**Chapter 1 notes**

Problem solving involves 2 main steps – modeling and solving

Models: data driven (chapter 1, you will learn more in STAT 354) and physical laws based (chapter 3 onwards). Chapter 2 overlaps with MATH 214

Another classification is discrete time (difference equation based) and continuous time models (differential equation based)

A system has inputs and outputs. The math models developed in this course will link the outputs and inputs. You have to develop the skill to do write such math models and solve it.

A system can be static or dynamic. We deal with dynamic systems in this course (system parameters that change over time).

Chapter 1

3 types of data-driven models

**Linear** model y= f(x)

y=mx+b

**Exponential** model

y = bemx

ln(y)= ln(b) +mx

Y= B+mx where Y = ln(y) and B= ln(b)

**Power** model

y = bxm

ln(y)= ln(b) +m ln(x)

Y= B+mX where Y = ln(y), X = ln(x), and B= ln(b)

**Function fitting**

More than 2 points. n = number of data points

**Linear ŷ**=mx+b

$$m\sum\_{}^{}x\_{i }^{2}+b\sum\_{}^{}x\_{i}= \sum\_{}^{}x\_{i}y\_{i}$$

$$m\sum\_{}^{}x\_{i}+nb = \sum\_{}^{}y\_{i}$$

**Exponential** (straight line on an ln(y) and x plot)

$$m\sum\_{}^{}x\_{i }^{2}+B\sum\_{}^{}x\_{i}= \sum\_{}^{}x\_{i}Y\_{i}$$

$$m\sum\_{}^{}x\_{i}+nB = \sum\_{}^{}Y\_{i}$$

Where Y = ln(y) and B = ln(b)

Model is Ŷ= B+mx and b= eB

ŷ = bemx

**Power** (straight line on an ln(y) and ln(x) plot)

$$m\sum\_{}^{}X\_{i }^{2}+B\sum\_{}^{}X\_{i}= \sum\_{}^{}X\_{i}Y\_{i}$$

$$m\sum\_{}^{}X\_{i}+nB = \sum\_{}^{}Y\_{i}$$

Where Y = ln(y) and B = ln(b) X = ln(x)

Model is Ŷ= B+mX and b= eB

ŷ= bxm

**Non-linear functions**

Linearization at x0

f(x)= f(x0) + f’(x0) (x-x0)