

# Subtyping and Inheritance

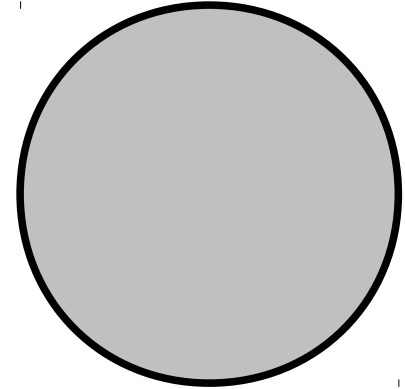
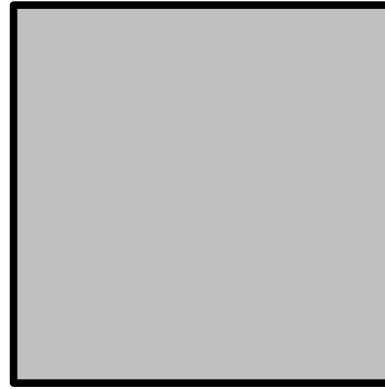
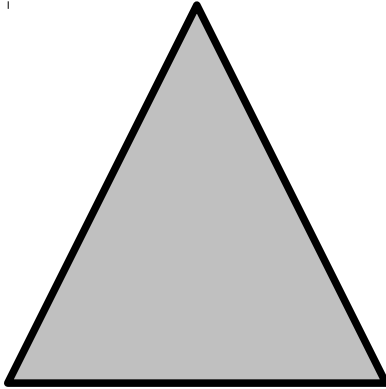
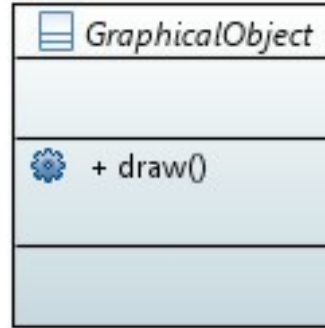
**Prof. Dr. Dirk Riehle**

**Friedrich-Alexander University Erlangen-Nürnberg**

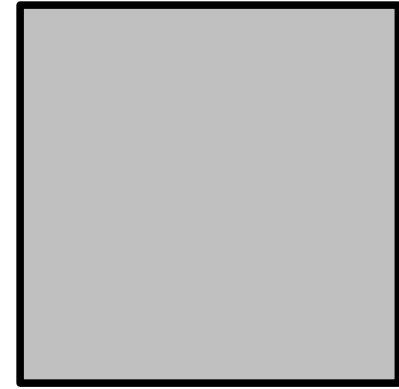
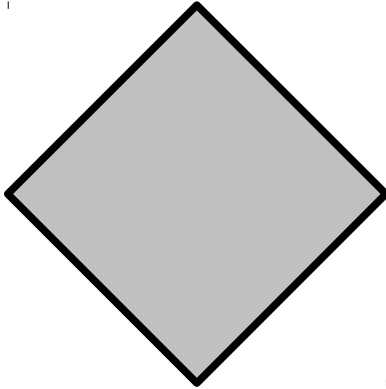
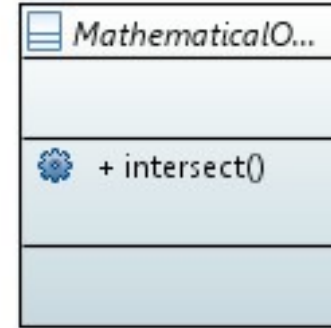
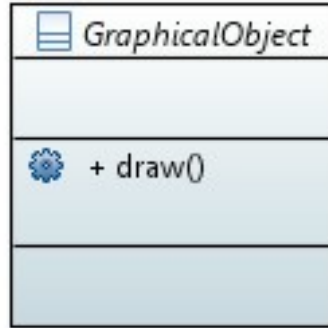
**ADAP C04**

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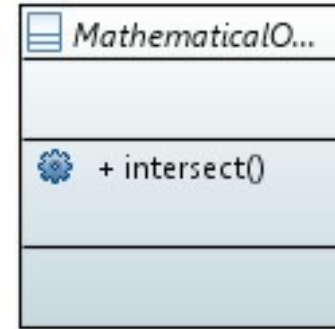
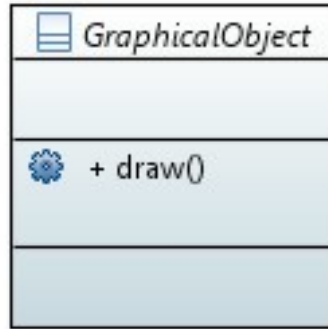
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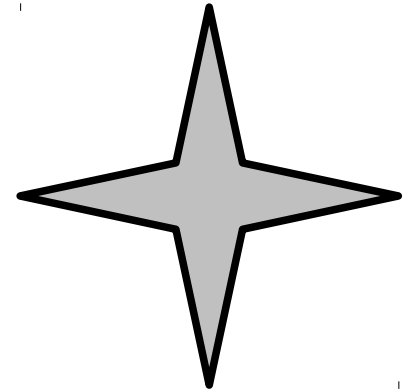
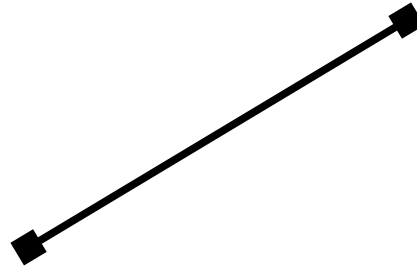
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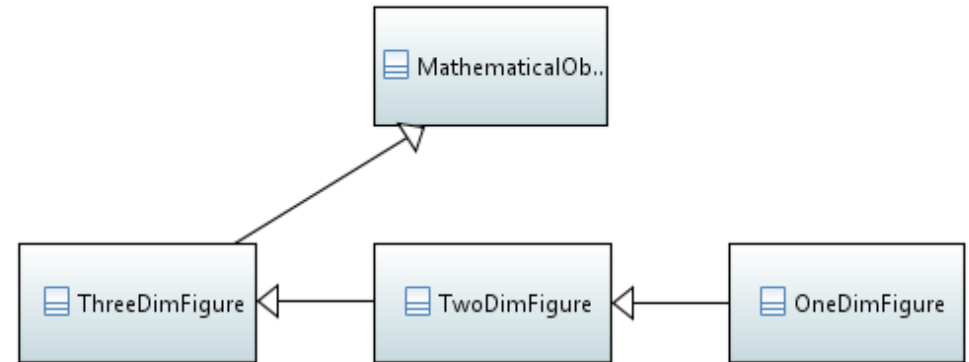
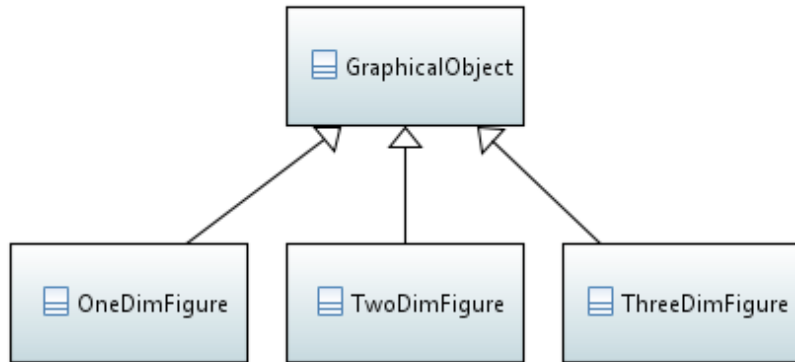
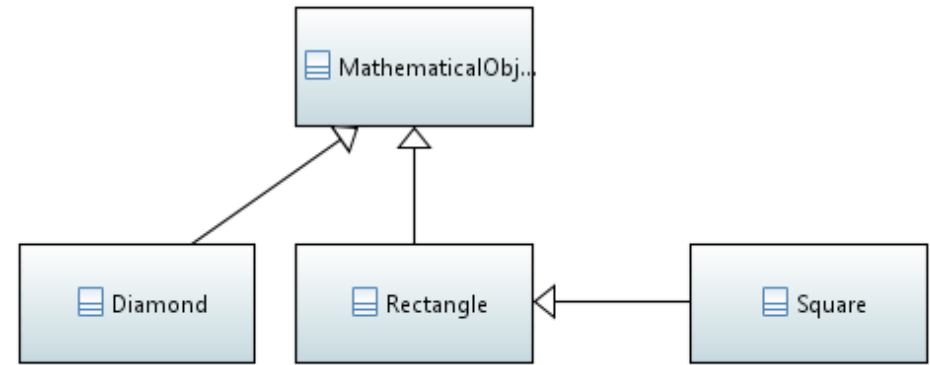
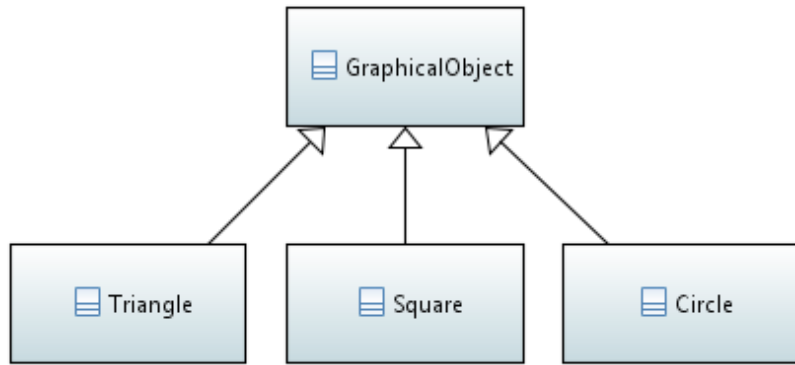
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# Subtyping Examples Discussion Continued



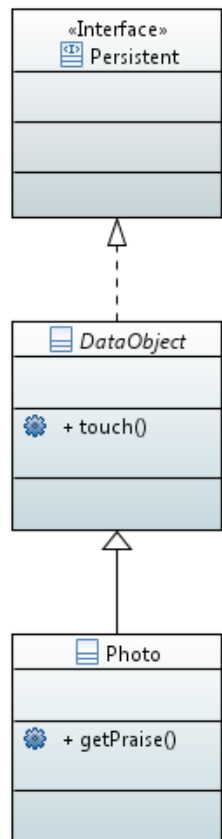
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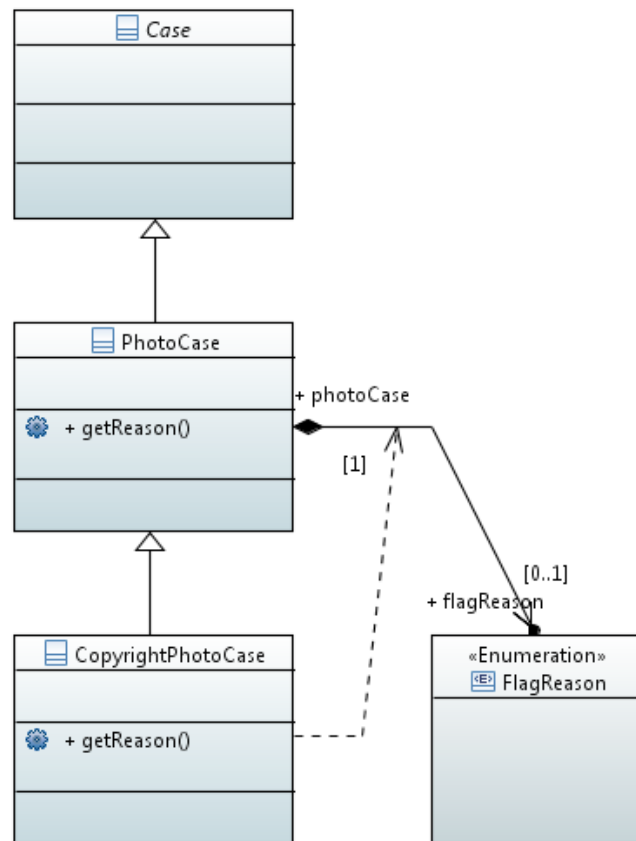


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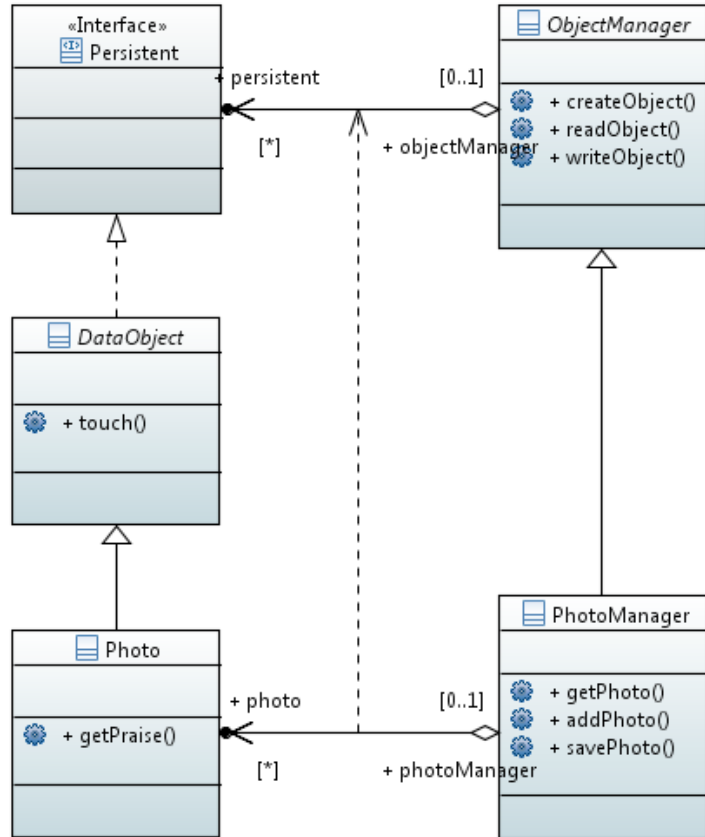
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# Dual Class Hierarchies



- Constrained subtypes
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  - PhotoManager
- Extended subtypes
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- Association refinement

# Covariance and Contravariance

- **Covariant redefinition**

- A method has been **covariantly** redefined in its result or argument types if those result or argument types are of a subclass of the original result or argument types

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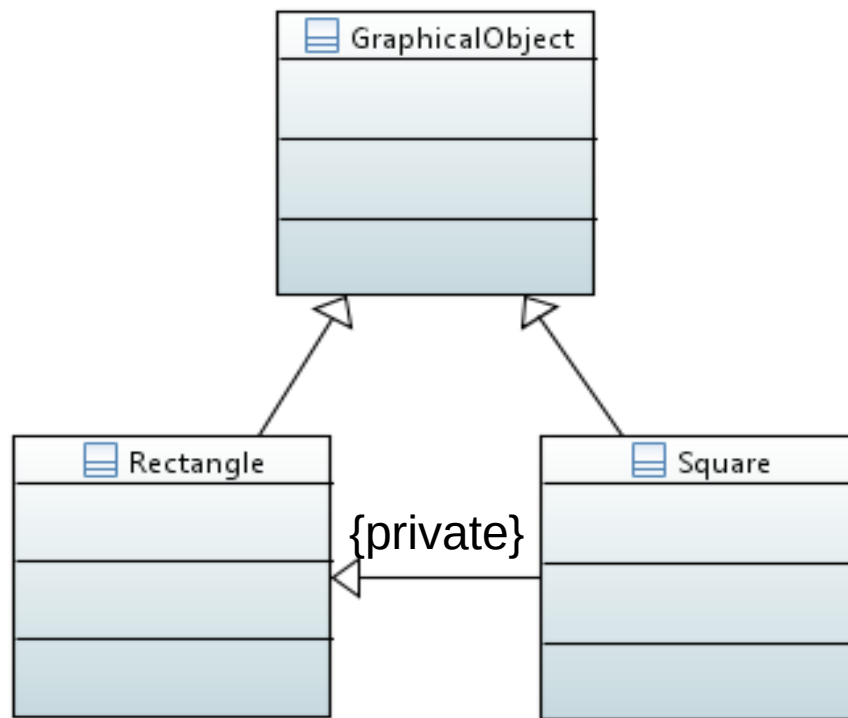
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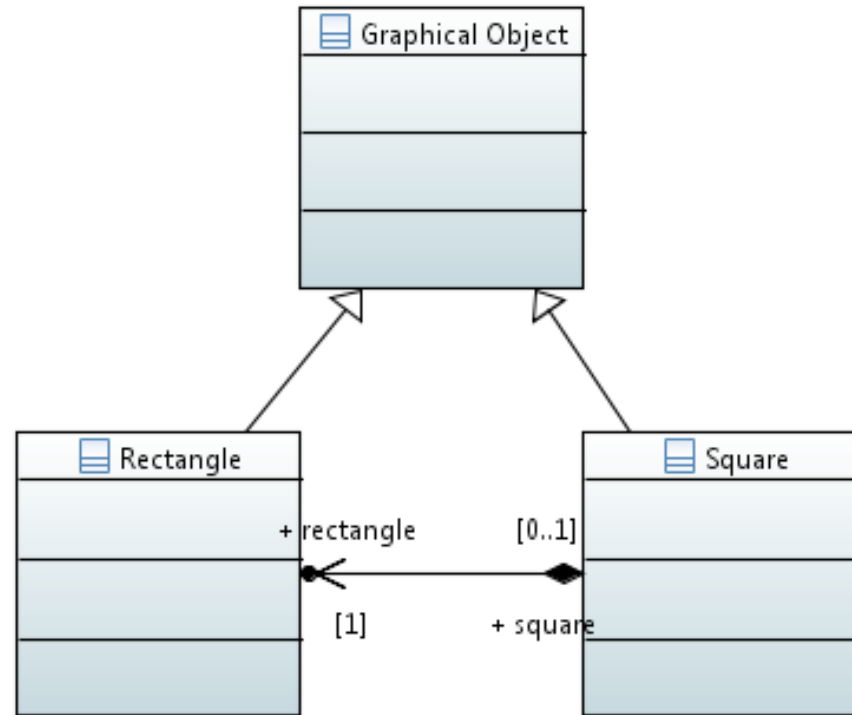
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**Not possible in Java (not a language feature)**



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**Well possible in Java (and other languages)**

# Interface vs. Implementation Inheritance

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# Inheritance and Abstractness

- Inheritance
  - Relationship between two classes, a superclass and a subclass
- Abstract(ness)
  - Relationship between a class and its instances (none if abstract)

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- By declaration
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# Corollaries to Abstract Superclass Rule

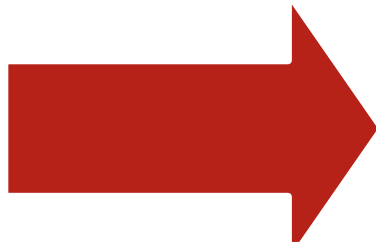
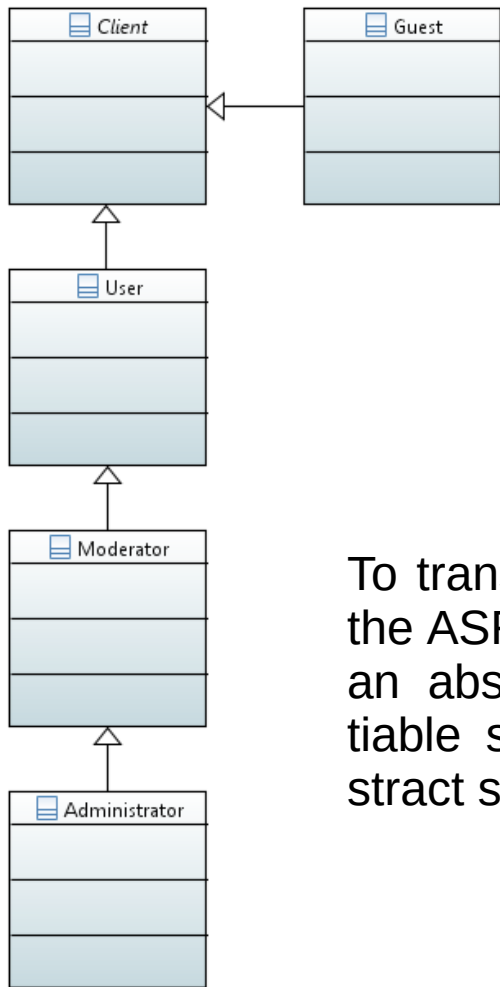
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  - No abstract class should subclass a concrete class
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- Soft corollaries (guidelines)
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- In a framework, leaf classes may be abstract
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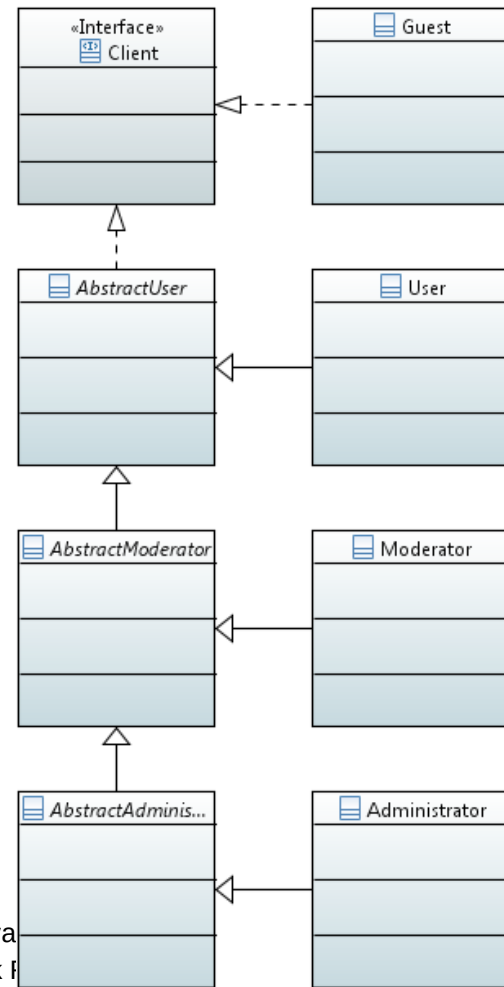
- The ASR helps comply with the LSP
  - The ASR automatically casts subclasses as constrained subtypes
    - Applying the ASR, developers have to think about subclasses
    - Subclasses fill in the holes defined by the abstract superclass
    - Thus, concrete subclasses constrain the abstract superclass
    - With this, the abstract superclass becomes better (re)usable



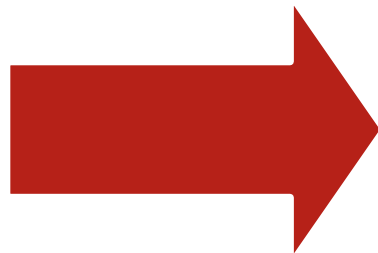
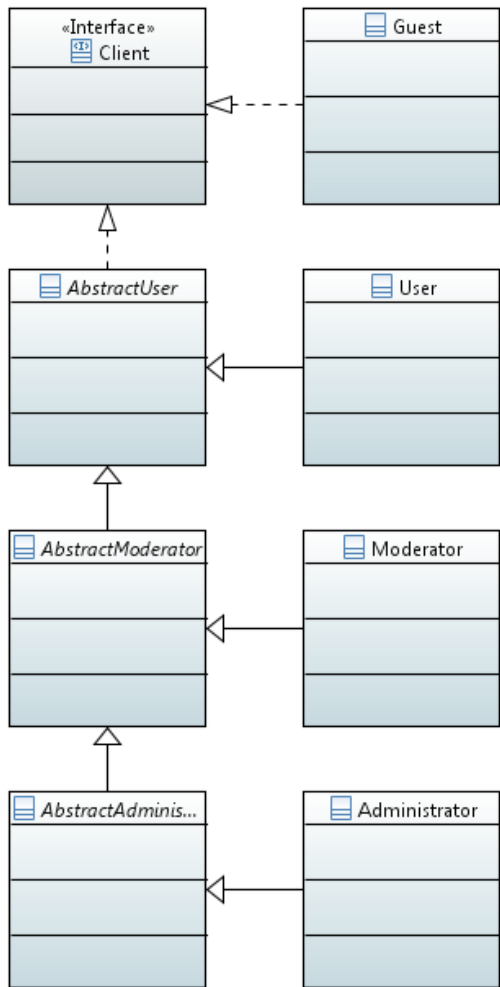
# Transforming a Class Hierarchy



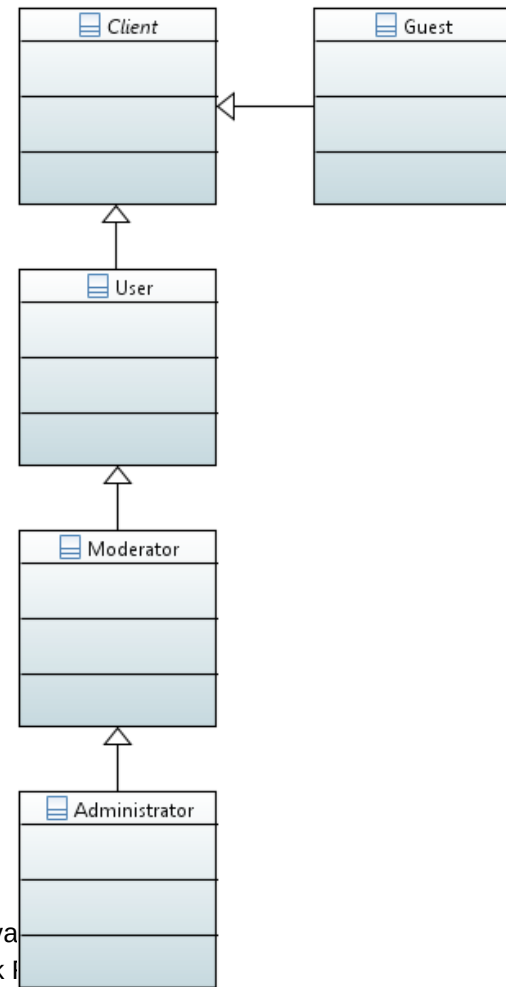
To transform a class hierarchy to conform to the ASR, split the instantiable superclass into an abstract class and introduce an instantiable subclass that completes the new abstract superclass.



# Simplifying a Class Hierarchy



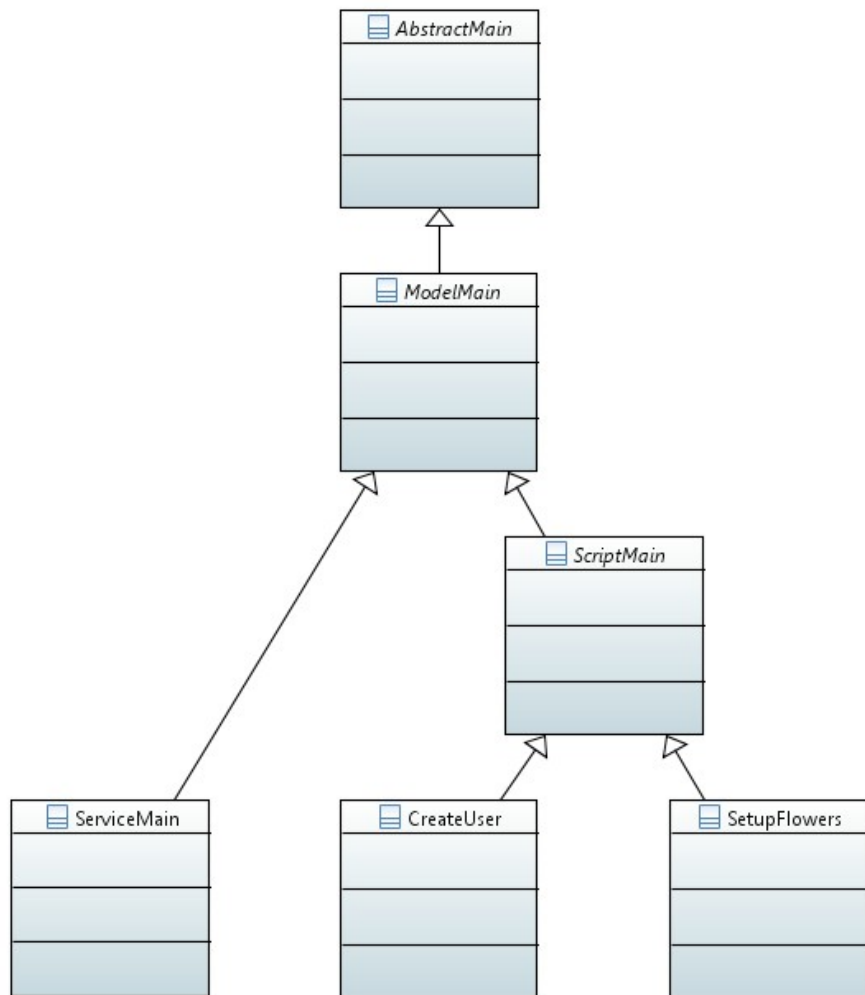
To simplify a class hierarchy, merge a default implementation with its abstract super-class.



# What to Use When?

- Transform to conform in preparation for
  - increasingly complex default implementation class
  - other implementation classes as alternatives
- Simplify (and not conform) to
  - reduce number of overall classes
  - assuming implementation class is basically empty

# Cascading Inheritance Interfaces



- **ServiceMain#startUp()** →
  - **ModelMain#startUp()** →
    - **AbstractMain#startUp()**
- **ServiceMain#shutDown()** →
  - **ModelMain#shutDown()** →
    - **AbstractMain#shutDown()**
- **CreateUser#execute()** →
- **ScriptMain#execute()**

# Cascading Superclass Calls

```
public void ServiceMain#startUp(boolean ip, String rd) ... {  
    super.startUp(ip, rd);  
    log.info("ModelMain#startUp() completed");  
  
    log.config(LogBuilder.createSystemMessage()...);  
    initWebPartTemplateService();  
    ...  
}
```

```
protected void ModelMain#startUp(boolean ip, String rd) ... {  
    super.startUp(ip);  
    log.info("AbstractMain#startUp() completed");  
  
    log.config(LogBuilder.createSystemMessage()...);  
    initImageStore();  
    ...  
}
```

```
protected void AbstractMain#startUp(boolean ip) throws Exception {  
    isInProduction = ip;  
}
```

# Traditional Run vs. ServletContext

```
public static main(String[] argv) { new FlowersMain.run() }

void FlowersMain#run() {
    ...
    startUp();
    execute();
    shutDown();
    ...
}
```

```
public void contextInitialized(ServletContextEvent sce) {
    ...
    serviceMain.startUp(true, rootDir);
    ...
}
public void contextDestroyed(ServletContextEvent sce) {
    ...
    serviceMain.shutDown();
    ...
}
```

# Review / Summary of Session

- Typing and subtyping
  - Liskov Substitutability Principle (LSP)
- Class hierarchies
  - Abstract Superclass Rule (ASR)
  - Interface vs. implementation inheritance
  - Types of class hierarchies

# Thank you! Questions?

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**[dirk@riehle.org](mailto:dirk@riehle.org) – <http://dirkriehle.com> – [@dirkriehle](#)**



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- Contributions
  - ...

# Subtyping and Inheritance

**Prof. Dr. Dirk Riehle**

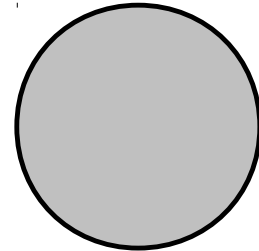
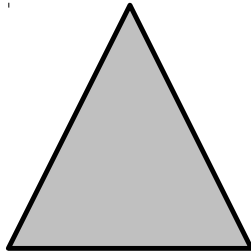
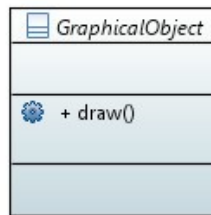
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**ADAP C04**

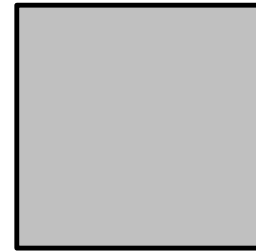
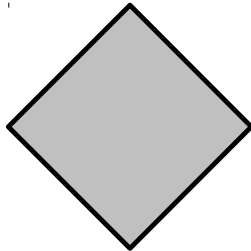
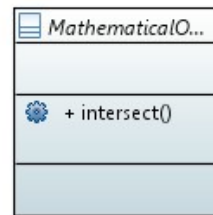
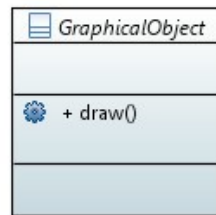
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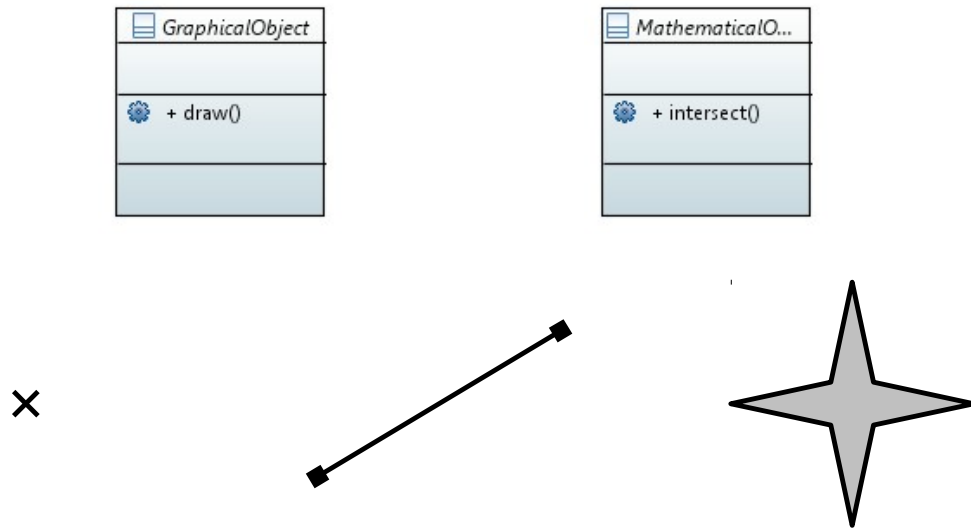
## Subtyping Examples 1 / 3



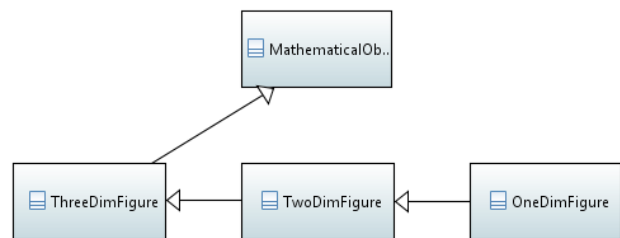
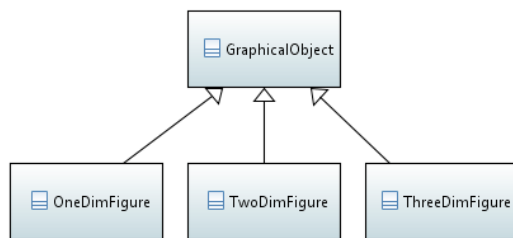
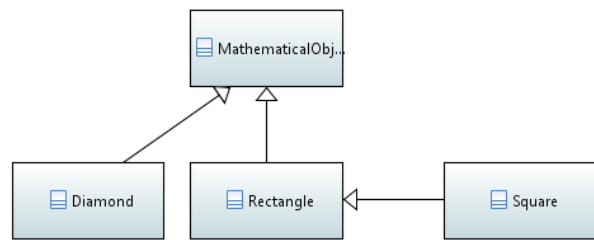
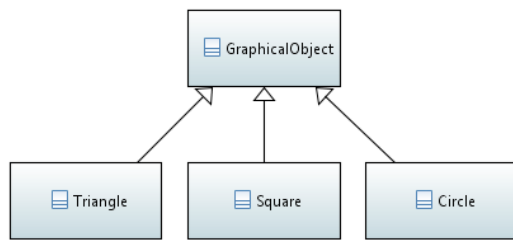
## Subtyping Examples 2 / 3



## Subtyping Examples 3 / 3



## Subtyping Examples Discussion Continued



## The Subtype Requirement [LW94] [1]

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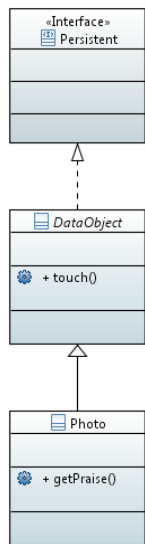
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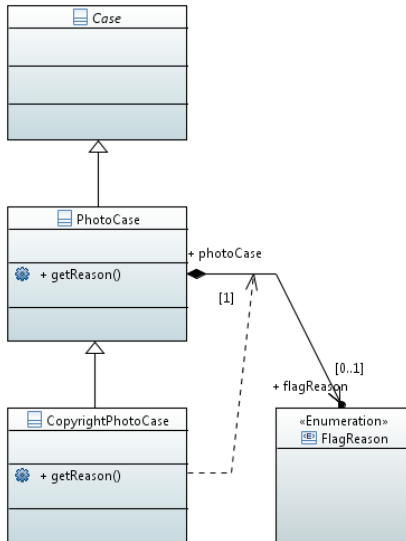
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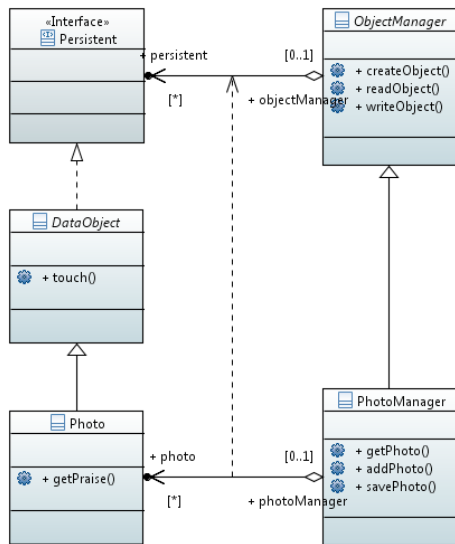
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  - ObjectManager
  - PhotoManager
- Extended subtypes
  - DataObject
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  - A method has been **covariantly** redefined in its result or argument types if those result or argument types are of a subclass of the original result or argument types
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## Covariance of Method Result Types

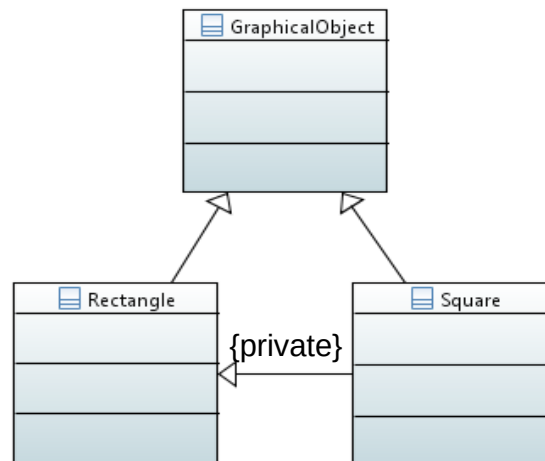
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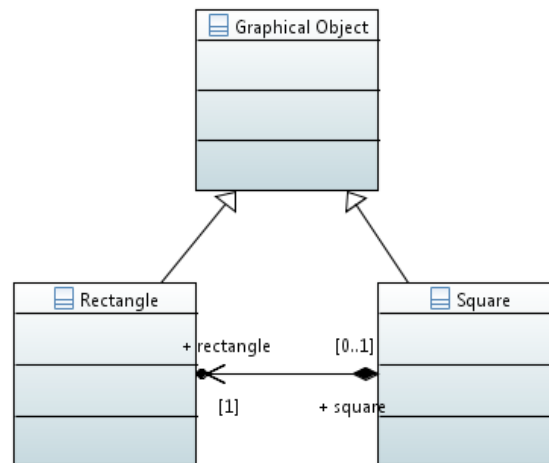


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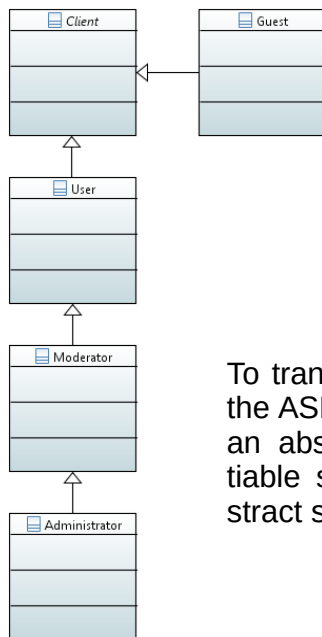
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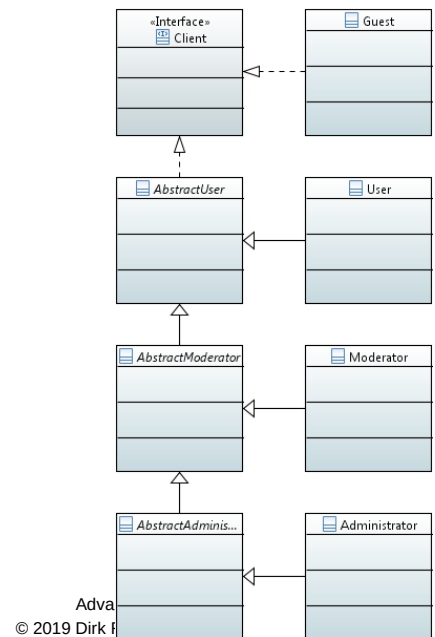
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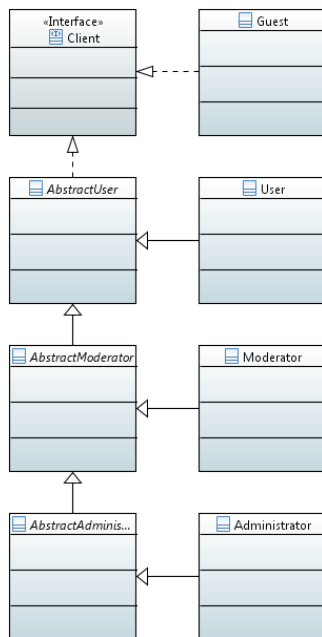
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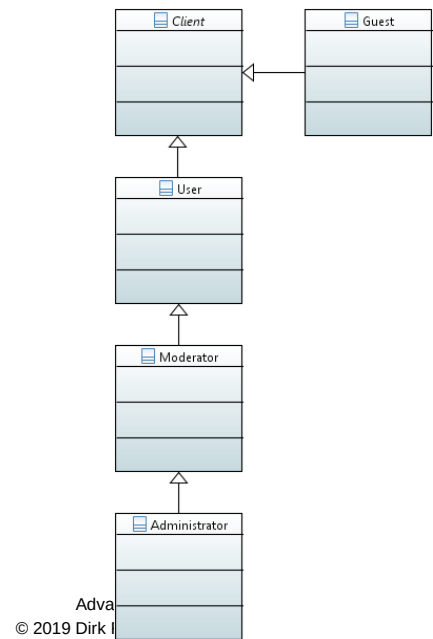
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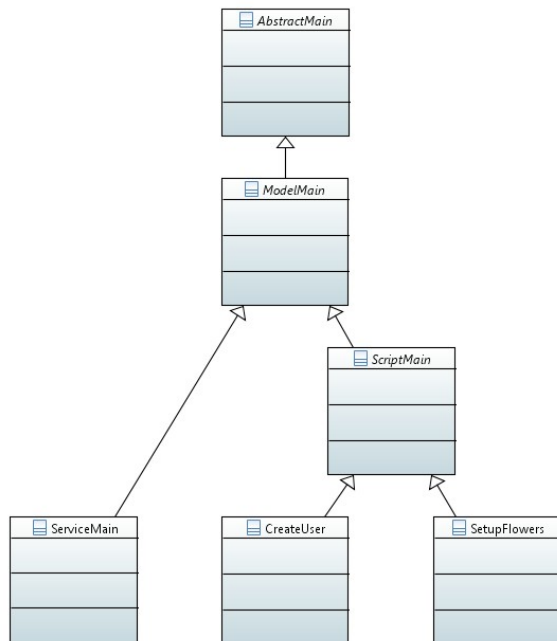
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```
protected void ModelMain#startUp(boolean ip, String rd) ... {  
    super.startUp(ip);  
    log.info("AbstractMain#startUp() completed");  
  
    log.config(LogBuilder.createSystemMessage());  
    initImageStore();  
    ...  
}
```

```
protected void AbstractMain#startUp(boolean ip) throws Exception {  
    isInProduction = ip;  
}
```

## Traditional Run vs. ServletContext

```
public static main(String[] argv) { new FlowersMain.run() }  
  
void FlowersMain#run() {  
    ...  
    startUp();  
    execute();  
    shutDown();  
    ...  
}
```

```
public void contextInitialized(ServletContextEvent sce) {  
    ...  
    serviceMain.startUp(true, rootDir);  
    ...  
}  
public void contextDestroyed(ServletContextEvent sce) {  
    ...  
    serviceMain.shutDown();  
    ...  
}
```

## Review / Summary of Session

- Typing and subtyping
  - Liskov Substitutability Principle (LSP)
- Class hierarchies
  - Abstract Superclass Rule (ASR)
  - Interface vs. implementation inheritance
  - Types of class hierarchies



# Thank you! Questions?

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DR

## Credits and License

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  - ...