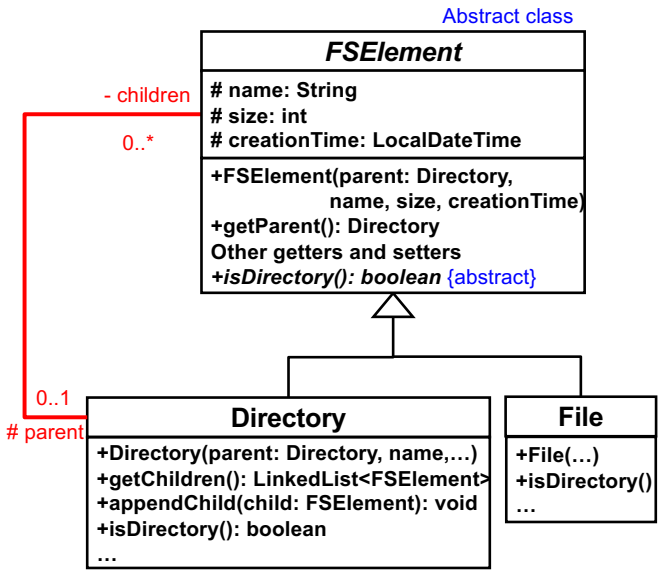
Composite Design Pattern



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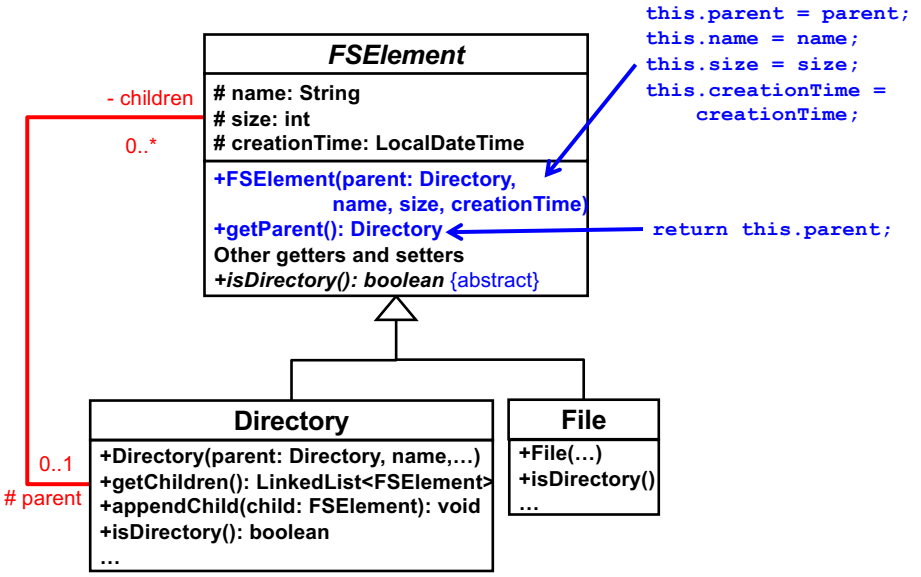

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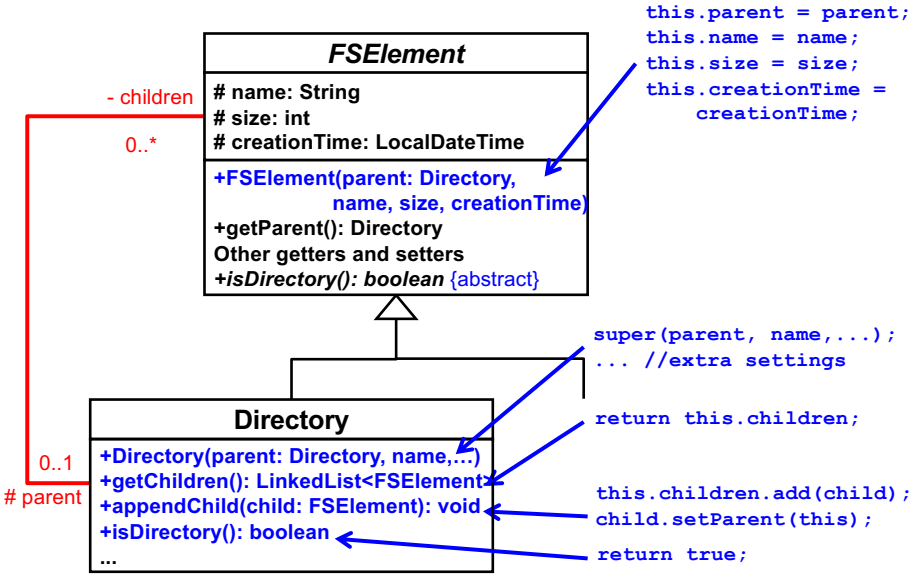

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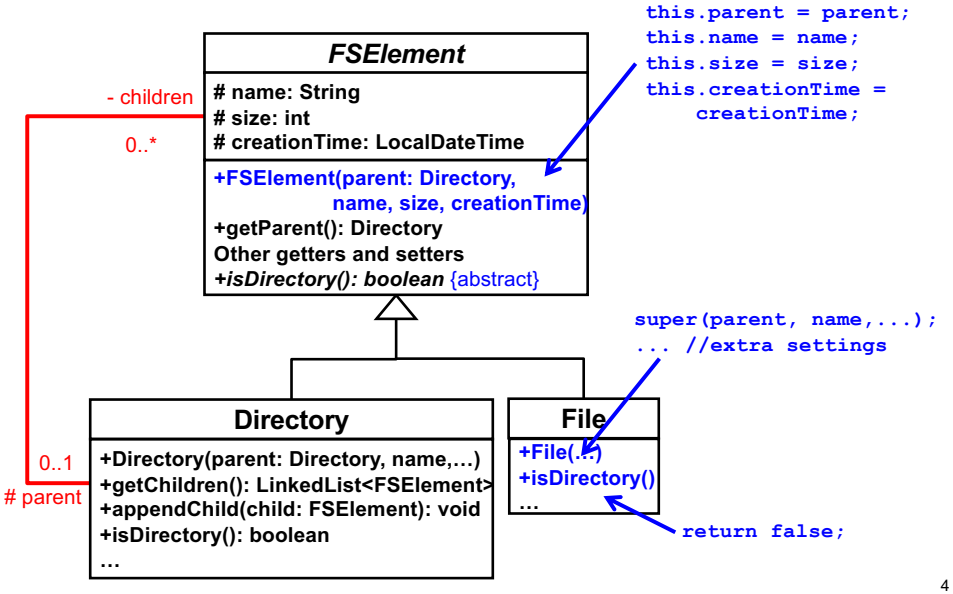

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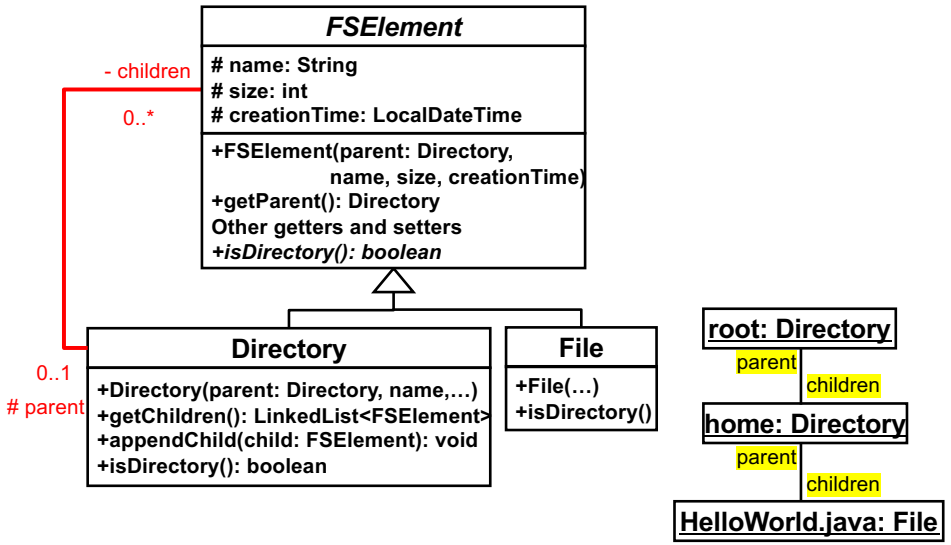


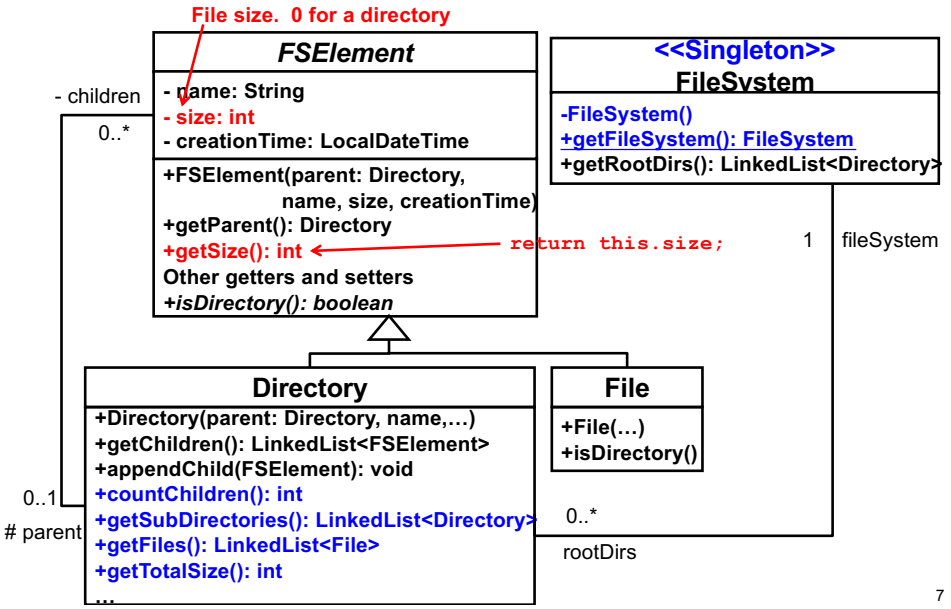

```
Directory root = new Directory(null, "root", ...);
Directory home = new Directory(root, "home", ...);

File file = new File(null, "HelloWorld.java", ...);
home.appendChild(file);

root.getChildren(); home.getChildren();
```


Benefits of *Composite*

- Client code of a tree structure can treat individual objects and compositions of objects uniformly.
  - "Treating…uniformly" means performing polymorphism on ….

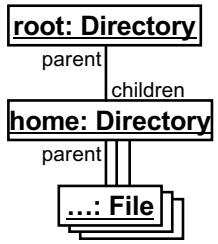
```
- Directory dir = ...;
  for( FSElement fsElement: dir.getChildren() ){
      System.out.println( fsElement.getName() );
      System.out.println( fsElement.getSize() );
      System.out.println( fsElement.getParent().getName() ); }
```


HW 6: Implement This



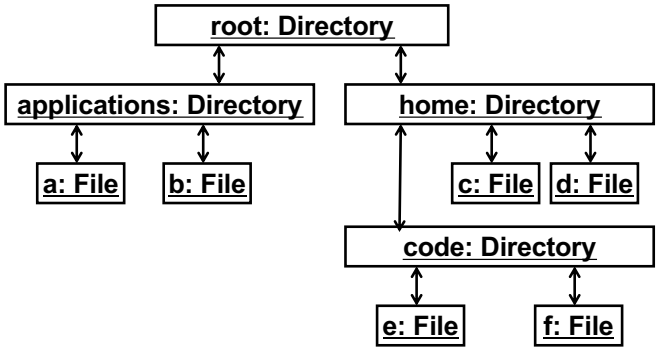
- `Directory`
  - `LinkedList<FSElement> children`: data field to reference files and subdirectories in the directory
  - `countChildren()`: returns the number of files and subdirectories in the directory.
  - `getTotalSize()`: returns the total disk consumption by all the files and subdirectories under the directory
    - Call `getTotalSize()` recursively on all sub-directories

```
Directory root = new Directory(null, "Root", ...);
Directory home = new Directory(root, "home", ...);
File file = new File(home, "...", ...);
File file = new File(home, "...", ...);
File file = new File(home, "...", ...);

root.getTotalSize();
```



- **`FileSystem`** (*Singleton* class)
  - Implement a static factory method: **`getFileSystem()`**
  - Define a (empty) private constructor
- Add any extra methods in any classes as you like.
  - The class diagram in a previous slide is not complete.
    - e.g., **`addRootDir()`** in **`FileSystem`**?

- Use this file system structure in your test cases.
  - Create this file system structure as a test fixture.
  - Assign values to data fields (size, etc) as you like.



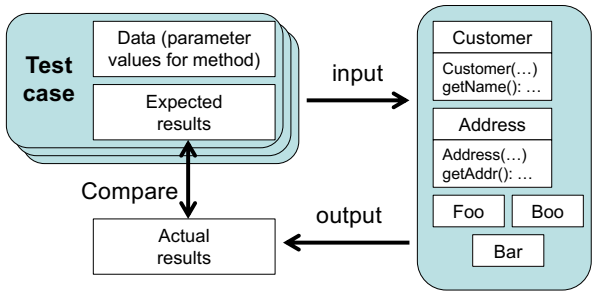
- Unit testing
  - Test each public method with **`DirectoryTest`**, **`FileTest`**, **`FileSystemTest`**
  - **`DirectoryTest`**
    - No need to define a test method for each getter method in **`Directory`**
    - Implement an equality-check for each **`Directory`** instance by calling getter methods of **`Directory`**
      - You can define your own logic for equality check.
      - c.f. HW 5, which performs equality-check for different **`Car`** instances
  - **`FileTest`**
    - Follow the instructions given for **`DirectoryTest`**


```
public DirectoryTest{
  ...
  private String dirToStringArray(Directory d){
    String[] dirInfo = {
      d.isFile(), d.getName(), d.getSize(),
      d.getCreationTime(), d.getParent().getName(),
        // Call FSElement's methods and put returned values
      d.countChildren(), ...
      ...
        // Call Directory's methods and put returned values };
      return dirInfo; }

  @Test
  public void verifyDirectoryEqualityRoot(){
    String[] expected = {..., ..., ...};

    Directory actual = ...;
    assertArrayEquals(expected,
                      dirToStringArray(actual) ); }

  @Test
  public void verifyDirectoryEqualityHome (){ ... }

  ...
}
```

- Deadline: Nov 5 (Tue) midnight

Test Fixtures

- Fixture
  - An instance of a class under test
  - An instance of another class that the class under test depends on
  - Input data
  - Expected result(s)
  - Set up of a file(s) and other resources
    - e.g., Socket
  - Set up of external systems/frameworks
    - e.g. Database, web server, web app framework, emulator (e.g. Android emulator)



Setting up Fixtures

- Class under test

```
public class Calculator{
 public int multiply(int x, int y){
   return x * y;
 }
 public float divide(int x, int y){
   if(y==0) throw
    new IllegalArgumentException(
     "division by zero");
   return (float)x / (float)y;
 }
]
```

- Test class

```
public class CalculatorTest{
 @Test
 public void multiply3By4(){
   Calculator cut = new Calculator();
   float actual = cut.multiply(3,4);
   float expected = 12;
   assertEquals(expected, actual); }

 @Test
 public void divide3By2(){
   Calculator cut = new Calculator();
   float actual = cut.divide(3,2);
   float expected = 1.5f;
   assertEquals(expected, actual)); }

@Test
 public void divide5By0(){
   Calculator cut = new Calculator();
   try{
     cut.divide(5, 0);
     fail("Division by zero"); }
   catch(IllegalArgumentException ex){
     assertEquals("division by zero",
                  ex.getMessage() ); } } }
```

Setting up fixtures -- inline setup

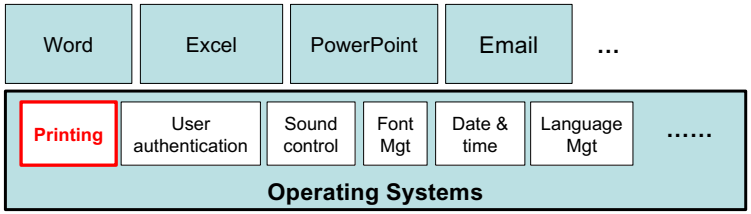
Implicit Setup

```
import org.junit.jupiter.api.BeforeAll;
import org.junit.Jupiter.api.AfterAll;

public class RectangleTest{
    private Rectangle cut;

    @BeforeAll
    public void setUp(){
        cut = new Calculator(); }

    @Test
    public void multiply3By4(){
        float actual = cut.multiply(3,4);
        float expected = 12;
        assertEquals(expected, actual); }

    @Test
    public void divide3By2(){
        float actual = cut.divide(3,2);
        ... }

    @Test
    public void divide5By0(){
        ... }

    @AfterAll
    public void doSomething(){...}  }
```

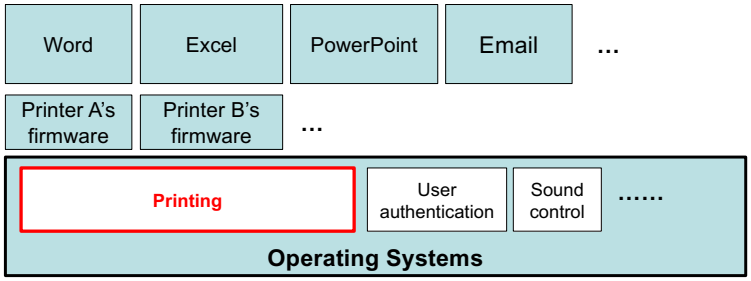
- Implicit setup makes a test class less redundant.
- Flow of execution
  - @BeforeAll setUp()
  - @Test multiply3By4()
  - @Test divide3By2()
  - @Test divide5By0()
  - @AfterAll doSomething()
  - The @BeforeAll method runs before all test methods.
  - The @AfterAll method runs after all test methods.
  - JUnit may run the test methods in a different order from their ordering in source code.

Quiz: Printing API

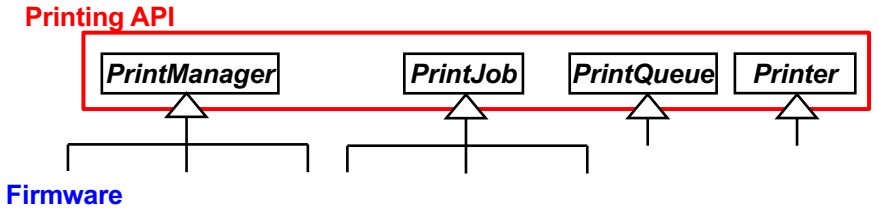
- Imagine a series of foundation services (or system APIs) that an operating system provides for apps.



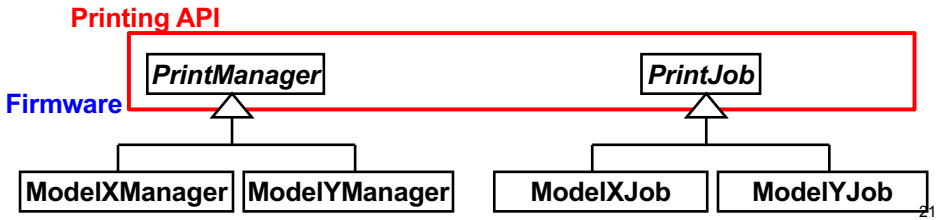
- Suppose you are trying to implement a printing API for the OS.
  - Your API will implement what are common among printer firmware.
    - e.g., print job, print queue, etc.
  - Firmware developers will use your API to implement their firmware
  - Apps will call firmware and your API to do printing.

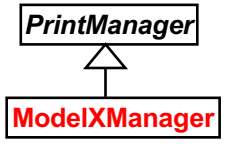


- The printing API has 4 classes:
  - `PrintManager`
    - Used by an app to start printing.
    - Creates a PrintJob, sends it to a PrintQueue and manages its lifecycle.
  - `PrintJob`
    - Represents a print job.
  - `PrintQueue`
  - `Printer`
  - They implement what are common among printer firmware.



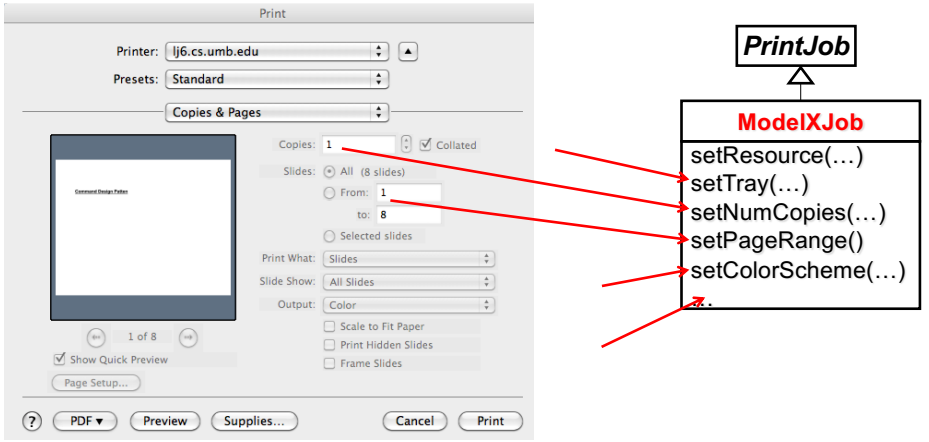
- API classes:
  - `PrintManager`
    - Used by an app to start printing.
    - Creates a PrintJob, sends it to a PrintQueue and manages its lifecycle.
  - `PrintJob`
  - They implement what are common among printer firmware.
  - Each firmware uses/extends them to implement its own printing service.



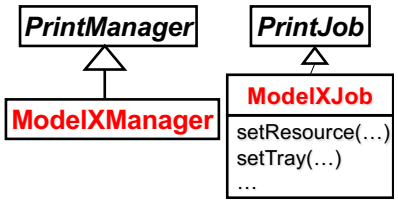


ModelXManager pops up a print configuration window and allows the user to set up a print job.

It creates an instance of ModelXJob once the user clicks "Print," and then sends it to a print queue.

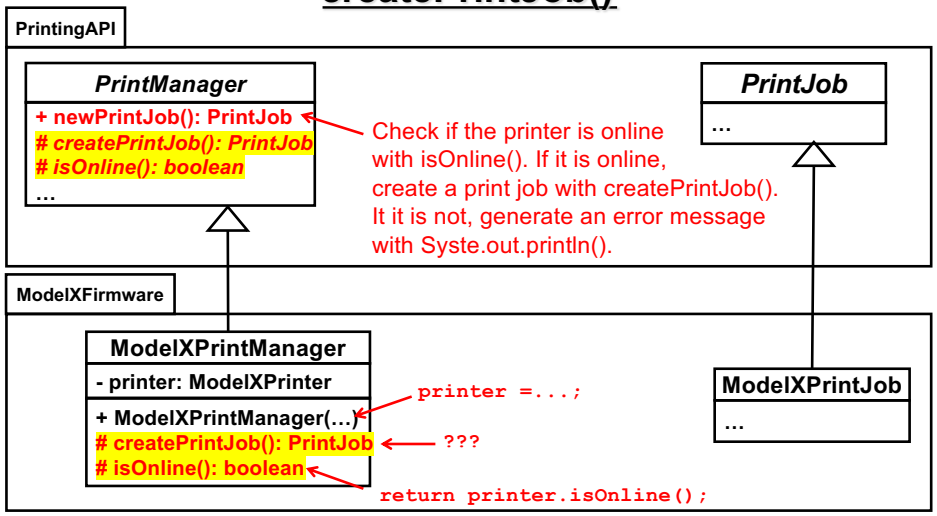


- Let's focus on the creation of print jobs.
- Requirements:
  - There is a common procedure that the printing API wants to run when creating a new print job.
    - You want to enforce this procedure in all firmware.
    - You want to implement it in PrintManager.
    - e.g. Check if the printer is online and create a print job if the printer is online.
      - toner level?
      - jammed?

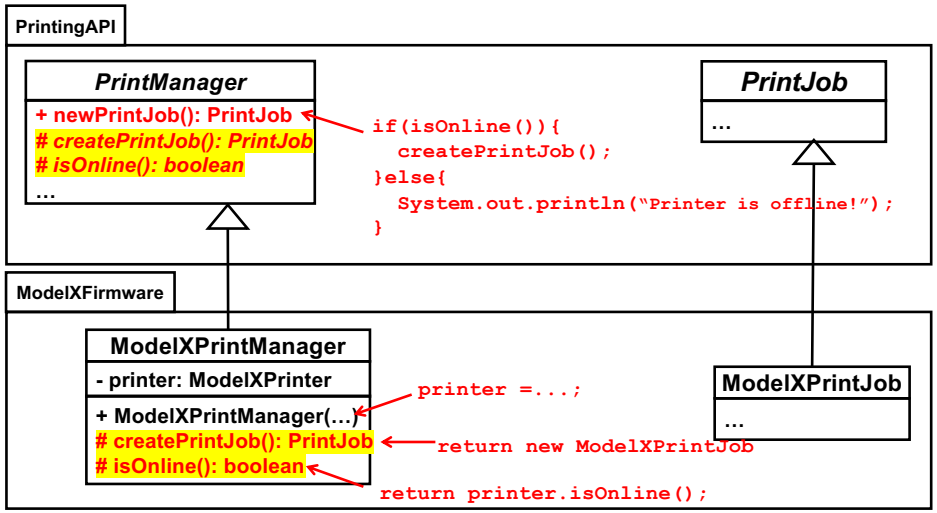


- How to implement this without knowing about subclasses (i.e., without stating subclasses)?

Write Pseudo Code for PrintManager's newPrintJob() and ModelXPrintManager's createPrintJob()




```
ModelXPrintManager manager = new ModelXPrintManager(...);
manager.newPrintJob();
```




```
ModelXPrintManager manager = new ModelXPrintManager(...);
manager.newPrintJob();
```