Jin L.C. Guo

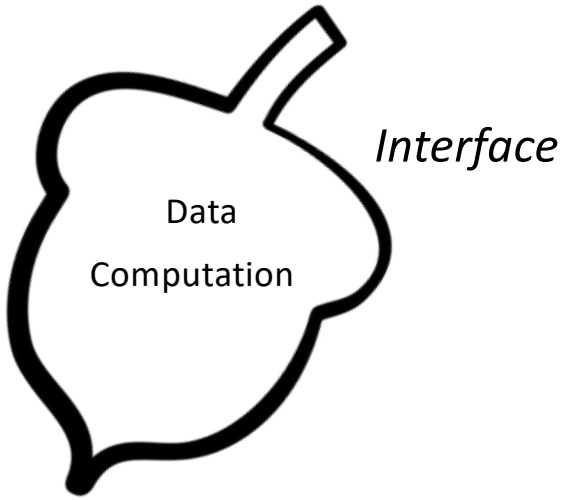
M2 (a) - Types and Polymorphism

Image Source: https://upload.wikimedia.org/wikipedia/commons/2/2b/Cepaea_nemoralis_active_pair_on_tree_trunk.jpg

Objective

- Interface type vs a class's interface;
- Subtype polymorphism
- Separation of concerns
- UML Class Diagrams

Object Interaction



Supply the service through interface

Activity 1:

- Evaluate the design of Class **Tokenizer**, which split input text into individual words (tokens), is it easy to be used or reused?

```
class Tokenizer {
   public Tokenizer(InputStreamReader reader) {…}
   public void readNextLine() throws IOException {…}
   public int numTokens() {…}
   public String getToken(int tokenPos) {…}
}
```

Standard Deck of 52 Cards

```
public final class Deck
{
  private  Stack<Card> aCards = new Stack<>();
  ...

  public Deck( Deck pDeck ) {...}

  public void shuffle() {...]
  public Card draw() {...}
  public boolean isEmpty() {...}
}
```

```
class Game
{
  Deck aDeck;
  ……
}
```

If we are building a library?

- User want to use the services to their own code for drawing cards

  not 52 cards
  don’t need to be shuffled

  isEmpty()
  draw() are all they need!

Java Interface

- Specification of related methods
- Reference to invoke those methods
- No implementation yet (except default and static methods)

```
public interface CardSource {
    /*
    * Remove a card from the source and return it.
    *
    * @return The card that was removed from the source
    * @pre !isEmpty()
    */
    Card draw();
    /*
    * @return True if there is not card in the source.
    */
    boolean isEmpty();
}
```

Subtype Relationship

```
public class Deck implements CardSource
```

```
CardSource source = new Deck();

if(!source.isEmpty())
        source.draw();
```

1. Deck need to provide implementation of methods in CardSource
2. Objects of Deck can be referred using variables of type CardSource.

Deck is-a **CardSource** (subtype relation)

```
public class StandardDeck implements CardSource

public class TwoDeck implements CardSource

public class ClubDeck implements CardSource

public class OrderedDeck implements CardSource
```

Polymorphic **CardSource**

Extensibility

Loosely coupling

Program to the interface

```
public static List<Card> drawCard(CardSource source, int pNumber)
{
    List<Card> result = new ArrayList<>();
    for(int index = 0; index<pNumber && !source.isEmpty(); index++)
    {
        result.add(source.draw());
    }
    return result;
}
```

Polymorphism

- Many + Forms
- In programming languages, it's the ability to present the same interface for different underlying types.

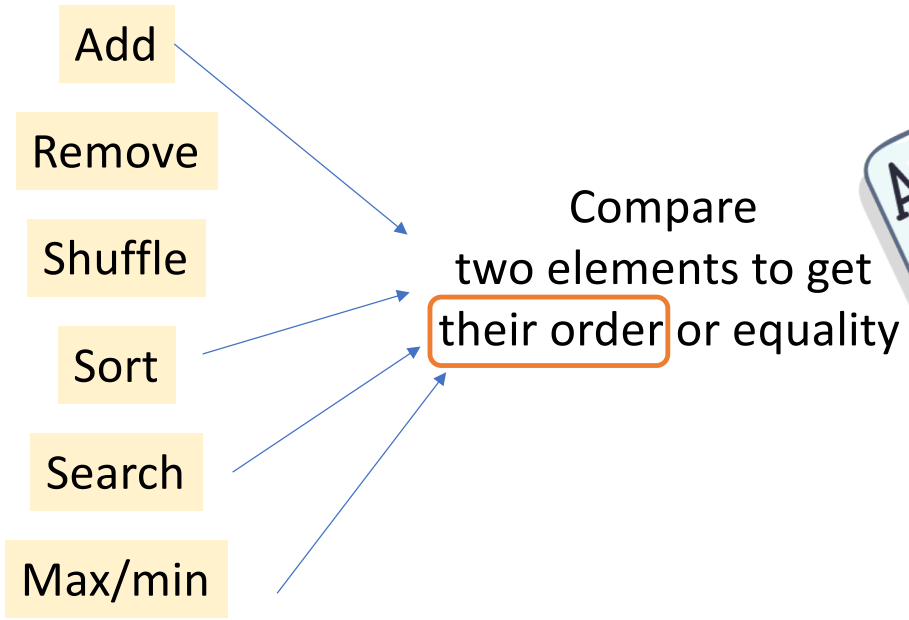
"*Colour polymorphism is likely to be disadvantageous to some populations and species due to genetic architecture and morph interactions*", Griffith Ecology Lab (https://griffithecology.com/)

Specifying Behavior with Interface

- What to separate?
- What to specify?

Collection

Collections



Information leaking

a design knowledge is reflected in many modules

Java Comparable Interface

- This interface imposes a total ordering on the objects of each class that implements it.

```
public interface Comparable<T>
{
        int compareTo(T o);
}
```

Generics: mechanism that takes type as parameter

Specification of Comparable

- Compares this object with the specified object for order.

- Returns a negative integer, zero, or a positive integer as this object is less than, equal to, or greater than the specified object.

- Also properties of implementor needs to ensure, for example:

  (x.compareTo(y)>0 && y.compareTo(z)>0) implies x.compareTo(z)>0

Client

```
if(object1.compareTo(object2) >0) /*...*/
```

Implements Comparable

```
Collections.sort(aCards);// aCards is a List<Card> instance
```

```
public class Card implements Comparable<Card>
{

 … …


    @Override
    public int compareTo(Card pCard)
    {
    … …   return aRank.compareTo(pCard.aRank);
    }
}
```

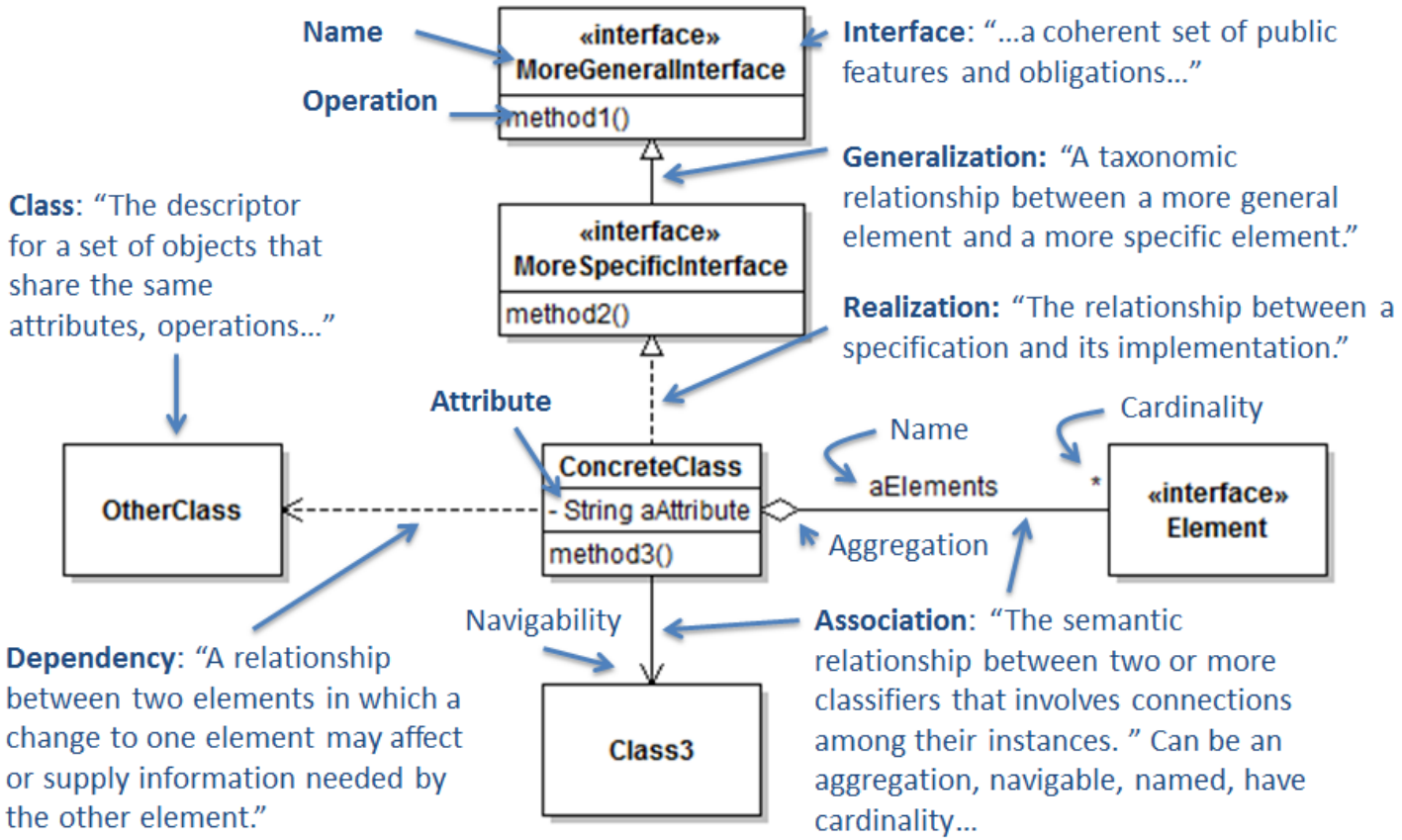
The base class of all Java language enumeration types has implemented `Comparable<E>`

Separation of Concern

- Concern: anything that matters in providing a solution to a problem
- Prevent information Leakage.
- To achieve “orthogonality”: changes in one doe not affect any of the others.

UML Class Diagram

- Represent Type (mainly classes and interfaces) definitions and relations
- *Static* view (cannot show *run-time* properties)
- Use the tool JetUML for this class.


Name
«interface»
MoreGeneralInterface
Operation
method1()
Interface: "...a coherent set of public features and obligations..."
Generalization: "A taxonomic relationship between a more general element and a more specific element."
«interface»
MoreSpecificInterface
method2()
Realization: "The relationship between a specification and its implementation."
Class: "The descriptor for a set of objects that share the same attributes, operations..."
Attribute
Cardinality
Name
ConcreteClass
aElements
*
«interface»
Element
OtherClass
- String aAttribute
method3()
Aggregation
Navigability
Association: "The semantic relationship between two or more classifiers that involves connections among their instances. " Can be an aggregation, navigable, named, have cardinality...
Dependency: "A relationship between two elements in which a change to one element may affect or supply information needed by the other element."
Class3

Activity 2: Class Diagram for Deck

- Draw the class diagram for a standard deck class including functions of shuffling, drawing, and sorting.

Class Diagram for Deck