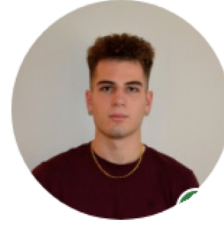


# An Open CS1 Learning Platform to Promote and Incentivize Deliberate Practice



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THE UNIVERSITY OF BRITISH COLUMBIA

Computer Science

# Motivation

- Increased enrollment in CS1 classes
- Many students find CS1 concepts difficult to master and workload too demanding
- Some students continue to ask for more practice questions
- Positive environment to encourage self-practice and learning at student's pace

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- Increased enrollment in CS1 classes
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- Positive environment to encourage self-practice and learning at student's pace
- Our solution: Course gamification platform 
  - Platform for additional practice
  - Combines concepts of [mastery learning](#) with [gamification](#)
  - Instructor can choose to count practice for extra marks or not
  - Students can get extra practice at minimal cost to the instructor

# Related Work: OER for CS

- OER benefits
  - Save instructor time in preparation
  - Save students money
  - Offer equitable learning opportunities
  - Support students in achieving same or better learning outcomes





# Related Work: OER for CS



- OER benefits
  - Save instructor time in preparation
  - Save students money
  - Offer equitable learning opportunities
  - Support students in achieving same or better learning outcomes
- OER in CS:
  - Used in formal and informal settings
  - Survey found main criterion for selection is quality of content
  - Other factors: topic coverage, level of difficulty, details available, programming language, presence of examples, content recency
  - Most used resources: assignments, problems, code examples
  - Most common barrier is lack of clarity in copyrights
  - Recent efforts in open question banks are limited (quantity and type)

# Related Work: Gamification Platforms

- Popular experimentation in CS education
- Generally positive impact on learning
  - Attendance, time spent practicing, activities completed, enrollment, self-reported enjoyment
  - Often led to improved programming knowledge (grades)



# Related Work: Gamification Platforms



- Popular experimentation in CS education
- Generally positive impact on learning
  - Attendance, time spent practicing, activities completed, enrollment, self-reported enjoyment
  - Often led to improved programming knowledge (grades)
- Lack of theoretical understanding of gamification on learning
  - Concern with use of extrinsic rewards
  - Over-engagement in playing rather than learning
  - Other negative effects: indifference, loss of performance, undesired behavior, declining effects

# Our System: Course Gamification

- <https://gamification.ok.ubc.ca/>

## A Free Platform to Practice Programming

Practice your programming skills with thousands of questions.

[Get Started ↗](#)

[Find Out More](#)

```
1 public static void main(String args[])
2 {
3     System.out.println("Hello, World!")
4 }
```

# Course Homepage

Homepage

## Open to Practice

This course is for practice. You can practice as much as you want.

### Question Bank

Improve your skills by solving practice questions.

[View](#)



### Assignments and Exams

Work on assignments and exams for this course.

[View](#)

### Challenges

Complete challenges on your own or in a team.

[View](#)

### Leaderboard

View your performance on the leaderboard for this website.

[View](#)

### Tokens

See how many tokens you earned.

[View](#)

# Concept Map Navigation

[Homepage](#) > [Practice](#) > [Concepts](#)

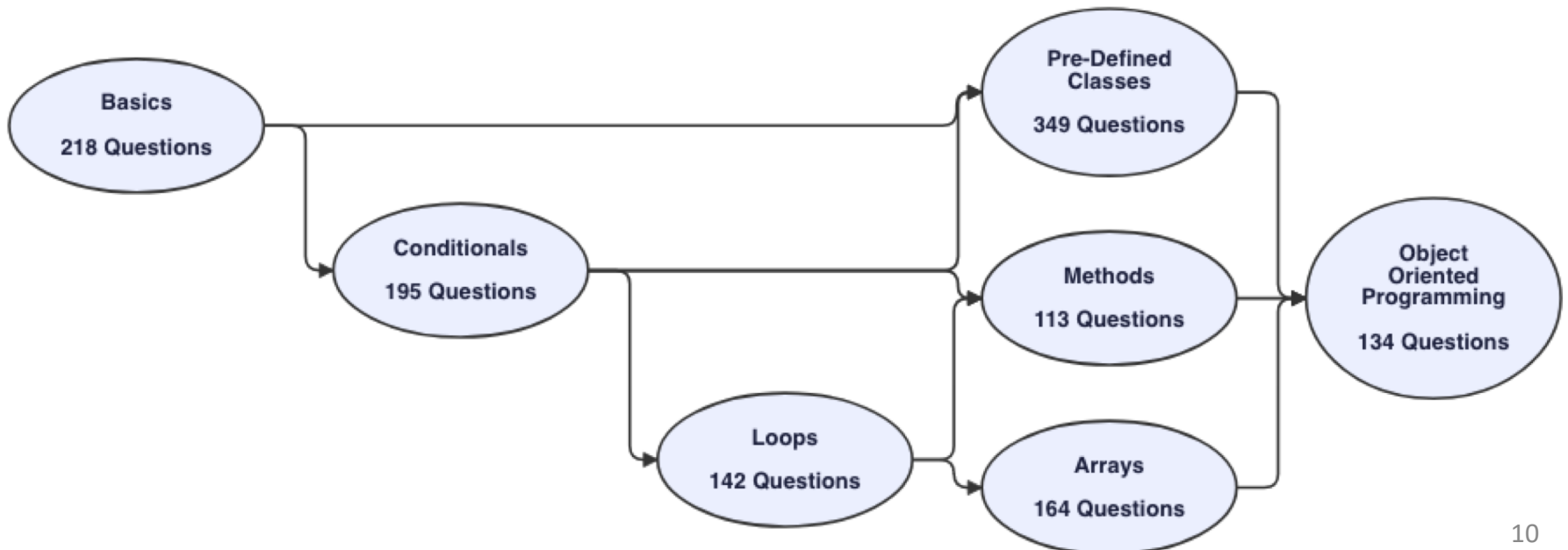
## Open to Practice

[← Back to Practice](#)

Map View

List View

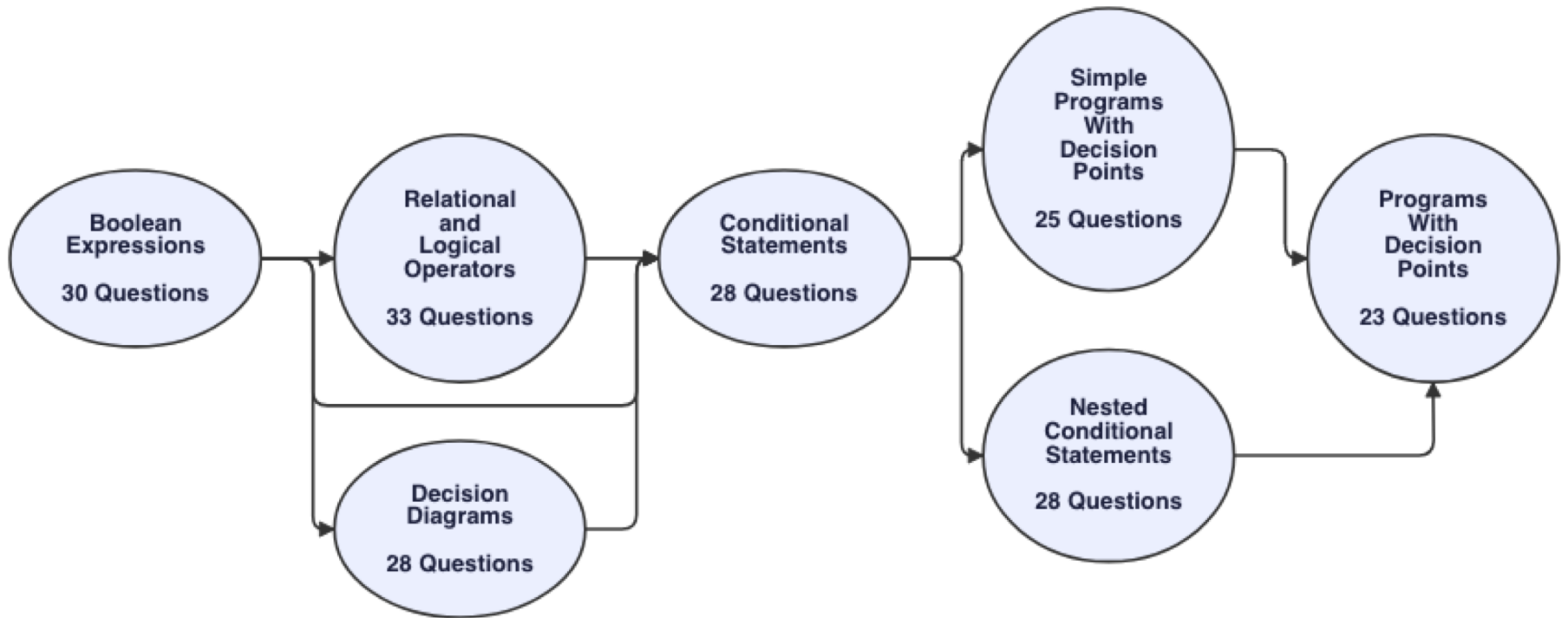
## Top-Level Categories



# Concept Map Navigation

[← Back](#)

## Sub-Categories for Conditionals



# Multiple Choice Questions

[← View Concept Map](#)

[← View List of Goals](#)

Basics > Arithmetic Operators

Question Settings:

Include Solved Questions:

Difficulty: Hard ✕ ∨

Browse Questions:

[<](#) [>](#)

[🔔 Report a Problem](#)

BASICS :: ARITHMETIC OPERATORS

QUESTION

Suppose we have an integer variable called `t` whose initial value is 45. What is the value stored in `t` after executing the following statement?

```
t = ++t * t--;
```

45

2116

2070

2116.0

[Submit](#)

### Past Submissions

2/3/23, 6:52 AM	<span>Correct</span>
Grade Given: 0.67 Tokens Received: 2.01 / 3.00 Answer: a	
<a href="#">See Details</a>	
2/3/23, 6:52 AM	<span>Incorrect</span>

[>](#)



# Parson's Questions

- Drag and drop lines of code to form working program

← Back to Concept Map

← View List of Goals

Question Settings:

Method: > Method Overloading

Include Solved Questions:

Difficulty: Medium

Browse Questions:

Add to Assessment

Report a Problem

METHODS :: METHOD OVERLOADING

QUESTION

Write a Java program that takes two variables, an integer and a double (they are already declared and initialized) and calculates the larger of the two variables. Write two methods named `max` to complete this. Each method should take in an integer and a double, but the parameter order should be opposite, and both should return the larger value. Then, print out the returned larger value in the main method.

Sample Output:

The greater value is: x

ORGANIZE THE FOLLOWING

LargerOfVars.java  
LINES

```
return b;
{
else
else
return b;
return a;
return a;
if (a > b)
public static double max(int a, double b)
int b = 584;
}
double a = 418.2;
{
}
if (a > b)
```

MY SOLUTION

```
public class LargerOfVars
{
public static void main(String[] args)
{
System.out.println("The greater value is: " + max(a, b));
}
}
public static double max(double a, int b)
public static double max(double a, int b)
```

**Generated Variables**

x: 4  
y: 19  
No Errors.

**Past Submissions**

6/27/23, 5:12 PM	Correct
6/26/23, 4:45 PM	Correct
6/21/23, 11:12 AM	Correct
6/11/23, 12:34 PM	Correct
4/12/23, 4:46 PM	Incorrect
3/25/23, 3:32 AM	Correct
3/19/23, 5:45 PM	Correct
6/15/22, 3:38 PM	Correct
6/15/22, 3:29 PM	Incorrect
6/15/22, 3:26 PM	Incorrect
7/15/21, 7:48 PM	Correct
7/15/21, 7:45 PM	Incorrect
7/15/21, 7:45 PM	Incorrect

# Written Programming Questions

[← Back to Concept Map](#)

[← View List of Goals](#)

Question Settings:

Method: > [Method Overloading](#)

Include Solved Questions:

Difficulty: Hard

Browse Questions:

METHODS :: METHOD OVERLOADING

QUESTION

Write a Java Program that asks a user for their name, username and student number and has an overloaded method called **checkStudentInfo** that checks if the username or student number are valid. One method takes the first name, the last name, and the username to check if the username follows the format of first\_name.last\_name, and returns a boolean. The other method takes the student number and checks it is at least 8-digits long, then returns a boolean. Both booleans should then be printed in the main method. The username should be case sensitive.

Sample Output:

Please enter a student's name:  
Georgia Evans

Please enter a username:  
Georgia.Evans

Please enter a student number:  
886735

Georgia.Evans is a valid username: true

886735 is a valid student number: false

COMPLETE THE FOLLOWING

AttendingStudent.java

```
1 - public class AttendingStudent {
2 -     public static void main(String[] args) {
3 -     }
4 - }
```

Press escape to de-focus the editor

**Generated Variables**

x: 4  
y: 19  
No Errors.

**Past Submissions**

6/27/23, 6:06 PM	Partially Correct
6/27/23, 6:05 PM	Partially Correct
5/27/23, 10:46 AM	Incorrect
5/27/23, 10:46 AM	Incorrect
1/14/23, 10:56 AM	Correct
1/14/23, 10:54 AM	Correct
1/14/23, 10:51 AM	Incorrect
1/14/23, 10:50 AM	Correct
1/14/23, 10:50 AM	Correct
1/14/23, 10:48 AM	Correct
1/14/23, 10:45 AM	Partially Correct
1/14/23, 10:45 AM	Partially Correct
1/14/23, 10:43 AM	Incorrect
1/14/23, 10:41 AM	Incorrect

# Immediate Feedback via JUnit Testing

- Allows for incremental programming
- JUnit extension beyond output testing
- See Wednesday's discussion paper (Adeyemi et al.)

## Submission 1

Grade Given: No Grade

Score: 9/10

Tokens Received: 1.8/2.0

Time Submitted: Feb 3, 2023, 7:02:30 AM

### What went well:

- Output follows correct structure
- Correctly detects canadian websites( string)[1]
- Correctly detects canadian websites( string)[2]
- Correctly detects canadian websites( string)[3]
- Correctly detects canadian websites( string)[4]
- Correctly detects non canadian websites( string)[1]
- Correctly detects non canadian websites( string)[2]
- Correctly detects non canadian websites( string)[3]
- Correctly detects non canadian websites( string)[4]

### Still needs some work:

- Unexpected error

If there are multiple issues, attempt to fix the first issue as that might solve subsequent issues

URLVALIDATOR.JAVA

```
1 import java.util.Scanner;
2 public class UrlValidator
3 {
4     public static void main( String[] args )
5     {
6         System.out.println( "Please enter a website URL:" );
7         Scanner scan = new Scanner( System.in );
8         String address = scan.next();
9         System.out.println( "Is this a Canadian website? " + address.ends
10     }
11 }
12
```

COMPILE OUTPUT

Compiled successfully!

POTENTIAL MISTAKES

Reliance on default encoding

Close

# Alternate List View Navigation

Map View

List View

Basics	218 Questions	Practice	▼
Pre-Defined Classes	349 Questions	Practice	▼
Conditionals	195 Questions	Practice	▲
Boolean Expressions	30 Questions	Practice	
Relational and Logical Operators	33 Questions	Practice	
Decision Diagrams	28 Questions	Practice	
Conditional Statements	28 Questions	Practice	
Simple Programs With Decision Points	25 Questions	Practice	
Nested Conditional Statements	28 Questions	Practice	
Programs With Decision Points	23 Questions	Practice	
Loops	142 Questions	Practice	▼
Methods	113 Questions	Practice	▼
Arrays	164 Questions	Practice	▼
Object Oriented Programming	134 Questions	Practice	▼

# Java Question Bank

Topic	MCQs	Programming Questions	Subtotal
Basics	204	0	204
Conditionals	160	24	184
Pre-Defined Classes	263	80	343
Loops	75	66	141
Methods	59	70	129
Arrays	60	105	165
Introductory OOP	144	210	354
<b>Total:</b>	<b>965</b>	<b>555</b>	<b>1,520</b>

The screenshot shows two cards on a website. The left card is titled 'Question Bank' and has a light green header. Below the title, it says 'Improve your skill' and 'practice question'. At the bottom of the card is a blue 'View' button. The right card is titled 'Assignment' and has a light orange header. Below the title, it says 'class' and 'or th'. At the bottom of the card is a blue 'View' button. A white tooltip box is overlaid on the cards, containing the text: 'All of our questions are licensed under CC BY-NC-SA 4.0'. There is also a small circular icon with an 'i' inside, likely an information icon, located between the two cards.

# Personal Analytics

## Personal Statistics

Accomplishments	Total
Questions Completed	2
Challenges Completed	0
Tokens Earned	34.9
Goals Completed	0

## Question Statistics

Difficulty	Number Completed	Category	Number Completed
Easy	2	Basics	1
Medium	0	Pre-Defined Classes	0
Hard	0	Conditionals	1
Type	Number Completed	Loops	0
Multiple Choice Questions	2	Methods	0
Parson's	0	Arrays	0
Java	0	Object Oriented Programming	0

# Freeform Practice

## COSC 111 Jan-Apr 2023

Start practicing by selecting a topic in the concept map, by setting personal goals to collect tokens, or by selecting a type of question at the bottom.

[← Back to Homepage](#)

### Concept Map

View programming concepts and practice questions in selected topics and difficulty levels.

Practice

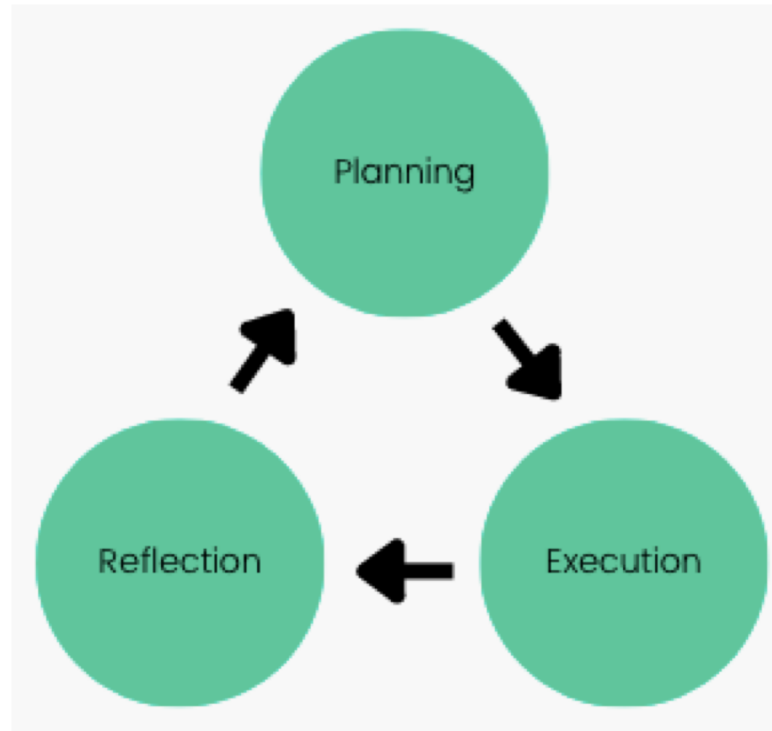
### Personal Goals

Develop goals for yourself that suit your own skill level and earn tokens when you achieve them.

View

# Self-Regulated Learning

- Encourages students to engage and reflect about their own learning





# Setting Goals

## Create New Goal

End date  
08.07.2023



End time  
12:06



## Tasks

+ Add Another

Category  
Basics :: Simple Calculation...

Difficulty  
Easy

Number of questions  
2

— Delete

8 question(s) available.

Category  
Pre-Defined Classes :: OOP...

Difficulty  
Easy

Number of questions  
2

— Delete

9 question(s) available.

Create Goal

# Monitoring Progress

## Active Goals

Create a new goal

### Tasks:

1. Solve 2 MEDIUM questions from Basics :: Arithmetic Operators (Solved 2 / 2) ✓
2. Review performance

Due: 7 days

2 / 3

Review Performance

### Tasks:

1. Solve 2 EASY questions from Basics :: Simple Calculation Programs (Solved 0 / 2) ▶ Practice
2. Solve 2 EASY questions from Pre-Defined Classes :: OOP Overview (Solved 0 / 2) ▶ Practice
3. Review performance

Due: 7 days

0 / 5

View Progress

## Past Goals



Looks like there are no goals to show

# Reflecting on Performance

## Goal Performance Review

### Tasks:

1. Solve 2 MEDIUM questions from Basics :: Arithmetic Operators (Solved 2 / 2) ✓
2. Review performance ✓

Due: 7 days

3 / 3

## Task 1

2 / 2

You have completed 2 out of 2 exercises in this task.

### Question Stats

Question Type	Questions Attempt	Questions Solved	Success Rate
All	2	2	100% ( ↑ 100% )
Multiple Choice	2	2	100% ( ↑ 100% )

### Practice Recommendations



You need to solve more questions in Basics :: Arithmetic Operators to improve your understanding of the topic. Practice is essential for mastering any subject.

# Assignments and Exams

Homepage > Assignments and Exams

## Test Course for Assignments

[← Back to Homepage](#)






You are viewing  
Assignments and Exams

[+ Add Assessment](#)






### Current Assessments

Assignment	A3	From: Thursday, Jun 29, 2023, 12:06 PM Until: Saturday, Jul 8, 2023, 12:06 PM	Available	Grade: 0%	    
------------	----	--	-----------	-----------	---

### Upcoming Assessments

Exam	Midterm	From: Tuesday, Jul 4, 2023, 12:18 PM Until: Wednesday, Jul 5, 2023, 12:18 PM	Coming Soon	Grade: TBA	    
------	---------	---	-------------	------------	---

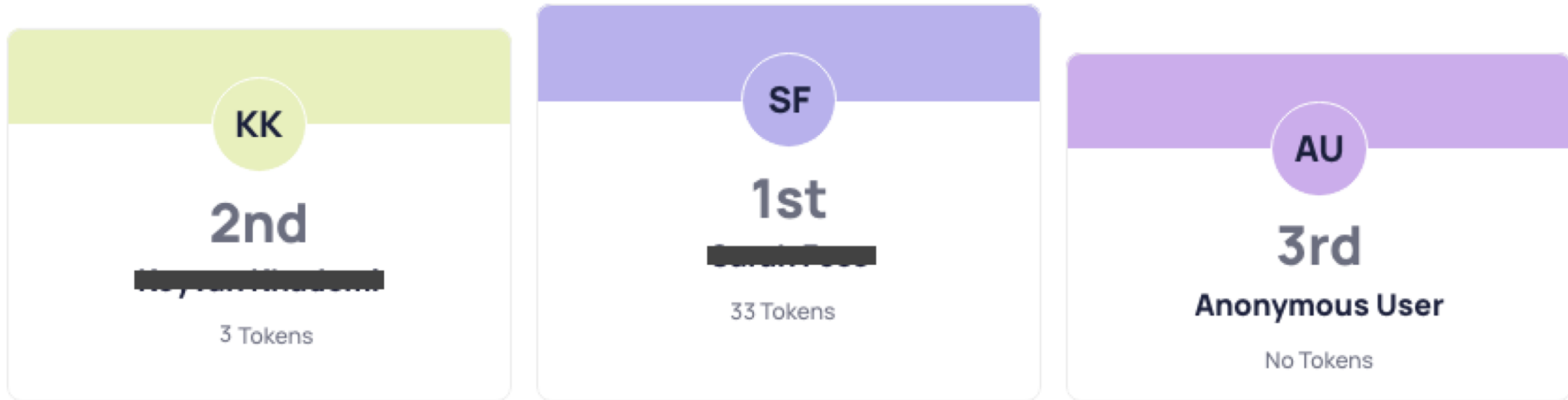
### Past Assessments






Assignment	A1	From: Monday, May 22, 2023, 12:06 PM Until: Monday, May 29, 2023, 12:06 PM	Closed	Grade: 0%	    
------------	----	---	--------	-----------	--

Assignment	A2	From: Monday, May 22, 2023, 12:07 PM Until: Monday, May 29, 2023, 12:07 PM	Closed	Grade: 0%	    
------------	----	---	--------	-----------	---

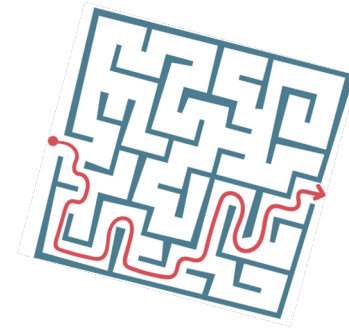
Exam	Practice Midterm	From: Monday, May 22, 2023, 12:18 PM Until: Monday, May 29, 2023, 12:18 PM	Closed	Grade: TBA	    
------	------------------	---	--------	------------	---

# Leaderboard



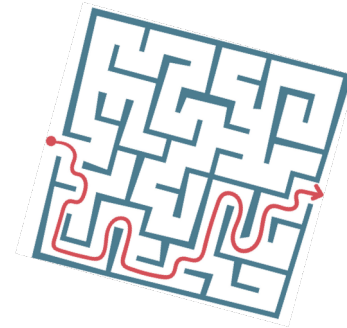
Rank ↕	Name ↕	Tokens ↕
4th	 	No Tokens
5th	 	No Tokens
6th	 Anonymous User	No Tokens

# Challenges



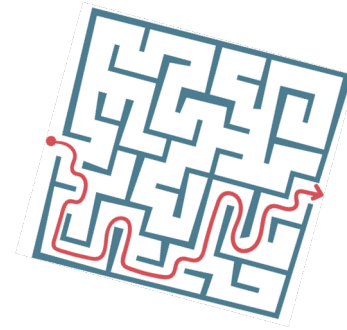
- Quota:
  - Users solve X questions in Y duration of time
  - Every team member receives tokens associated with those X questions
  - Goal: Incentivize students to do enough practice

# Challenges



- **Quota:**
  - Users solve X questions in Y duration of time
  - Every team member receives tokens associated with those X questions
  - **Goal: Incentivize students to do enough practice**
- **Top k teams**
  - Users solve X questions in Y duration of time
  - Only members of teams ranked in top K receive tokens based on number of attempts used
  - **Goal: Promote a deeper level of problem-solving by using fewer attempts**

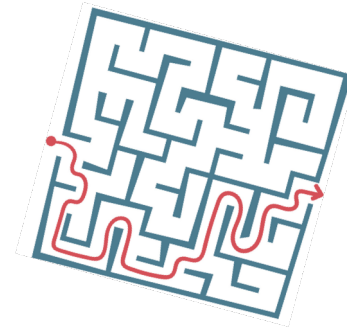
# Challenges



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  - Every team member receives tokens associated with those X questions
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- **Top k teams**
  - Users solve X questions in Y duration of time
  - Only members of teams ranked in top K receive tokens based on number of attempts used
  - **Goal:** Promote a deeper level of problem-solving by using fewer attempts
- **Consistency**
  - Users who complete an existing challenge in Z consecutive weeks
  - Every member receives Z additional tokens
  - **Goal:** Promote consistency in study habits



# Challenges



- **Quota:**
  - Users solve X questions in Y duration of time
  - Every team member receives tokens associated with those X questions
  - **Goal: Incentivize students to do enough practice**
- **Top k teams**
  - Users solve X questions in Y duration of time
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  - **Goal: Promote a deeper level of problem-solving by using fewer attempts**
- **Consistency**
  - Users who complete an existing challenge in Z consecutive weeks
  - Every member receives Z additional tokens
  - **Goal: Promote consistency in study habits**
- **Student-created**
  - Students create a challenge of one of the above types by defining parameters
  - Tokens awarded based on challenge type
  - **Goal: Increase student's sense of ownership and make challenges more playful**

# Pilot Studies



- Since May 2022: Six CS1 classes with 650+ students
  - Generally positive feedback from students, instructors, and teaching assistants
  - No incentive for system use
  - May 2003: students completed assignments with system

# Pilot Studies



- Since May 2022: Six CS1 classes with 650+ students
  - Generally positive feedback from students, instructors, and teaching assistants
  - No incentive for system use
  - May 2003: students completed assignments with system
- Pilot study in January 2003 with 85 students
  - Self-regulated learning:
    - Pre-course survey showed students engage in goal setting
    - No system activity on goal planning-execution-reflection cycle
  - Gamification features:
    - Leaderboard usage showed novelty effect
    - About half the usage for challenges
    - Fewer female students, stopped after midterm #1

# Summary and Future Work

- Course Gamification:
  - Open gamification platform for CS1 Java programming
- Next steps:
  - Continue to pilot at UBC this coming year
  - Analyze collected data
- Interested?
  - Seeking collaborators
  - Piloting at other institutions  
<https://gamification.ok.ubc.ca/>
  - Contact: Dr. Bowen Hui [bowen.hui@ubc.ca](mailto:bowen.hui@ubc.ca)

