ME 3255 – Computational Mechanics

Prof. Ryan C. Cooper

ME 3255 – Computational Mechanics

- Introduction to scientific programming using Matlab/Octave
  - Best (Good?) practices for programming
  - Github (basic use)
  - Matlab/Octave functions
- Use tools to approximate solutions for:
  - Linear problems
  - Nonlinear problems
  - Differential equations

ME 3255 – Computational Mechanics

Grading

Item	Percent	Requirement
Homework	50 %	Turn in homeworks by assigned due date
Midterm Exam	10 %	One midterm exam
Final Project	30 %	A final project that will consist of code and documentation
Participation	10 %	During class online form will be sent out, you must submit form with your user ID to get credit

Who is taking this class?

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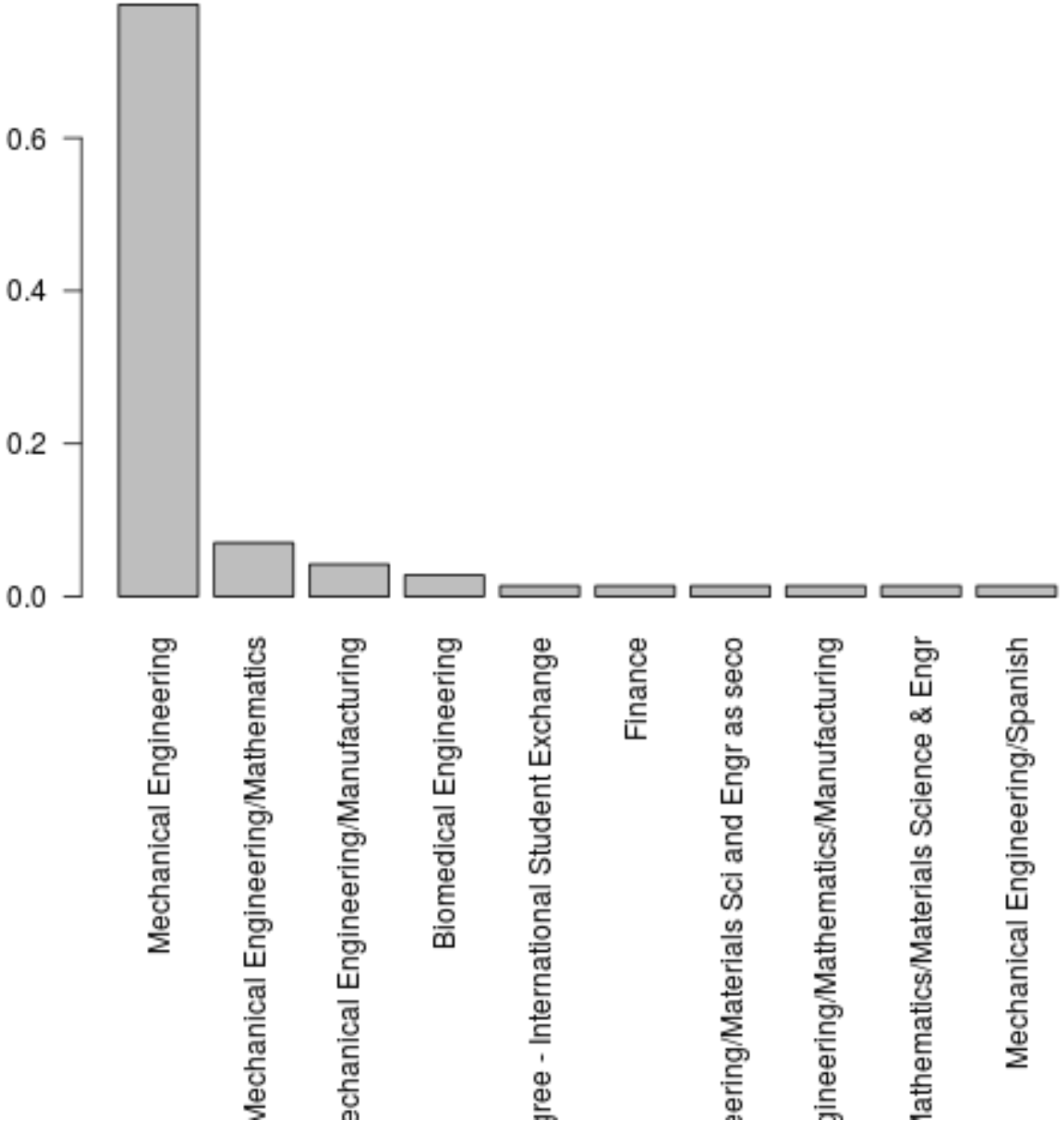

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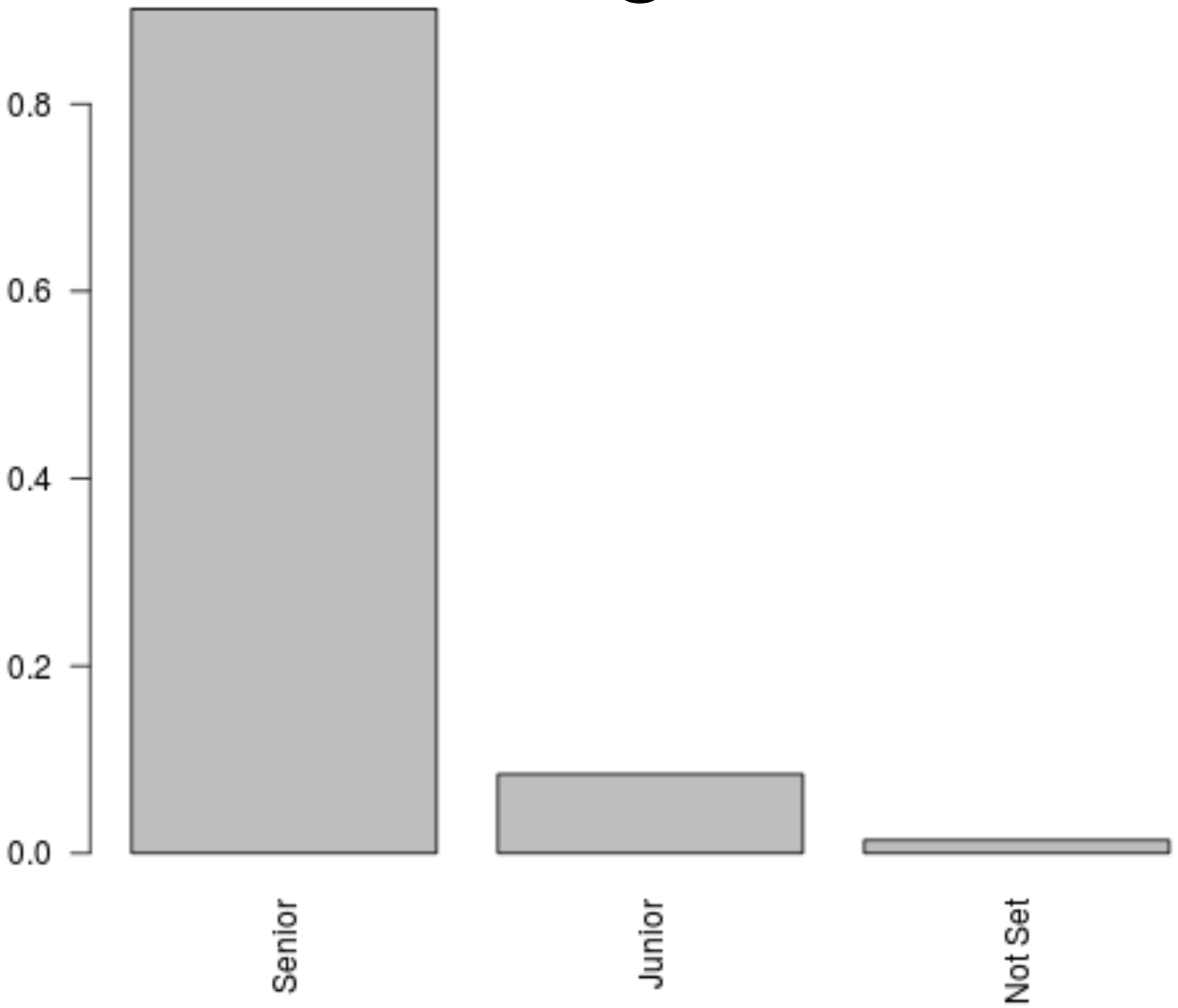
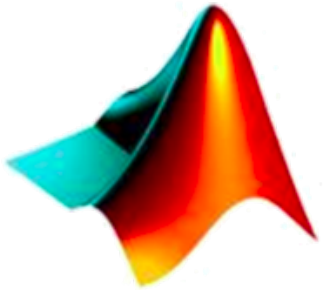


Why use Matlab/Octave?



MATLAB

GNU Octave

Scientific Programming Language

- Powerful mathematics-oriented syntax with built-in plotting and visualization tools
- Free software, runs on GNU/Linux, macOS, BSD, and Windows
- Drop-in compatible with many Matlab scripts

- Powerful set of tools for matrix and vector operations
- Excellent documentation
- User contributed code on mathworks.com/matlabcentral/fileexchange

- Free, open source software
  - If feature doesn't exist, you can make it yourself
- Most matlab functions available
- Documentation is great (but not as great as matlab)
- Can use most matlab files

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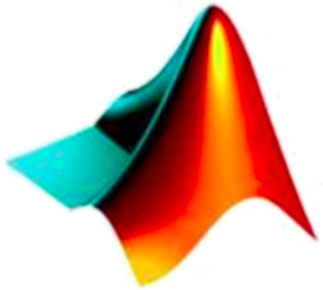

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cost	$2650	$0

Why use Matlab/Octave?

- Matlab written in C/C++ and java
- Octave primarily written in C++
- Both provide quick access to efficient numerical algorithms
- Great for
  - Quick programming
  - Back of the envelope calculations
  - Data processing and visualization
  - Statistics and curve-fitting
- Not meant for
  - Complicated for and while loops
  - Multimillion degree of freedom problems
  - Optimized coding

Why use Matlab/Octave?

- Matlab and Octave are **high-level**, **interpreted** languages
- **High-level**: many details of human-computer interactions taken care of (in contrast, the lowest level language is machine code)

Example of machine code: A function in hexadecimal representation of 32-bit x86 machine code to calculate the nth Fibonacci number:

```
8B542408 83FA0077 06B80000 0000C383
FA027706 B8010000 00C353BB 01000000
B9010000 008D0419 83FA0376 078BD989
C14AEBF1 5BC3
```

- **Interpreted**: interpreted languages have precompiled functions that are called by the main program. This means, to run a matlab file `example.m` you need to first load matlab/octave then execute the program
  - Advantage: troubleshooting is much easier because you can call functions one at a time and pull up help files
  - Disadvantage: Lots of overhead (memory taken up by unused functions)

Why use Github?

- This class briefly introduces a number of numerical methods
  - These have been done and optimized by others
- Github allows access to thousands of open-source projects
  - Can use code in your own projects
  - Can contribute back to community
- Organizes your own code with good looking README.md files
- Creates an interactive website for your code

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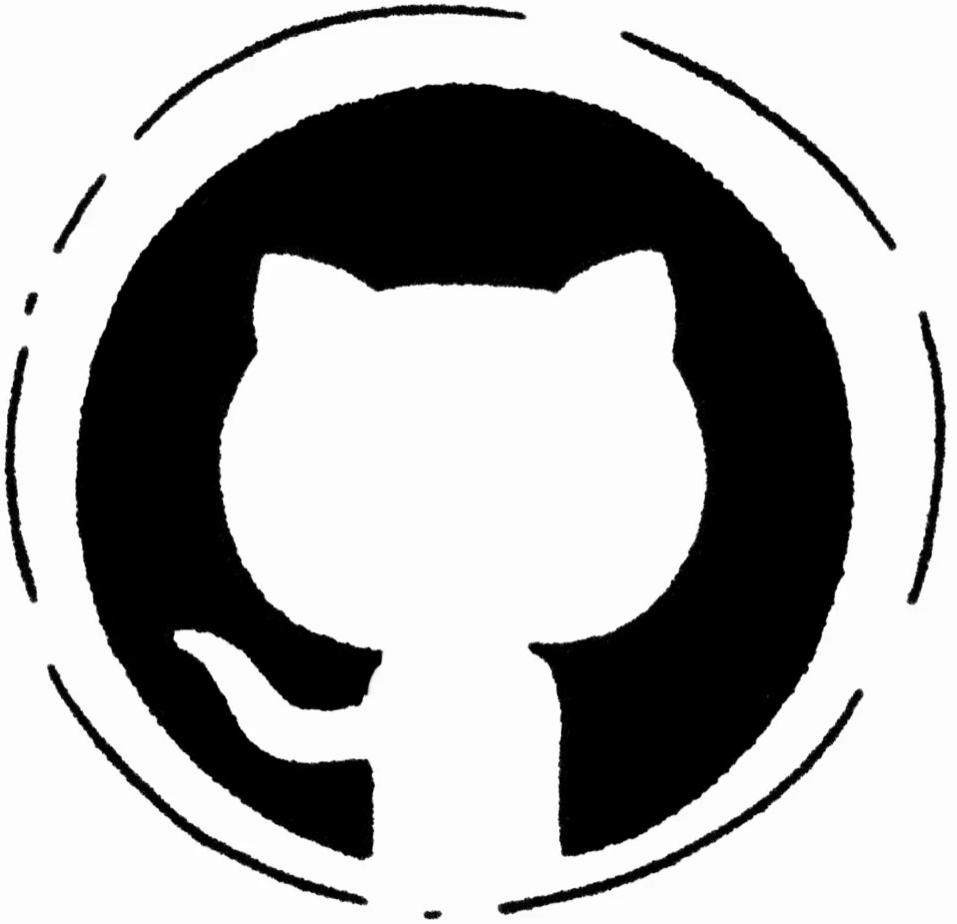

What can we do with these tools?

Mathematical model relates dependent variables to independent variables, parameters, and forcing functions.

$$\text{dependent vars} = \text{f}\left(\text{independent vars},\ \text{parameters},\ \text{forcing}\right)$$

consider the velocity of a free-falling object:

$$\sum \bar{\text{F}} = \bar{\text{F}}_{\text{drag}} + \bar{\text{F}}_{\text{gravity}}$$

$$\bar{\text{a}} = \frac{\sum \bar{\text{F}}}{\text{m}}$$