Computability

CPS 001

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Write Your Names
(or just exercise your curiosity)
What is Computer Science?
What can a computer do?  What can a computer not do?
Types of Problems

- **Tractable**
  - Problems that **can** be solved by a computer in a “reasonable” amount of time.
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  - But **can** be solved eventually.
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- **Intractable**
  - Problems that *can’t* be solved by a computer in a “reasonable” amount of time,
  - But *can* be solved eventually.

- **Non-computable**
  - Problems that *can never* be solved by a computer.
Questions?
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- What is a “problem?”
Questions?

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- What if I do something dumb, and it takes forever?
Questions?

- What is a “problem?”
- What if I do something dumb, and it takes forever?
- What does “reasonable” mean?
Is there a path from Ann to Bob?
Is there a path from Ann to Bob?
How much oil can flow?
How much oil can flow?
Can you color this map with 4 colors?
Can you color this map with 3 colors?
Can you color this map with 3 colors?
Can you color this map with 3 colors?
Can you solve this puzzle?
Can you solve this puzzle?
Can you solve this puzzle?

- Does “Intractable” mean impossible?
What is the hardest problem that you can think of?
How can we deal with these problems?
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  - Can “expect” to solve some in reasonable time
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- Approximation
  - Can guarantee that we’re “close” to the right answer
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- Approximation
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- Parallel Computers?
Non-Computable Problems

- Problems that *cannot* be solved by a computer *ever*
If you start this program, will it ever stop running?

```java
while(1==1) {
    System.out.println("Still Running.");
}
return;
```
If you start this program, will it ever stop running?

```java
int i = 1;
while (i > 0) {
    System.out.println("Still Running.");
    i++;
}
return;
```
If you start this program, will it ever stop running?

public class Client {

    public static void main(String[] args) {
        if(args.length != 2) {
            System.out.println("Usage: vbj Client <carrier-name> <aircraft-name>");
            return;
        }

        String carrierName = args[0];
        String aircraftName = args[1];
        org.omg.CORBA.Object carrier = null;
        org.omg.CORBA.Object aircraft = null;
        org.omg.CORBA.ORB orb = null;
        try {
            orb = org.omg.CORBA.ORB.init(args, null);
        } catch (org.omg.CORBA.SystemException se) {
            System.err.println("ORB init failure " + se);
            System.exit(1);
        }

        try {
            carrier = orb.bind("IDL:Ship/AircraftCarrier:1.0", carrierName, null, null);
        } catch (org.omg.CORBA.SystemException se) {
            System.err.println("ORB init failure " + se);
            System.exit(1);
        }

        org.omg.CORBA.Request request = carrier._request("launch");
        request.add_in_arg().insert_string(aircraftName);
        request.set_return_type(orb.get_primitive_tc(org.omg.CORBA.TCKind.tk_objref));
        request.invoke();
        aircraft = request.result().value().extract_Object();

        org.omg.CORBA.Request request = aircraft._request("codeNumber");
        request.set_return_type(orb.get_primitive_tc(org.omg.CORBA.TCKind.tk_string));
        request.invoke();
        String designation = request.result().value().extract_string();
        System.out.println("Aircraft " + designation + " is coming your way");

        org.omg.CORBA.Request request = aircraft._request("attitude");
        int altitude = 10000;
        org.omg.CORBA.Any ioAltitude = request.add_inout_arg();
        ioAltitude.insert_long(altitude);
        String direction = "headup";
        request.add_in_arg().insert_string(direction);
        request.invoke();
        altitude = ioAltitude.extract_long();
        System.out.println("Aircraft is heading up to " + altitude + " Feet.");
    }
}

Proof of impossibility!
What else can’t we know about our programs?

- Do two programs do the same thing?
- Do programs have any bugs?
- Do programs do what they’re supposed to do?
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