table of all nodes

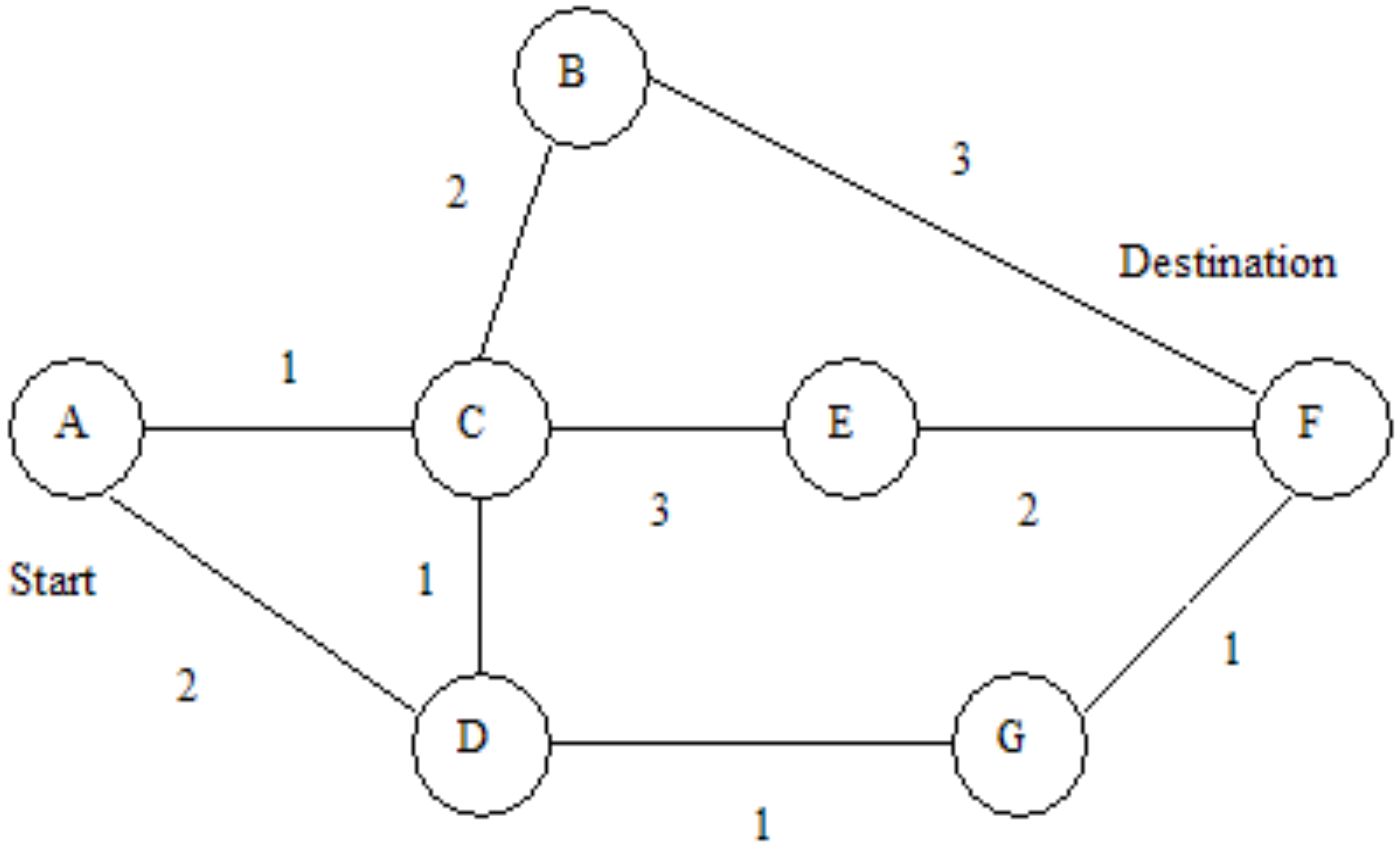
Initialize table and create S, set of all traveled to

Add to S when travel to a node (because it is the shortest path you can take)

Update the table with new distances

Repeat last two steps until get to desired locale

Djikstra's Algorithm cont'd



Find the shortest path!

Sorting + Searching

Insertion Sort: O n^2

-Go through "cards", comparing the starting position with the one to its right and then moving leftwards

Selection Sort: O n^2

-Find local minimum among unsorted, switching with current position as iterate through

Binary Search: O logn

Linear search: O n

Assorted Things

Strings: equals, not ==

Casting: explicitly from high-->low

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References

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