Lecture 10

Representation Invariants

Representation invariant: Object → Boolean

- Indicates whether a data structure is well-formed
- Defines set of valid values for the data structure
- Specified inside the implementation, not the specification

ex. Rep Invariant for CharSet data type from last class

```
class CharSet{
// Rep invariant: elts has no nulls and no duplicate characters
    private List<Character> elts;
}
```

Representation Exposure

- Do not expose the representation outside the class
- Violates rep invariant and abstraction boundaries

Should ADT implementation check that the rep invariant holds?

- Yes: if not expensive to the program
- Yes: for debugging
- Yes: for all public methods
- No: if the method is private (private methods are a part of the implementation)

Best practice: Check on entry of a method and exit of a method

```
public void delete(Character c) {
    checkRep();
    elts.remove(c);
    CheckRep();
}

private void checkRep() {
    for (int i = 0; i < elts.size(); i++) {
        assert elts.indexOf(elts.elementAt(i)) == i;
    }
}
```

Procedure:

1. First, constructor needs to satisfy invariant.
2. For each public method of ADT
   - Assume that rep invariant holds at beginning of method
   - "Prove" that rep invariant holds at end of method (if it terminates)
   - Only necessary for methods that can mutate the rep invariant

ex. proving rep invariant holds at end of method

```
// Rep invariant: elts has no nulls and no duplicates
public void insert(Character c) {
    // Use member() method to check if c exists
    if (c != null && !elts.contains(c)) { elts.add(c); }
}
```

if elts has no nulls at beginning, it has no nulls at the end, AND if elts has no duplicates at the beginning, it has no duplicates at the end

Abstraction Function

Maps concrete representation to abstract value it represents

Takes high level view of ADT, tells you how to generate the representation

$$\text{AF} : \text{Object} \rightarrow \text{Abstract Value}$$

$$\text{AF}(\text{CharSet this}) = \{c \mid c \text{ is contained in this.elts}\}$$