CPSC 340 Tutorial 1

Clement Fung

University of British Columbia

cfung1@cs.ubc.ca

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Overview

Assignment 0 Concept Review

- Linear Algebra
- Gradients
- Probability
- Big-O Notation

Julia Overview

- A0 Code Walkthrough

Linear Algebra

- Matrices $A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$ are denoted by upper-case letters
- A above is a 2 by 3 matrix (nrow by ncol)
- Vectors $x = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ are denoted by lower-case letters
- Vectors are column vectors by default (d by 1)
- Difference between A and A^T
- Matrix Multiplication: Computing Ax

Gradients

- Define:
  - $\mathbb{R}^d, \nabla f(x)$
- Difference between $\nabla f(x)$ and $\frac{\partial f(x)}{\partial x_j}$
- Sanity check:
  - Check the dimensions of gradient vector and input x
  - $f(x)$ is a scalar
  - $\nabla f(x)$ is the same dimension as x
- Exercise: Find the gradient
  - $f(x) = a^T x$
  - $f(x) = log(a^T x)$
  - $f(x) = (exp(a^T x) - 1)^3$

Probability Rules

Conditional Probability.

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

Bayes' Rule.

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Independence.

$$A \perp B \Rightarrow P(A|B) = P(A)$$

Marginalization.

$$P(A) = P(A, B) + P(A, \bar{B})$$

Probability Exercise (borrowed from Wikipedia)

Rolling two dice, D_1 and D_2.

- What is $P(D_1 == 2)$?
- What is $P(D_1 + D_2 \leq 5)$?
- What is $P(D_1 == 2 \cap D_1 + D_2 \leq 5)$?
- What is $P(D_1 == 2 | D_1 + D_2 \leq 5)$?

Probability Exercise (borrowed from Wikipedia)

What is $P(D_1 == 2)$?

	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

Probability Exercise (borrowed from Wikipedia)

What is $P(D_1 + D_2 \leq 5)$?

	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
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Big-O Notation

The notation

$$g(n) = O(f(n))$$

means "for all large n, $g(n) \leq cf(n)$ for some constant c > 0".
Examples:

- $20n + 5 = O(n)$
- $n^2 + 50n + 10000 = O(n^2)$
- $1/n + 10 = O(1)$
- $\log(n) + n = O(n)$
- $n\log(n) + n = O(n\log(n))$

Julia Overview

Declaring matrices, vectors, arrays

- `A = [1 2 3; 4 5 6; 7 8 9]` is a 3x3 matrix
- `b = [1 2 3]` is a row vector
- `c = [1; 2; 3]` is a column vector

Multiplication is overloaded

- `A * 2` matrix-scalar
- `A * c` matrix-vector
- `A * A` matrix-matrix

Element-wise operations

- `A * A` matrix-matrix
- `A .* A` element-wise multiplication

Julia Overview

Transpose

- `A'` gives the transpose
- `c * c` throws error
- `c' * c` works

Solving linear systems

- `A \ b` solves $Ax = b$

Julia Overview

Accessing elements: (use square brackets!)

- `c[1]` accesses first element of c (Julia is 1-indexed)
- `A[1,2]` is scalar
- `A[2,:]` is row vector
- `A[2:3,:]` is 2-rows
- `A[2:end,:]` also works
- `A[[1,3],:]` non-continuous slice

Booleans

- `A .== 2` for element-wise equals
- `A .> 2` for element-wise boolean
- See: any(), all(), find() when boolean indexing

Julia Overview

Things of note:

- Use include() to import functions
- Use readdlm() to read files
- Julia passes variables by reference!
  - Be careful:
  - `x = y;`
  - `y[2] = 5;`
  - `x[2]` is changed!

Julia Overview

Let's walk through the A0 code.