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# **Data Structures and Algorithms**

**XMUT-COMP 103 - 2024 T1**

**Introduction to Collections**

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# Some differences: COMP 103 vs COMP 102

- COMP 102 introduced ArrayLists.
- COMP 103 will be using Lists and other kinds of collections all the time.
  
- In COMP 102, we just cared whether your program worked.
- In COMP 103, we will care how well your program works.
  - Especially, how efficient is it?
  - When a problem has lots of different solutions, how do we choose a good solution?
  
- Does it really matter? If the program works, isn't that good enough?

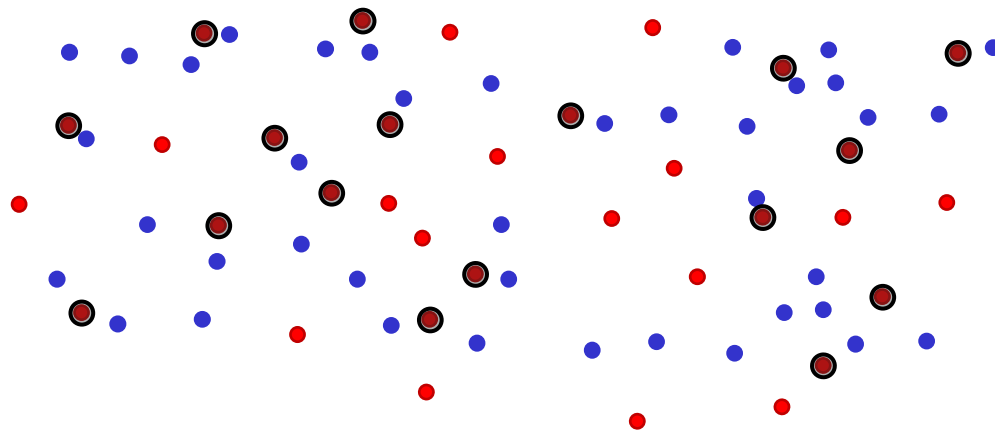
# Example of why code quality matters

- A potential question is COMP 102
  - Dealing with Lists of City objects  
[Cities have locations, *double* distanceTo(*City* otherCity ) computes the distance ]

findAllCloseCities(...)

given a **sources** list, a **targets** list, and a distance.

Return a new list of the target cities that are closer than dist from some source city.



# Course Structure

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## Topics:

- Programming with unstructured and linear collections
- Different Kinds of collections:
  - Lists, Sets, Bags, Maps, Stacks, Queues, Priority Queues
- Algorithms using collections.
- Complexity
- Recursion
- Programming with Linked collections
  - Building, traversing tree structured collections
  - Building, traversing graph/network structured collections
- More complex algorithms

# Recurring Themes

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- Good Design:
  - Which choices should you make?
  - Choosing appropriate implementations for collections
  - Making the right choice the first time
- Efficiency:
  - How fast is it?
  - How much memory does it take?
  - By analysis, and by benchmarking
- Testing:
  - Does it work right?

# Programming with Libraries

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- Modern programs (especially GUI and network) are too big to build from scratch.
  - ⇒ Have to reuse code written by other people
- Libraries are collections of code designed for reuse.
  - Java has a huge collection of standard libraries....
  - Learning to use libraries is essential

# Libraries for COMP 103

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- `ecs100`            UI, etc
  - `java.io`            Classes for dealing with files
  - `java.util`            Collection classes            (you've used ArrayList, now .....)  
                              Other utility classes
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- We will use these libraries in almost every program
  - We will use other libraries also, where appropriate.

# Collections of information

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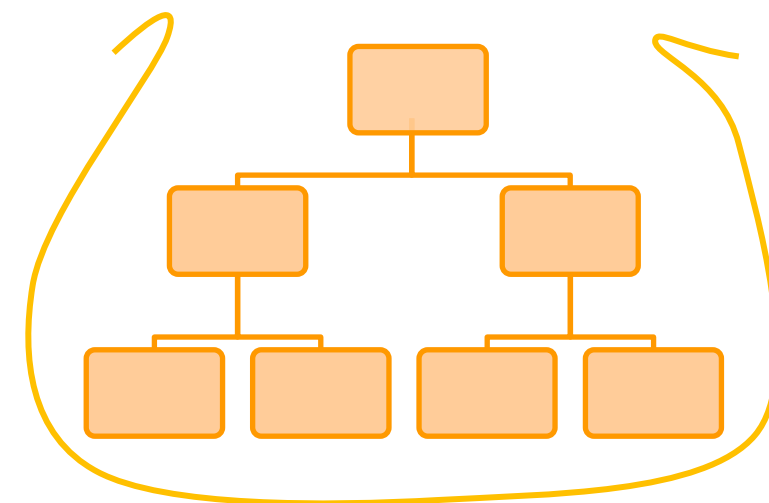
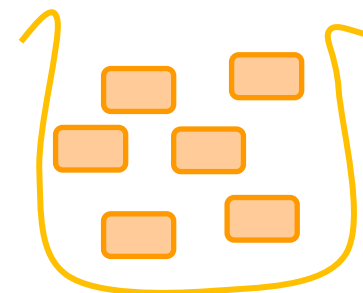
- Lots of information that computers deal with comes in **Collections** of data
  - Need to be able to store information in a way that reflects its structure
  - Need to be able to manipulate the information in lots of different ways
- Information about
  - earthquakes,
  - courses,
  - phone contacts,
  - documents
  - images, movies
  - people,
  - windows,
  - files,
  - network connections
  - ...



# Collections in Java

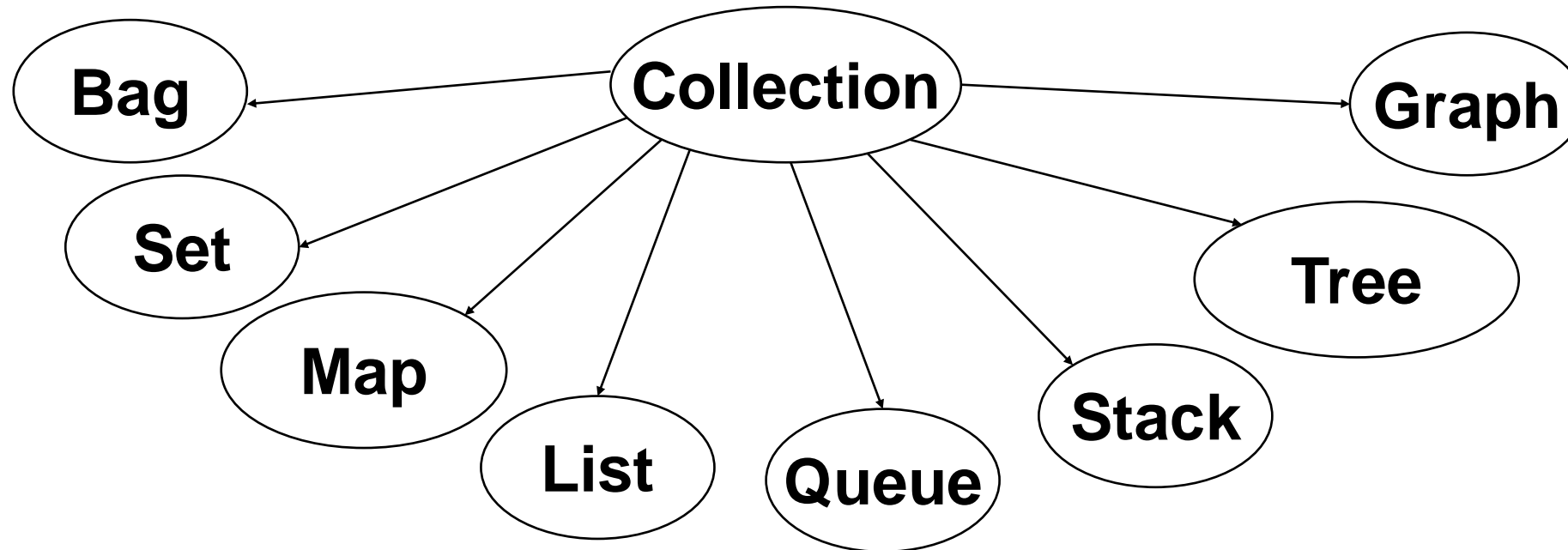
What is a Collection in Java?

- An object that contains other objects
- What defines the collection type?
  - What you can do to it
  - What structure it imposes on its contents
  - What properties it ensures
- Mostly we won't care much how it works inside:
  - As long as it has the right behaviour, the inside doesn't matter?
  - But we need to know what operations are expensive (and how expensive they are)
  - For trees, we will need to make our own!



# “Standard” Collections

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What's the difference?

Structure

Constraints