AP® Computer Science A Elevens Lab Student Guide

The AP Program wishes to acknowledge and thank the following individuals for their contributions in developing this lab and the accompanying documentation.
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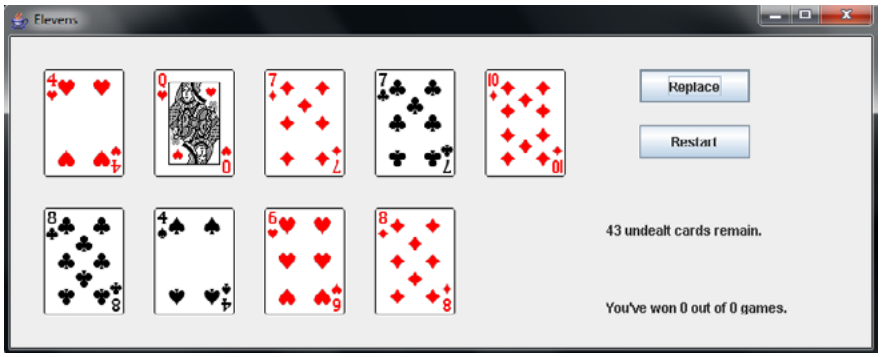
Elevens Lab Student Guide

Introduction

The following activities are related to a simple solitaire game called Elevens. You will learn the rules of Elevens, and will be able to play it by using the supplied Graphical User Interface (GUI) shown at the right. You will learn about the design and the Object Oriented Principles that suggested that design. You will also implement much of the code.



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Activity 8: Using an Abstract Board Class

Introduction:

The Elevens game belongs to a set of related solitaire games. In this activity you will learn about some of these related games. Then you will see how inheritance can be used to reuse the code that is common to all of these games without rewriting it.

Exploration: Related Games

Thirteens

A game related to Elevens, called *Thirteens*, uses a 10-card board. Ace, 2, … , 10, jack, queen correspond to the point values of 1, 2, …, 10, 11, 12. Pairs of cards whose point values add up to 13 are selected and removed. Kings are selected and removed singly. Chances of winning are claimed to be about 1 out of 2.

Tens

Another relative of Elevens, called *Tens*, uses a 13-card board. Pairs of cards whose point values add to 10 are selected and removed, as are quartets of kings, queens, jacks, and tens, all of the same rank (for example, K♠, K♥, K♦, and K♣). Chances of winning are claimed to be about 1 in 8 games.

Exploration: Abstract Classes

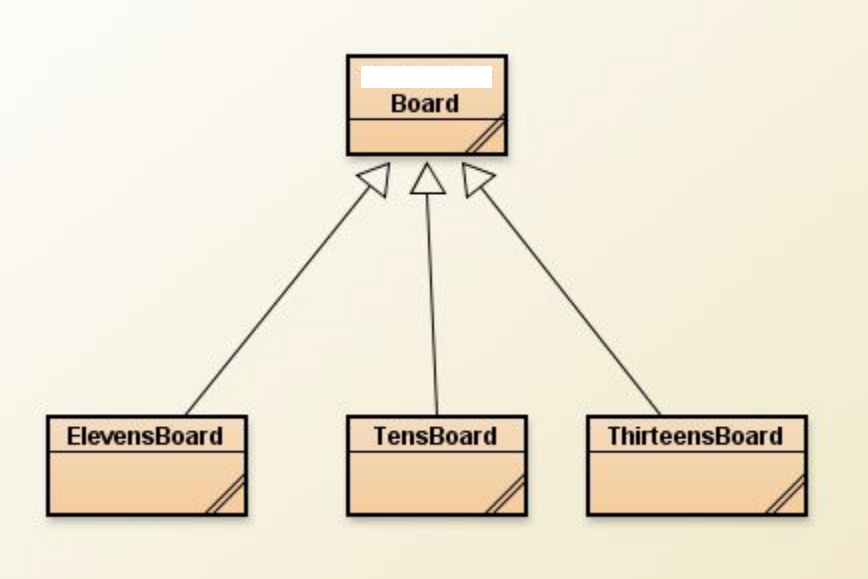
In reading the descriptions of Elevens and its related games, it is evident that these games share common state and behaviors. Each game requires:

- State (instance variables) — a deck of cards and the cards "on the" board.
- Behavior (methods) — to deal the cards, to remove and replace selected cards, to check for a win, to check if selected cards satisfy the rules of the game, to see if there are more legal selections available, and so on.

With all of this state and behavior in common, it would seem that inheritance could allow us to write code once and reuse it, instead of having to copy it for each different game.

But how? If we use the "IS-A" test, a `ThirteensBoard` "IS-A" `ElevensBoard` is not true. They have a lot in common, but an inheritance relationship between the two does not exist. So how do we create an inheritance hierarchy to take advantage of the commonalities between these two related boards?

The answer is to use a common superclass. Take all the state and behavior that these boards have in common and put them into a new `Board` class. Then have `ElevensBoard`, `TensBoard`, and `ThirteensBoard` inherit from the `Board` class. This makes sense because each of them is just a different kind of board. An `ElevensBoard` "IS-A" `Board`, a `ThirteensBoard` "IS-A" `Board`, and a `TensBoard` "IS-A" `Board`. A diagram that shows the inheritance relationships of these classes is included below.



Let's see how this works out for dividing up our original `ElevensBoard` code from Activity 7. Because all these games need a deck and the cards on the board, all of the instance variables can go into `Board`. Some methods, like `deal`, will work the same for every game, so they should be in `Board` too. Methods like `containsJQK` are Elevens-specific and should be in `ElevensBoard`. So far, so good.

Note: abstract classes are not part of AP Exam and we will be doing this lab slightly differently.

But what should we do with the `isLegal` and `anotherPlayIsPossible` methods? Every Elevens-related game will have both of these methods, but they need to work differently for each different game. That's exactly why Java has `abstract` methods. Because each of these games needs `isLegal` and `anotherPlayIsPossible` methods, we include those methods in `Board`. However, because the implementation of these methods depends on the specific game, we make them `abstract` in `Board` and don't include their implementations there. Also, because `Board` now contains `abstract` methods, it must also be specified as `abstract`. Finally, we override each of these `abstract` methods in the subclasses to implement their specific behavior for that game.