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# CS222-Data Structures and Algorithms
# Course Introduction

Dr Govindha R Yeluripati

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# Outline

- Understanding the importance
- Objectives and Outcomes
- Pre-requisites
- Resources
- Facilitators
- Schedule
- Software
- Topics
- Assessment and Evaluation
- Policies

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# Before we begin

- Consider the following problem:

Given a group of N numbers, determine the $k^{th}$ largest.

(This is called the Selection problem)

Reading: Section 1.1 of T2

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# Before we begin

- Solution 1 (Selection problem):

1) Read the N numbers into an array
2) Sort the array in decreasing order by some simple algorithm (e.g., bubble sort)
3) Return the element in the position k

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# Before we begin

- Solution 2 (Selection problem): Slightly better

1) Read the first k elements into an array
2) Sort them in decreasing order
3) Read each of the remaining elements one by one.

   As a new element arrives, it is ignored if it is smaller than the kth element in the array.
   Otherwise, it is placed in its correct spot in the array, bumping one element out of the array.
4) When the elements end, the element in the kth position is returned as the answer

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# Before we begin

- Which of the two solutions is better?
- Remember: both work

- Think about huge input: N = 30,000, 000, k = 15, 000, 000

- A simulation shows that each of these algorithms requires several days to finish

- Can we do any better?

  YES, we study an algorithm in our course that can finish within a second

  (Quick sort)

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# Some questions to think…

- Okay, in the previous problem (selection), how did you **store** the elements?
- Does the way of storing matter?
- What are the popular ways/methods of storing data in computer memory (can be RAM/Disk)?
- Will it have any impact on the efficiency of the application?

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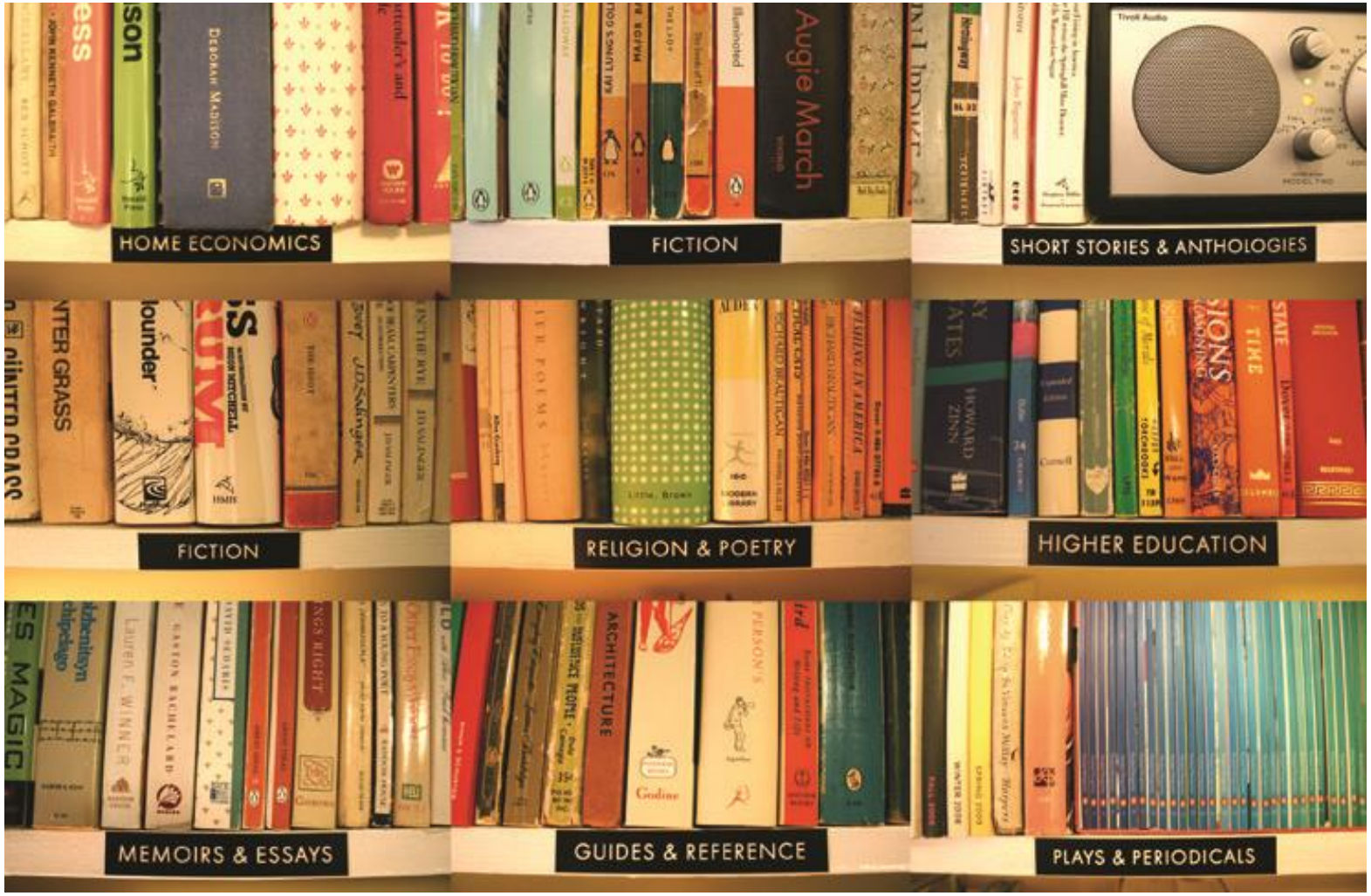
# Let’s understand more with a practical problem

- Suppose that your library of books is completely unorganized, and you need to pick the Data Structures and Algorithms book written by Dr Govindha Yeluripati

# Let’s understand more with a practical problem



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# Let’s understand more with a practical problem

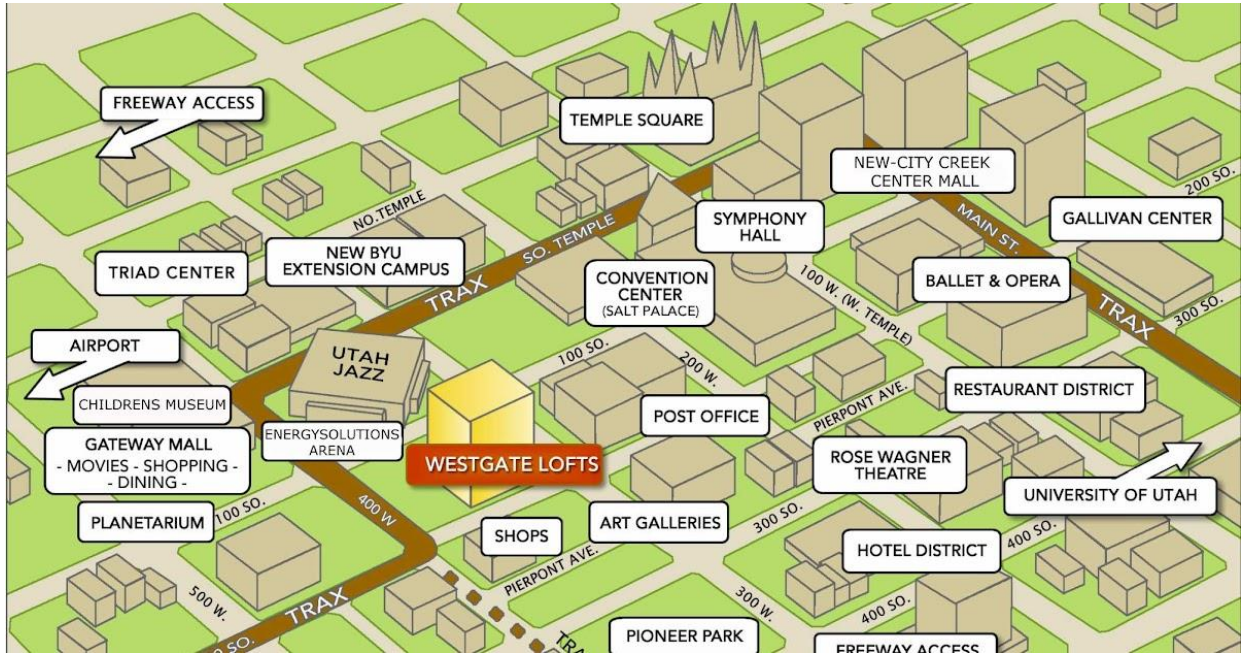
# Some more practical problems…

- Why is it easy to look for a word in a dictionary?


- Because it contains a **sorted** list of words

# Some more practical problems…

- Why is it easy to look for a place/direction/way if you have a city map?




- Because the information is well organized with the required details such as position/ coordinates, distance and names.

# Some more practical problems…

- How is the information about the daily cash spending of a business stored/organized?

| Cash | | | | |
|---|---|---|---|---|
| Date | Description | Increase | Decrease | Balance |
| Jan. 1, 20X3 | Balance forward | | | $ 50,000 |
| Jan. 2, 20X3 | Collected receivable | $ 10,000 | | 60,000 |
| Jan. 3, 20X3 | Cash sale | 5,000 | | 65,000 |
| Jan. 5, 20X3 | Paid rent | | $ 7,000 | 58,000 |
| Jan. 7, 20X3 | Paid salary | | 3,000 | 55,000 |
| Jan. 8, 20X3 | Cash sale | 4,000 | | 59,000 |
| Jan. 8, 20X3 | Paid bills | | 2,000 | 57,000 |
| Jan. 10, 20X3 | Paid tax | | 1,000 | 56,000 |
| Jan. 12, 20X3 | Collected receivable | 7,000 | | 63,000 |

- A well-structured tabular format.

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# So, what's the observation?

- Does the arrangement make any difference in searching for the thing/infomation you are looking for?

- That's exactly what happens when you store/arrange the data in different ways in computer memory.

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# The CS222 Course

- Data Structures is the most fundamental building block concept in Computer science
- Algorithms is a different but a highly related concept

- Good knowledge of data structures and the algorithms used to manipulate them is extremely important to build efficient software systems

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# CS222-Objectives

This course aims to:

1) equip the students with the skills necessary for performing the analysis of algorithms and determining their efficiency using asymptotic notation.
2) provide knowledge and understanding of the concept of abstract data types.
3) instill the ability to understand, explain, implement, and apply fundamental data structures.
4) emphasize the importance of searching and sorting algorithms and study the characteristics of commonly used algorithms by implementing them.

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# CS222-Learning Outcomes

Upon successful completion of this course, students will be able to:

1) analyze, compute, and express the running time of algorithms using asymptotic notation (O, Ω, Θ) and thus determine the efficiency of computer programs.
2) explain and implement a variety of commonly used data structures such as stacks, queues, lists, trees, graphs, and hash tables.
3) explain and implement prominent searching and sorting algorithms.
4) identify and apply appropriate data structures for the solution of real-world problems.
5) develop a solid foundation required for pursuing advanced computing courses.

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# CS222-Prerequisites Information

- Programming knowledge (Java)
- Discrete Structures and Theory (Preferable, not mandatory)

- This course is a pre-requisite for CS456: Algorithm Design and Analysis

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# CS222: Resources

**Textbooks:**

**T1**: Goodrich, M. T., Tamassia, R., & Goldwasser, M. H. (2014). Data Structures and Algorithms in Java, Sixth Edition, John Wiley & Sons.

**T2**: Weiss, M.A (2012). Data Structures and Algorithm Analysis in Java, Third Edition, Pearson

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# CS222: Resources

**References:**


**R1**: Liang, Y. D (2019). Introduction to Java programming and data structures, Eleventh (Global) Edition, Pearson Education.

**R2**: Cormen, T.H., Leiserson, C.E., Rivest, R.L., & Stein, C (2009). Introduction to Algorithms, MIT Press

**R3**: W. Savitch (2012). Java: An Introduction to Problem-Solving and Programming, Sixth Edition, Prentice Hall.

**R4**: Lafore, R (1998). Data Structures and Algorithms in Java, Waite Group Press.

**R5**: Hubbard, J.H (2007). Data Structures with Java, Schaum's outline series, McGraw Hill.

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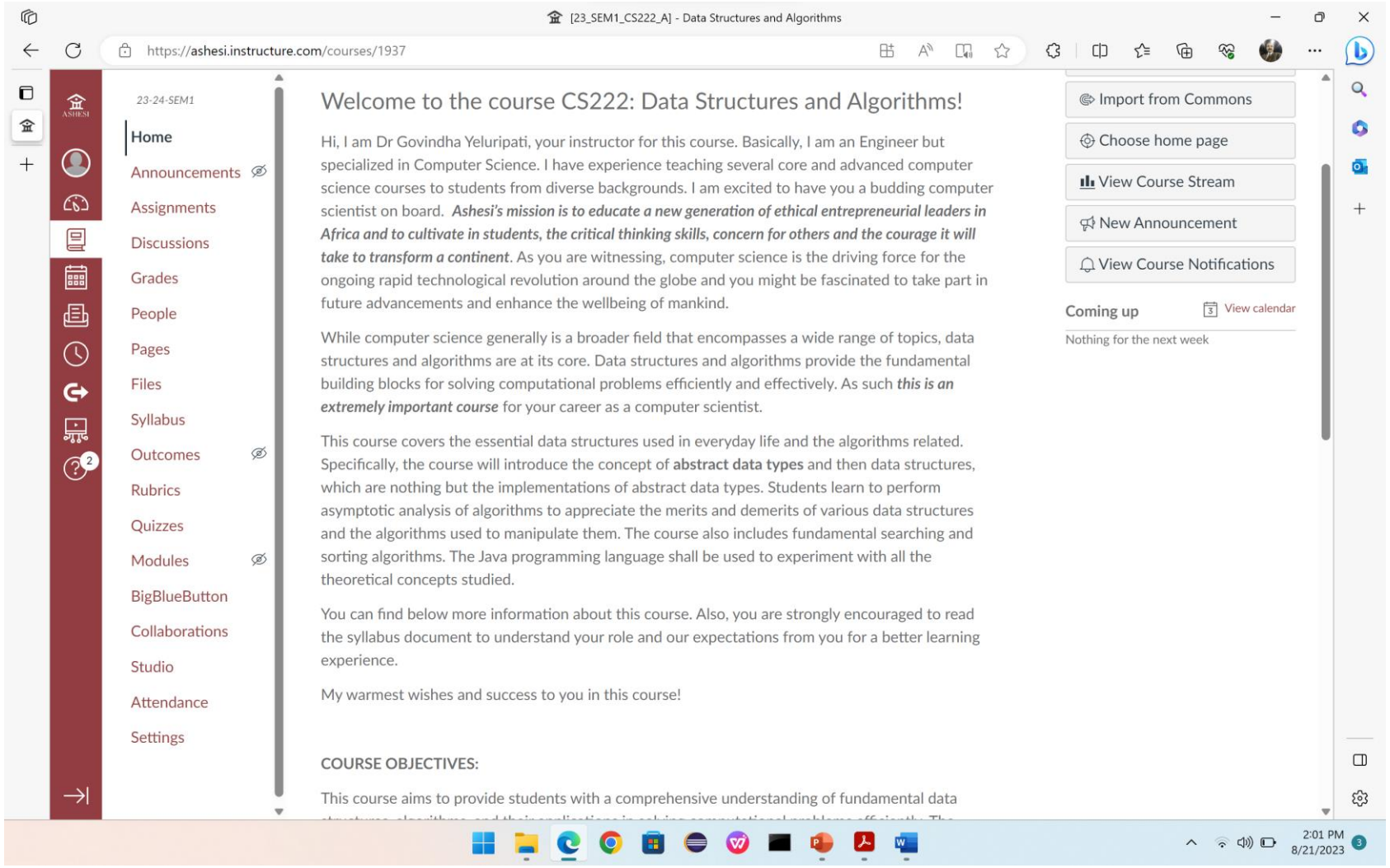
# CS222: Resources

**Online Tutorials:**

1) DSA using Java Tutorial
2) DSA Tutorial
3) DSA Tutorials
4) Data Structures & Algorithms
5) Data Structures and Algorithms in Java (YouTube)
6) Data Structures and Algorithms (YouTube)
7) Data Structures and Algorithms in Java
8) Data Structures Easy to Advanced (YouTube)
9) Foundations of Data Structures (edX)
10) Visual Learning Platform
11) Algorithms, Part1(Coursera)

# CS222: Resources

**CANVAS:**



# CS222: Facilitators

| | Instructor | Faculty Intern |
|---|---|---|
| **Name** | *Dr. Govindha Ramaiah Yeluripati* | *Gideon Donkor Bonsu* |
| **Email** | *gyeluripati@ashesi.edu.gh* | *gideon.bonsu@ashesi.edu.gh* |
| **Office Room** | 205-E | *Room 103 (Engineering Building)* |
| **Consultation hours** | Mondays/Wednesdays, 2-4 PM<br>or *by appointment* | Mondays/Wednesdays, 2-4 PM<br>or *by appointment* |

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# CS222: Class Schedule

| | Section A | Section B |
|---|---|---|
| **Lectures** | Tuesdays (13:15 – 14:45)<br>Thursdays (13:15 – 14:45) | Tuesdays (15:00 -16:30)<br>Thursdays (15:00 -16:30) |
| **Labs** | Fridays (13:50 – 15:20) | Fridays (12:10 -13:40) |
| **Venue** | D & B Jackson Hall 221 (for all sessions) | |

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# CS222: Software

- Java Development Kit (JDK) 17 or later, download from Java Downloads | Oracle and a text editor like Notepad or Notepad++ (recommended for programming).

- Alternatively, you can use any Java IDE you are comfortable with.

- Popular IDEs:

  Eclipse, IntelliJ, NetBeans, BlueJ, JCreator, and jGRASP

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# CS222: Topics

Week1: Data Structures definition, classification, Simple Data Structures in Java

Week2: Data Abstraction, Classes and Objects, Interfaces, Abstract classes, Generics

Week3: Algorithm analysis, Running time, Asymptotic analysis (O, Ω, Θ)

Week4: Linked lists

Week5: Searching algorithms, Hashing

Week6: Sorting Algorithms (Insertion, Selection, Merge, Quick)

Week7: Recursion, Abstract Data Types (ADT)

Week8: Mid-semester break

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# CS222: Topics

Week9: List ADT

Week10: Stack ADT

Week11: Queue ADT

Week12: Trees, Binary Search Tree ADT

Week13: Priority Queues (Heaps)

Week14: Graph ADT, Graph Algorithms

Week15: Java Collections Framework

Week16: Revision

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# CS222: Assessment and Evaluation

| Assessment | Weighting | Timeline |
|---|---|---|
| Quizzes (4) | 10% | Weeks 3, 7, 11, 15 |
| Lab Exercises (9) | 30% | Weeks 1, 2, 4, 6, 9, 10, 11, 12, 14 |
| Mid-Sem Exam | 20% | Week 9 |
| Final Project | 15% | Week 15 |
| Final Exam | 25% | Week 17 |
| Total | 100% | End of Semester |

# Course policies

- GENERAL ACADEMIC POLICIES: It is the student's responsibility to be familiar with and adhere to Ashesi's policies (Ashesi's Student Handbook)
- LATE SUBMISSION POLICY: Assignments submitted late will receive a 10% penalty per 24-hour period
- ATTENDANCE POLICY: Attendance will be marked after 5 minutes of the start of a class. That absence will count towards Ashesi's attendance policy.
- PARTICIPATION: Students are strongly encouraged to interact and participate in discussions
- PROFESSIONALISM: Highly professional and polite behaviour is expected with facilitators and fellow students.

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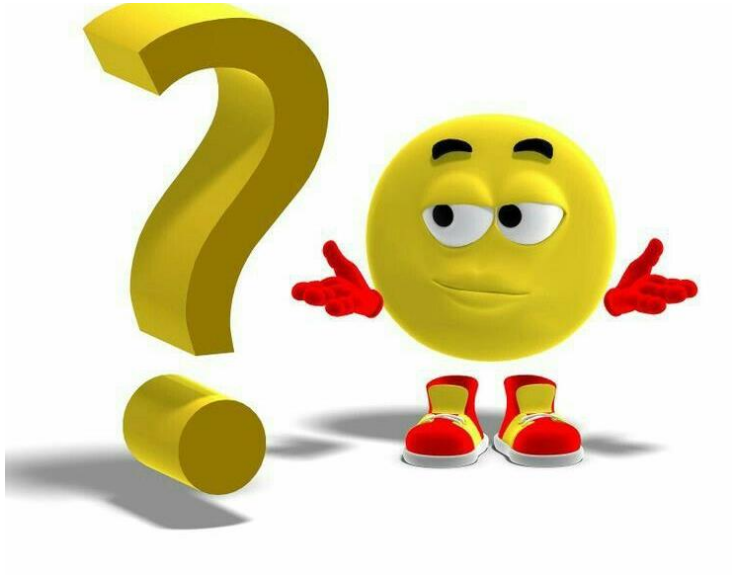
# Thank You!



Any questions?