# *CS101 - Data Abstraction*

# DS Basics - Module2

Aravind Mohan

Allegheny College

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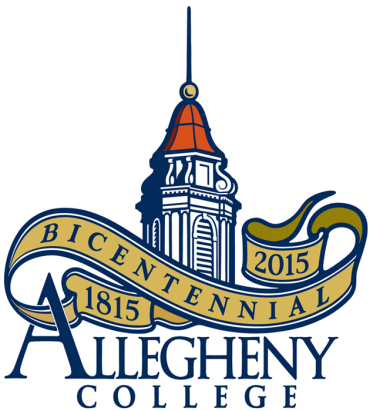


# Ready for a programming challenge?

- Given the following arr, find the indices for the minimum value, maximum value, and calculate average for the entire array.

```
arr = [[7, 12, 4, -1],[-2, 3],
[8, 9, 0, 1],[-12, 3, 4], [2]]
```

# An array of objects

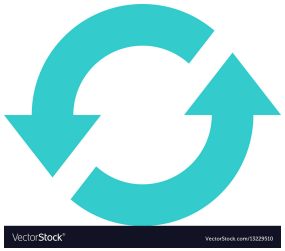
- **An array of objects** is a set of objects, with each object is of heterogeneous type.
- So a homogeneous data store with heterogeneous cells?

# A List of objects

- **Example:**

  student.py, driver.py, and stub.py in code/student folder.

# An alternative approach to Process Data




- **Recursion** is a technique that solves a problem by solving a smaller problem of the same type.
- Sometimes, the best way to solve a problem is by solving a smaller version of the exact same problem first.

# Recursion Vs Iteration

- Iteration can be used in place of recursion.
  - An iterative algorithm uses a looping construct.
  - A recursive algorithm uses a branching structure.
- Recursive solutions are often less efficient, in terms of both time and space, than iterative solutions.
- Recursion can simplify the solution of a problem, often resulting in shorter, more easily understood source code.

# How do I write a recursive function?

- Determine the size factor
- Determine the base case(s)

  (the one for which you know the answer)
- Determine the general case(s)

  (the one where the problem is expressed as a smaller version of itself)
- Verify the algorithm

  use the (”Three-Question-Method”)

# Three-Question Verification Method

1. The Base-Case Question:

   Is there a nonrecursive way out of the function, and does the routine work correctly for this base case?

2. The Smaller-Caller Question:

   Does each recursive call to the function involve a smaller case of the original problem, leading inescapably to the base case?

3. The General-Case Question:

   Assuming that the recursive call(s) work correctly, does the whole function work correctly?

# Example 1: Factorial Calculation


- Question: What is ”12!”?
  - 12! = 12*11*10*9*8*7*6*5*4*3*2*1
  - 12! = 479,001,600
- Iterative calculation: Put it in a for-loop.
- Recursive calculation: Use fact(n-1) to calculate fact(n).
- Do each of these provide identical answers?
- Do each of these run at (roughly) the same speed?

# Example 2: Fibonacci Calculation


- Question: What are the Fibonacci numbers?
  - 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233
  - Each number is the sum of the two numbers preceding it.
- Iterative calculation: Put it in a for-loop.
- Recursive calculation: Use fib(n-1) and fib(n-2) to calculate fib(n).
- Do each of these provide identical answers?
- Do each of these run at (roughly) the same speed?

# Next ...

- **Linked List**

# Reading Assignment

- **GT** Chapter 4 - 4.1, 4.2, 4.3
- **GT** Chapter 5 - 5.5, 5.6

# Questions?

**Please ask if there are any Questions!**