Faculty of Engineering, Alexandria University   Year: 2nd year
CS 221: PROGRAMMING-2   Duration: 180 Minutes
Dept. of Computer and Systems Engineering   Final Exam: 2017

answer ALL questions:

It is required to build a *score recording* system for tennis games. The tennis referee, as shown in Figure 1, uses a tablet to give the *point* either to player 1 or player 2 incase of single (or team 1 or team 2 in case of double) at the end of the ball exchange. The system keeps track of the score according to the tennis scoring rules, found in appendix I. After the end of each ball exchange, the system pops out a message concerning the score for the referee to speak out loud to the players and spectators. The message follows the rules explained in appendix I. The system keeps track of which player has the *serve* (i.e., starting the ball exchange). The tennis score board, illustrated in Figure 2, is connected to your system to display the results. Nowadays, the tennis score board is a small PC with a huge monitor. Other result consumers, such as TV sports channels (Figure 3), should be able to connect to your system and keep their displayed score in-sync (*LIVE*) with each score change done by the referee.

Astonishingly, ping pong, volleyball, and beach volleyball have similar scoring concepts, e.g., match, set, game, serving, etc. Yet, the devil hides in details. Each sport has its different rules for counting scores.

Now, it is desired to extend your score recording system to include these *sports* as well. At the beginning of the game, the referee chooses the desired sport (tennis, ping pong, volleyball, or beach volleyball) and the system loads the right set of scoring rules.

For the sake of simplicity, assume that your score recording system, the score board at the stadium and the results displayed on the TV are *one* virtual system. In other words, do not bother yourself about the physical communication between these systems. Consider these systems to be all running under one Java virtual machine.

Figure 1. Tennis referee using your system.

Figure 2. Tennis score board. Note the yellow dot indicating who is serving right now.
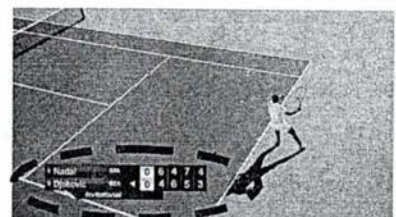

Figure 3. Results displayed on the sports channel. Note that it displays the same sort of data as in figure 2 but in different format.

Question 1 (10 grades):
Draw a simple use case diagram illustrating the interaction between the referee, your system, and the result displaying systems.

Question 2 (15 grades):
Which design principle would you use to isolate the various components displaying the results from the tennis scoring logic?
Explain your chosen design principle with the help of a simple block diagram.

Question 3 (25 grades):
Identify at least:
- 1 creational design patterns,
- 1 structural design pattern, and
- 3 behavioral design patterns.

Explain briefly (2-3 sentences) the usage of each design pattern in the system.

Question 4 (5 grades):
Identify one use for the *Immutable* design pattern in your solution.
Explain its usage briefly (2-3 sentences).

Question 5 (20 grades):
Draw a detailed UML class diagram for each of the design patterns you applied in Questions 3 and 4.

Question 6 (15 grades):
Draw the state diagram for a normal *game (not a tie breaker-game)*.

GOOD LUCK

Khaled Nagi

Appendix I: Tennis scoring system (source Wikipedia)

A _tennis_ match is composed of _points_, _games_, and _sets_. A match is won when a player or a doubles team wins the majority of prescribed sets. Traditionally, matches are either a best of three sets or best of five sets format.

A set consists of a number of _games_ (a minimum of six), which in turn consist of _points_, with a tiebreak played if the set is tied at six games per player. Tennis scoring rests on the premise that serving is advantageous over receiving, hence it is only possible to win a set or match by breaking the opponent's serve game at least once, before a tiebreak is required. Likewise, it is not possible to win a tiebreak without winning at least one point during an opponent's turn at serve (called a mini-break).

Serving is moved to the opponent after each game.

Game score

A game consists of a sequence of points played with the same player serving, and is won by the first player to have won at least four points by two points or more over their opponent. In scoring an individual standard game of tennis, the server's score is always called first and the opponent's score second. Score calling is unique to the sport of tennis in that each point has a corresponding call that is different from its point value.

Number of points won	Corresponding call[1]
0	"love"
1	"15"
2	"30"
3	"40"
4	"game"

When players are tied by one or two points, the score is described as "15-all" and "30-all" respectively. However, if each player has won three points, the score is described as "**deuce**". From this point on, whenever the score is tied, it is described as "deuce" regardless of how many points have been played.

In standard play, scoring beyond a "deuce" score, in which both players have scored three points each, requires that one player must get two points ahead in order to win the game. This type of tennis scoring is known as "advantage scoring" (or "ads"). In this type of scoring, the player who wins the next point after deuce is said to have the **advantage**. If the player with advantage loses the next point, the score is again deuce, since the score is tied. If the player with the advantage wins the next point, that player has won the game, since the player now leads by two points. The referee announces the score in this format "advantage player 1".

The current point score is announced orally before each point by the referee. When stating the score, the server's score is stated first. If the referee announces the score as "30–love", for example, it means that the server has won two points and the receiver none.

The table below shows the scoring for _tie breaks_:

Tie break point score examples	Corresponding call
3–4	
4–3	
4–4, 5–5, 6–6, etc.	
4–7	"set"

Set score

Description

In tennis, a set consists of a sequence of games played with alternating serve and return roles. There are two types of set formats that require different types of scoring.

- An *advantage set* is played until a player wins 6 games and that player or team has a 2-game lead over his opponent. The set continues, without tiebreak(er), until a player or team wins the set by 2 games. OR

- A *tie-break set* is played with the same rules as the advantage set, except when the score is tied at 6–6, a tie-break game (or tiebreaker) is played. Typically, the tie-break game continues until one player wins seven points by a margin of two or more points.

The score of games within a set is counted in the ordinary manner, except when a player has a score of no games it is read as "love". The score is written using digits separated by a dash. This score is announced by the referee at the start of each game.

Example set scores	Corresponding verbal set score
0–0	"love – love"
3–6	"set"

In doubles, service alternates between the teams. One player serves for an entire service game, with that player's partner serving for the entirety of the team's next service game. Players of the receiving team receive the serve on alternating points, with each player of the receiving team declaring which side of the court (deuce or ad side) they will receive serve on for the duration of the set.

Scoring a tiebreak game

At a score of 6–6, a set is often determined by one more game called a "twelve point tiebreaker". Only one more game is played to determine the winner of the set; the score of the set is always 7–6 (or 6–7). Points are counted using ordinary numbering. The set is decided by the player who wins at least seven points in the tiebreak but also has two points more than his opponent. For example, if the score is 6 points to 5 points and the player with 6 points wins the next point, he or she wins the tiebreak and the set. If the player with 5 points wins the point, the tiebreak continues and cannot be won on the next point, since no player will be two points better than his opponent.

Match score

Description

Most singles matches consist of an odd number of sets, the match winner being the player who wins more than half of the sets. The match ends as soon as this winning condition is met. Men's singles and doubles matches may consist of up to five sets (the winner being the first to take the majority of total allocated sets) while women's singles matches are usually best of three sets.

The score of a complete match may be given the scores of each set given separately. The match winner's score is stated first. For example, Federer won by "6–4, 6–7, 6–4, 6–2". This match was won three sets to one, with the match loser winning the second set on a tiebreaker.