

COMP202 Winter 2005 Assignment #2

Distributed: **Jan 25**, Due: **Feb 8**

For the sake of the environment, please don't print this assignment – just view it online.

1 Golf Practice Range

In this assignment you will create a program to simulate a golf practice range. Your program will...

- show the user a listing of example player types
- ask the user for his/her golfing ability (a number between 0.1 and 1.0)
- determine a random vertical and horizontal distance to the target
- show the user a listing of golf clubs
- prompt the user for his/her choice of golf club (a code such as "3w", for 3 wood)
- show the user a listing of swing strengths
- prompt the user for his/her desired swing strength (a number between 0.1 and 1.0)
- calculate the flight time of the ball until it first hits the ground
- report the distance to where the ball first hit the ground
- generate a random extra bounce distance
- report the total horizontal distance covered by the ball (including bounce)
- report the distance away from the target

You will need to use the Scanner, Random, DecimalFormat, and Math classes to create this program. All the output should be nicely formatted, as in the example output below. Floating point numbers must be formatted to **one or two** decimal places, as in the example output. You can assume that the "type" of user input is correct (ie. a floating point number will be entered when it is expected), but you must check that it is within the range expected; that is, if you're expecting a floating point number, you can expect to get one, but if you're expecting it to be greater than zero and less than one and it isn't then you must set a default. You will need to implement error checking for all three inputs.

You must keep the vertical offset between 0 (inclusive) and 1.0 (exclusive) meters above or below the golfer's position. Unfortunately, you must assume the ball **always** lands at its target vertical offset.

Your output must be given in both meters and yards when discussing horizontal distances to target, as in the example output below.

The random magnitude of the horizontal offset (the distance to target) must be between 30 and 330 yards (inclusive).

The clubs that you are to make available to the user must have the properties listed in table 1. The "loft" is the club-face angle (the angle of rise); the "yardage" is the maximum distance in yards that Tiger Woods could hit a ball using the corresponding club; the "code" is the character string that the user will have to type in order to select a particular club.

name	loft (in degrees)	yardage	code
1 wood	13.0	300	1w
3 wood	15.0	265	3w
3 iron	16.5	240	3i
4 iron	17.5	227	4i
5 iron	19.0	213	5i
6 iron	20.5	200	6i
7 iron	22.5	187	7i
8 iron	25.0	173	8i
9 iron	28.0	160	9i

Table 1: Club properties.

You will have to calculate the club swing-speed coefficient for each club, which is the ratio of a given club's maximum yardage divided by Tiger's best for a 1 wood. The reason for this is that the initial ball speed will be calculated as a function of how fast Tiger Woods' 1 wood club head is moving at the instant of impact with the golf ball.

After telling the user the distance to the target (in meters and yards), including the vertical offset (just in meters), you will have to present the user with a club selection menu, as in the example output below.

After the user chooses a club (using the club code), you will have to assign that club's name, loft, and swing-speed coefficient to some generic club variables which you will use for the remainder of the source code.

The purpose of the swing-strength question is that golfers vary their swing-strength depending on club choice and the distance to target. It's rare that a golfer uses his/her full strength upon each swing.

The initial speed of the ball is calculated by relating the maximum club speed of Tiger Woods' 1 wood club head (the head of the club that he can swing fastest) to the following factors:

- club swing-speed coefficient
- the user's golfing ability
- the user's desired swing strength
- ball elasticity coefficient

Due to the properties of a 1 wood, Tiger Woods can swing the club such that the club head is moving 209 *km/h* at the instant of impact with the ball. All other clubs will be slower. The 3 wood will be only 88% as fast as the 1 wood; the 3 iron will be 80% as fast as the 1 wood; the 4 iron will be 76% as fast as the 1 wood; and each subsequent (higher numbered) iron will continue this trend (of being slower than the club before it). You may recognize these ratios when you calculate each club's swing-speed coefficient.

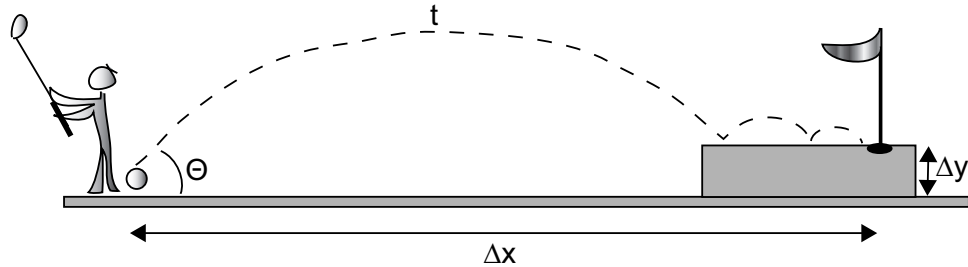
Golf balls are designed with elasticity, which means that they will blast away from the club head faster than if they were ridged, static, objects. Your program must use the ball-elasticity coefficient of 1.35, meaning that the ball will have a speed 35% faster than the club head at time of impact.

What happens to the club immediately after impact? It slows down to more than half its original speed because it has transferred its kinetic energy to the ball!

The formula for the initial ball speed is:

$$\begin{aligned}
 \text{initial speed} &= \text{max club speed by tiger woods} \\
 &\quad * \text{club swing speed coefficient} \\
 &\quad * \sqrt{\text{golfing ability}} \\
 &\quad * \sqrt{\text{swing strength}} \\
 &\quad * \text{ball elasticity coefficient}
 \end{aligned}$$

Having calculated the initial speed, you will need to use the loft of the club to determine the horizontal and vertical components of the ball's speed. Please note that the input to trigonometric functions must be in **radians**.



Physics Equations

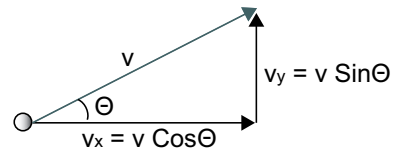
- v - initial velocity, in m/s
- v_x - horizontal component of the velocity, in m/s
- v_y - vertical component of the velocity, in m/s
- a - acceleration due to gravity at Earth's surface: $-9.81m/s^2$
- t - flight time in seconds s
- θ - angle of rise, in degrees
- Δ_x - horizontal offset, in m
- Δ_y - vertical offset, in m

$$v_x = v \cos \theta$$

$$v_y = v \sin \theta$$

$$\Delta_y = v_y t + \frac{1}{2} a t^2$$

$$\Delta_x = v_x t$$



Useful Equations

- 1 radian = $\frac{180}{\pi}$ degrees
- 1 yard = 0.9144 meters
- 1 km/h = $\frac{1000}{3600} m/s$

Quadratic Equation

Given: $at^2 + bt + c = 0$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Example output

```
=====
Welcome to the Golf Practice Range!
=====
```

What is your golfing ability?

```
-----
EXAMPLE PLAYER TYPES...
-----+-----
who          | golfing ability
-----+-----
Little Sally |          0.55
Luc Devroy   |          0.6
Grampa Golfer |         0.7
Frequent Golfer |        0.75
"The Rock"   |          0.8
Average Pro  |         0.95
Tiger Woods  |          1.0
```

Please enter a number, between 0.1 and 1.0,
corresponding to your "golfing ability" ==> 0.75

The hole is 265 meters (290 yards) away,
and 0.9 meters in height, relative to your position.

```
-----
YOUR CLUBS...
-----+-----+-----
club   | angle | code
-----+-----+-----
1 wood | 13.0 | 1w
3 wood | 15.0 | 3w
-----+-----+-----
3 iron | 16.5 | 3i
4 iron | 17.5 | 4i
5 iron | 19.0 | 5i
6 iron | 20.5 | 6i
7 iron | 22.5 | 7i
8 iron | 25.0 | 8i
9 iron | 28.0 | 9i
```

Please enter the code of the club you want to use ==> 1w

You'll be hitting with a 1 wood, which will hit
your ball at an angle of 13.0 degrees above the ground.

club	Little Sally	Frequent Golfer	Pro	Tiger Woods
1 wood	165	225	285	300
3 wood	146	200	253	267
3 iron	131	179	226	238
4 iron	...	...	...	224
5 iron	...	...	...	212
6 iron	...	...	...	199
7 iron	...	...	...	188
8 iron	...	...	...	174
9 iron	88	121	153	161

Table 2: Expected yardages by various players swinging with full strength.

Example output continued...

```
-----
SWING STRENGTHS...
-----+-----
Gentle swing | 0.1
Half strength | 0.5
Let it rip!!! | 1.0
```

How hard do you want to swing the 1 wood?

Remember that the hole is 265 meters (290 yards) away,
and 0.9 meters in height, relative to your position.

Please enter a number, between 0.1 and 1.0,
corresponding to how you want to swing the club ==> 1.0

```
Swinging the 1 wood with 1.0 strength, will launch the ball 67.9 m/s.
Your ball's flight time: 3.05 seconds
Distance to where your ball first hit the ground: 201.74 meters (220.62 yards)
Your ball bounced an extra: 5 meters!
Meters left to hole: 58 meters (63.43 yards)
```

Approximate expected yardages

While you're testing, you should override the vertical offset by setting it to zero such that you can compare your results with table 2. What's the easiest way of doing this? Well, in the section where you setup the quadratic equation coefficients, you can simply comment-out the "c" coefficient (ie. the vertical offset), like this:

```
//double c = -1 * vertical_offset;
double c = 0;
```

Why are some of the entries not included? The most important ones are the outter limits; if you achieve those, then the inner ones will be correct too.

Why are some of Tiger Woods' yardages in table 2 off by about a yard or two as compared with the yardages in table 1? The loft angles in table 1 are only approximate; secondly, there is a factor of numerical error in the calculations (such as rounding).

Additional help to get you going...

At the following URL is a file that outlines how your program may be implemented. Feel free to use it, including the comments, and add your own where you feel necessary.

<http://www.cs.mcgill.ca/~abatko/cs202/assignments/ass02/GolfPracticeRange.java>

Additional explanations will be posted at the following URL:

<http://www.cs.mcgill.ca/~abatko/cs202/assignments/ass02/explanations.txt>

Please note that "loft" is equal to the ball's rise angle; in fact the following terms are used interchangeably: loft, angle, rise angle, and theta.

Behind the scenes with Tiger Woods

How does Tiger Woods achieve a club head speed of 209 *km/h*?

The following is a version of an article from Golf Digest, entitled "The year Tiger roared; Behind the scenes of a season to remember", and written by Tim Rosaforte. It's a "version" because the units of speed were converted to kilometers per hour from miles per hour for your convenience.

If you want to see the original, access this URL:

http://www.golfdigest.com/magazines/index.ssf?/features/the_year_3z0ukggc.html

How'd he do that?

Tiger is so adroit with his golf swing that he can give ball-launch readings without even looking at the monitor, which measures clubhead speed, launch angle and spin rate. Engineers have left test sessions spellbound at Tiger's ability to know exactly where the clubhead is at impact, and what unmarked prototype ball he is using just by feel – and sometimes sound.

One session at Isleworth the week of the Honda Classic was the most memorable. "After five to six shots, he'd start playing games," says Kel Devlin. "He'd say, 'OK, I'm going to cut one here, so my spin rate will be 400 r.p.m.'s more than if I hit a draw.' He'd wind up, and it would be 400 r.p.m.'s more. He'd hit a shot and be within 100 r.p.m.'s of what the ball launched at. Every once in a while we'd slip in a different ball. He'd say, 'That was a different ball. It felt harder.' Or he'd hit one off the bottom of the club and he'd say, 'My swing speed was 206 km/h, but since it was off the bottom of the club, the spin rate was probably 3,100.' He'd be nailing it."

"Then he said, 'OK, I'm going to crank it up, give it 8 km/h more swing speed.' Sure enough, it would register 8 km/h more in swing speed. Everybody sitting there was dumbfounded. There was a road on the back of the range at Isleworth. We asked him, 'How far to the road?' He said 290 (yards), and then he cranks on it and flies it right to the middle of the road. Then he says, 'OK, I'm going to hit it over the road now,' and he bombs it an extra five yards over the road."

"He's got so much control on what he does with the golf club, it's incredible. He's worked so hard at getting the right launch angle and the right spin rate on the driver that it's made him a better driver. He launches it at 12 degrees with a spin rate of 2,800, which is perfect. Add 209 km/h clubhead speed and it translates to 300 yards pretty easy."

Marking scheme

You must submit your source code (.java file) and your bytecode (.class file) to "Assignment 2 box" on WebCT. Clearly indicate, at the top of the source code, your name, student ID number, course number, section number, and the assignment number.

- 3/20 for correct syntax/compilation
- 14/20 for solving the problem (including correct algorithm)
- 3/20 for style (comments, indentation, understandable user interface)