SECTION 3 GRAPHS & TESTING

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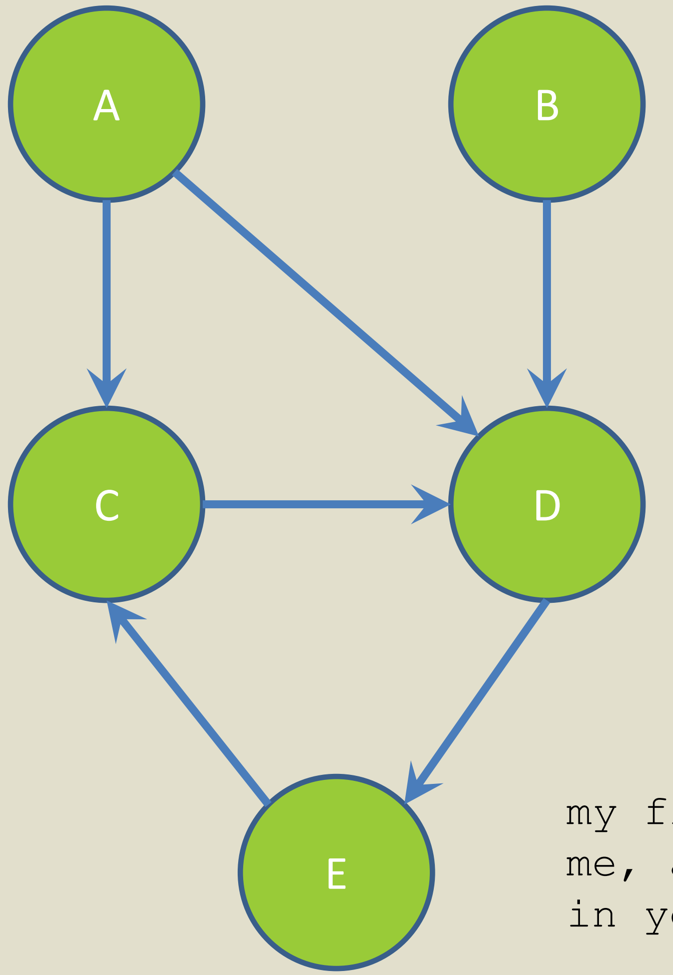
Agenda

- Graphs
- Testing

Graph



= collection of nodes (vertices) and edges

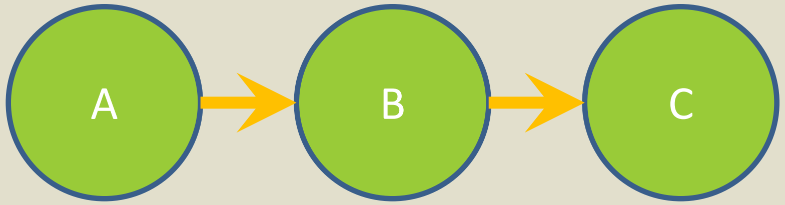
Nodes: states or objects within the graph

Edges: connection between two nodes

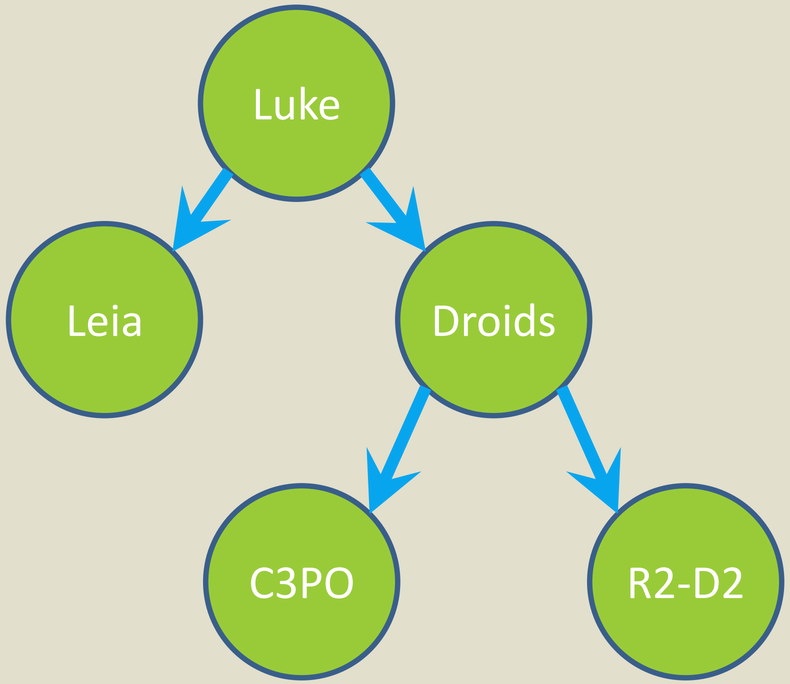
```
my friend: I can't figure out how to store nodes in my graph
me, an intellectual: you can't figure how to store *vertices*
in your graph
```

Some examples

Linked Lists



Binary Trees



Directed graph vs ***Undirected*** graph

- ***Directed*** graph

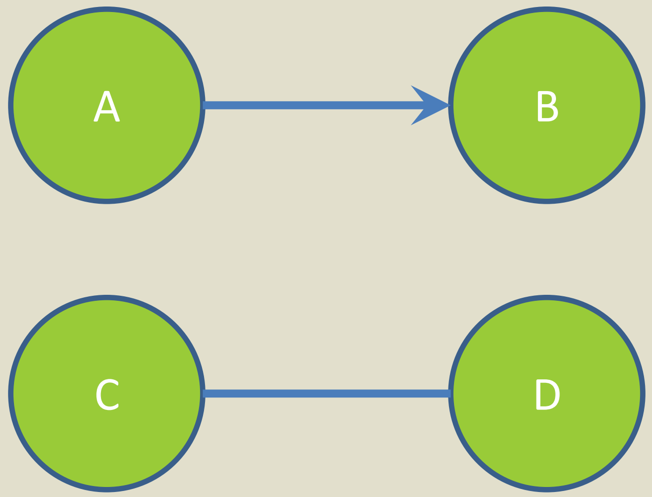
  = edges have a source and destination

- Arrows as edges

- Parent and child nodes related by an edge

Directed graph vs ***Undirected*** graph

- Directed
- Undirected

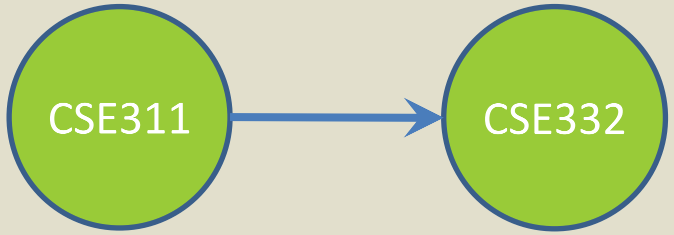


What are some examples?

Directed graph vs ***Undirected*** graph

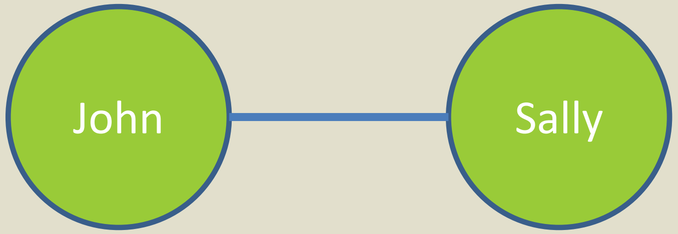
Directed:

- Build systems
- Course prerequisites

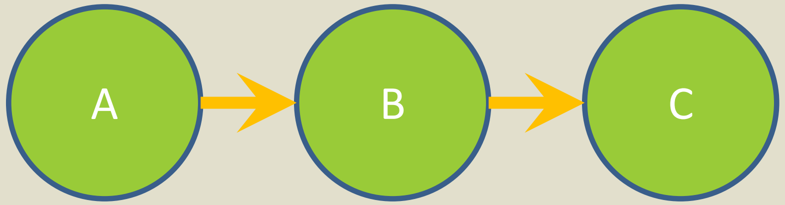


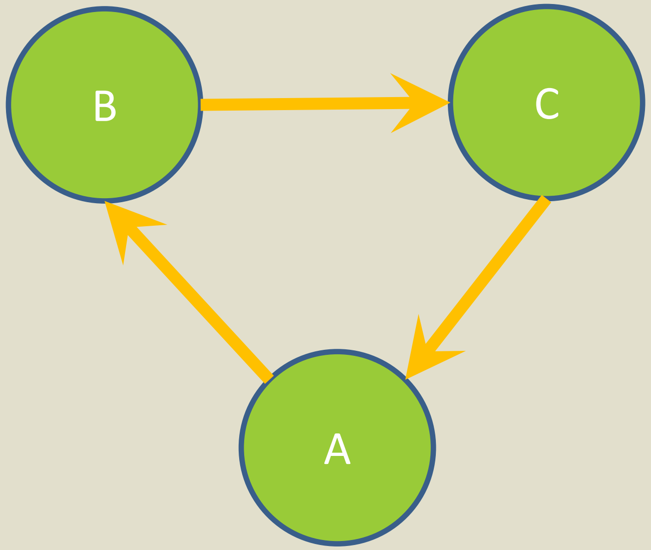
Undirected:

- Facebook friends
- Map of U-District Restaurants



Cyclic *vs* ***Acyclic***





Special type of graphs:
Directed Acyclic Graphs (DAGs)

Why do we need them?

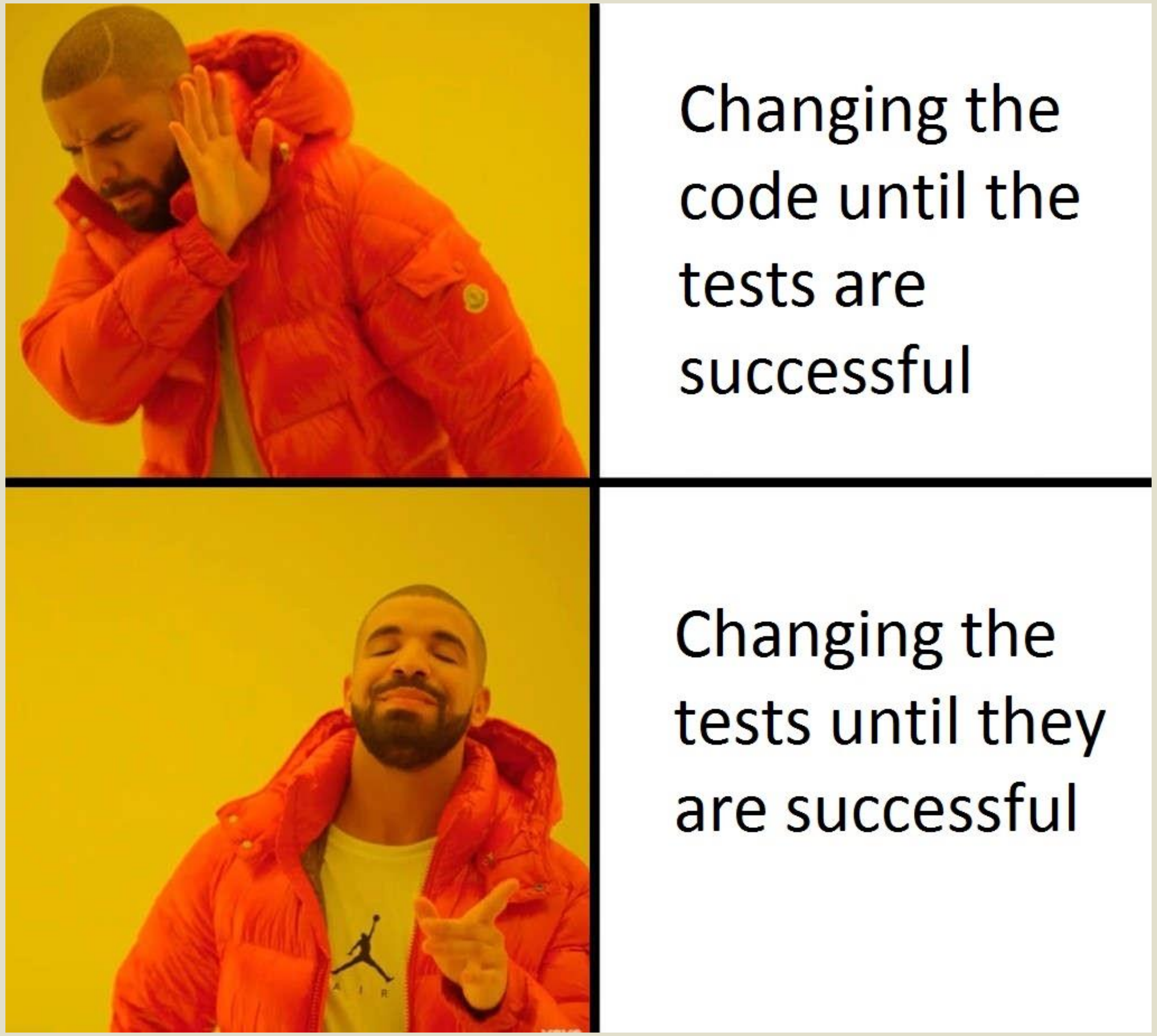
Worksheet

What is Testing?

- Implementation tests

- Specification tests

When to do which one?


Changing the code until the tests are successful
Changing the tests until they are successful

Implementation vs. Specification

- **Implementation tests:**
  - How you decide to implement the object.
  - See if each component (unit) is working properly.

- **Specification tests:**
  - Testing your API against the specifications.
  - Usually larger than unit tests.

Black box vs. Clear box

- **Black box:**
  - Written with knowledge of **only** the Specification.
- **Clear box:**
  - Written with full knowledge of an implementation.

Worksheet

A JUnit test class (Demo)

- A method with `@Test` is a JUnit test.
- All `@Test` methods run when JUnit runs.

```
import org.junit.*;
import static org.junit.Assert.*;

public class TestSuite {

    @Test
    public void Test1() { … }
```

Using JUnit assertions

- Verifies that a **value** matches **expectations**
  - `assertEquals(42, meaningOfLife());`
  - `assertTrue(list.isEmpty());`

- If the assert fails:
  - Test immediately terminates.
  - Other tests in the test class still run.
  - Results show information about failed tests.

Using JUnit assertions

Assertion	Case for failure
`assertTrue(test)`	the boolean test is false
`assertFalse(test)`	the boolean test is true
`assertEquals(expected, actual)`	the values are not equal
`assertSame(expected, actual)`	the values are not the same (by ==)
`assertNotSame(expected, actual)`	the values are the same (by ==)
`assertNull(value)`	the given value is not null
`assertNotNull(value)`	the given value is null

- And others: http://www.junit.org/apidocs/org/junit/Assert.html
- Each method can also be passed a string to display if it fails:
  - `assertEquals("message", expected, actual)`

Checking for exceptions (Demo)

- Verify that a method throws an exception when it should:
  - Passes only if specified exception is thrown
- Only time it's OK to write a test without a form of `asserts`

```
@Test(expected=IndexOutOfBoundsException.class)
public void testGetEmptyList() {
    List<String> list = new ArrayList<String>();
    list.get(0);
}
```

Setup and teardown

- Methods to run before/after each test case method is called:

```
@Before
public void name() { ... }
@After
public void name() { ... }
```

- Methods to run once before/after the entire test class runs:

```
@BeforeClass
public static void name() { ... }
@AfterClass
public static void name() { ... }
```

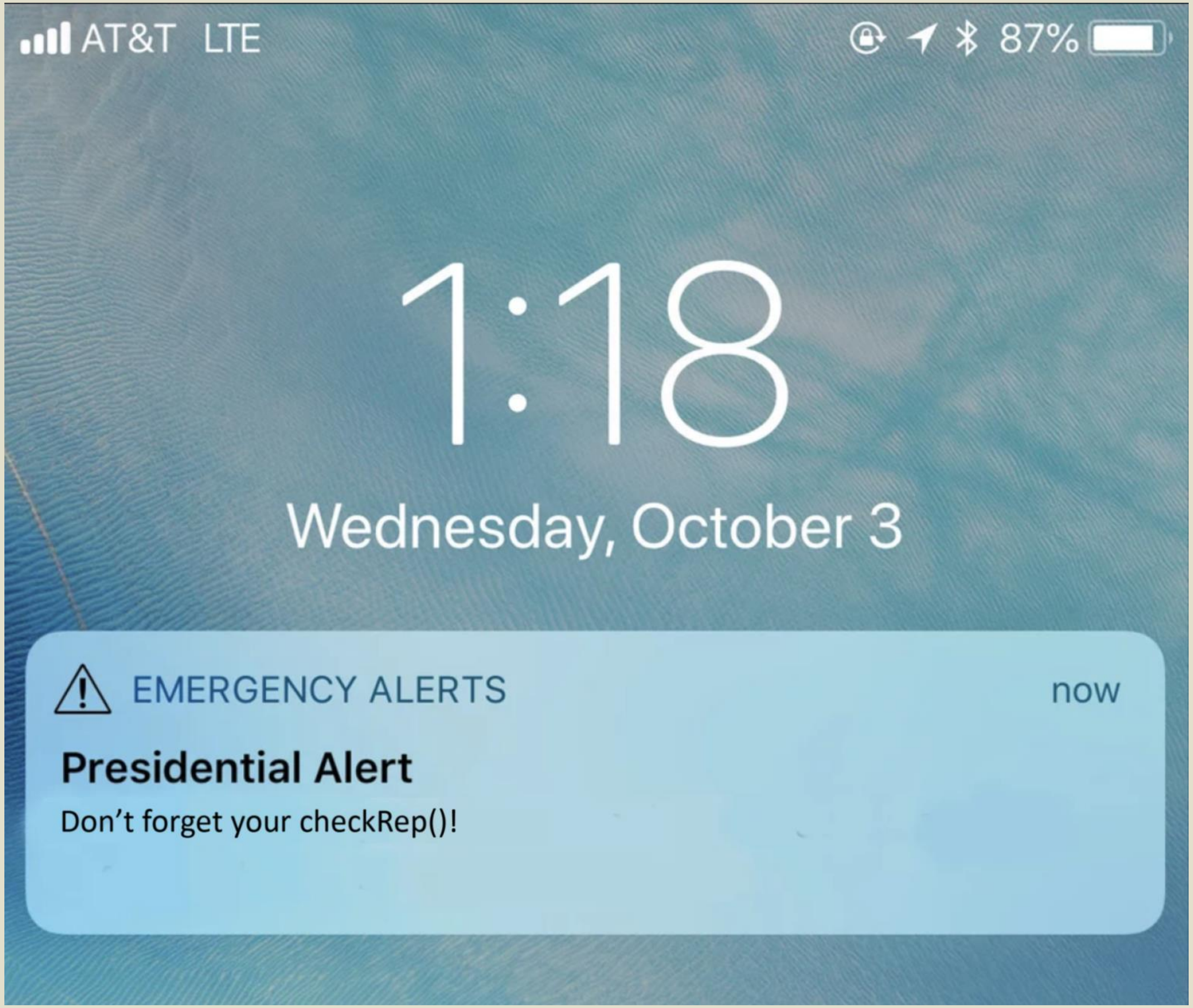
Setup and teardown

```
public class Example {
    List<String> empty;

    @Before
    public void initialize() {
        empty = new ArrayList<>();
    }
    @Test
    public void size() {...}
    @Test
    public void remove() {...}
}
```

Ground rules

1. Don't Repeat Yourself
   - Use constants and helper methods
2. Be Descriptive
   - Take advantage of message, expected, and actual values
3. Keep Tests Small
   - Isolate bugs one at a time; *failing assertion halts test*
4. Be Thorough
   - Test big, small, boundaries, exceptions, errors



Presidential Alert

Don’t forget your checkRep()!

Expensive checkReps()

- Before your final commit, remove the checking of expensive parts of your checkRep or the checking of your checkRep entirely
- Example: boolean flag and structure your checkRep as so:

```
private void checkRep() {
    cheap-stuff
    if(DEBUG_FLAG) { // or can have this for entire checkRep
      expensive-stuff
    }
    cheap-stuff
    ...
```

Summary

- **Demo** will be uploaded
- **JUnit documentation** online
- Reminder: you can generate the **JavaDoc API** for your code
  - *Located under `build/docs/javadoc` in project folder.*
  - *IntelliJ Gradle Instructions in the Editing/Compiling Handout.*