DSCI

INF 564- Probability & Statistics for Data Science

Why do (electrical and Computer) Engineers study probability?

- Natural Phenomena are uncertain and hard to be modeled precisely
- As a result, the data that are

collected are uncertain

- Probability theory is the most important and useful theory that analyzes uncertainty

- Probability Theory has enabled humans to build elegant information technology solutions

- Information Technology in turn made collecting big amounts of data possible

Probability Theory, through a powerful tool called Statistics, provides a plethora of methods to analyze and model data

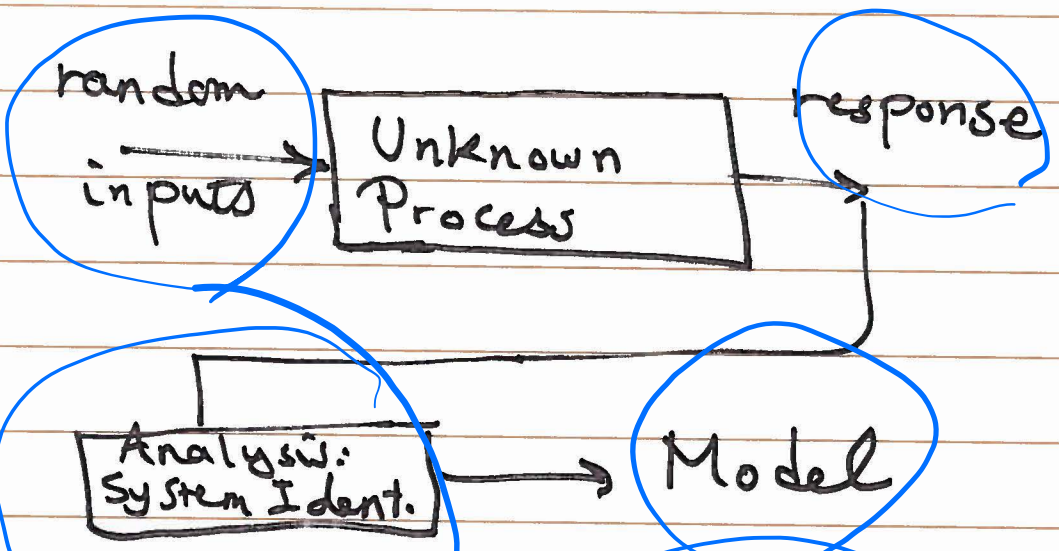
In some sense:

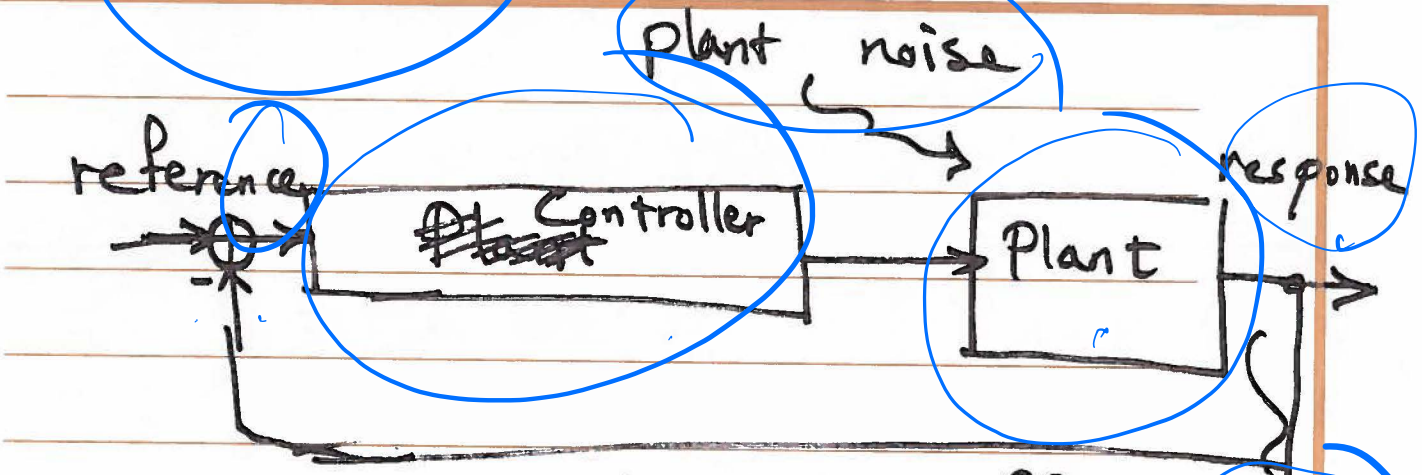
Engineering $\approx$ Analysis and Design Using Data

Studying Probability is a MUST.

Examples:

Control Systems



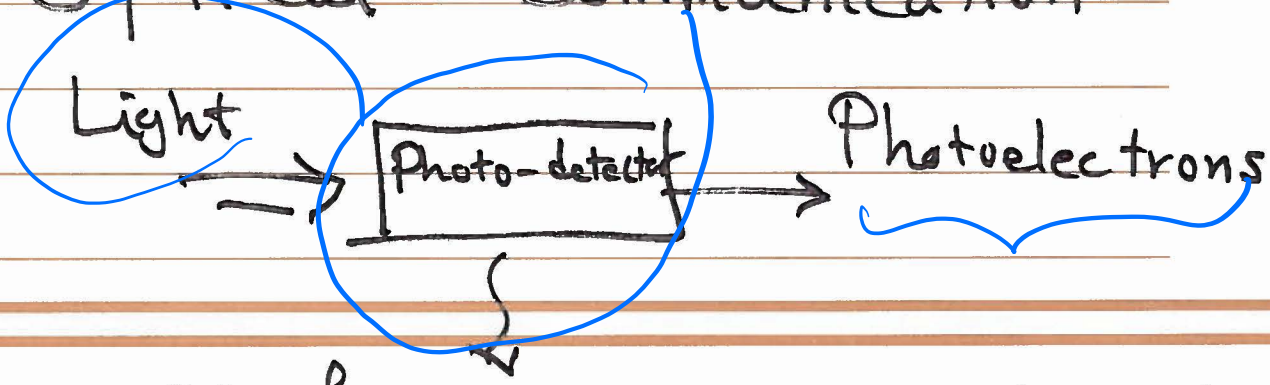


noise can adversely affect the performance of the system

Probability Theory provides

analysis tools To model the effect of noise and To mitigate it

Optical Communication



Interface between optical and electronic subsystems

Number of photoelectrons produced modeled by a Poisson Random Variable $\Rightarrow$ Used To determine if the transmitted bit was 0 or 1

Machine Learning:

- Uses Statistics to build algorithms that learn patterns from data

- Probability and Statistics are also used To measure how well learning systems work

Wireless Communications:

Analysis of the effect of (Gaussian) noise on signals that carry information is at the heart of communications

One of the most important branches of probability Theory, i.e. Information Theory, gave rise to the modern Communications Theory. (Contributed by Claude Shannon)

Variability in the design of digital and ~~analogue~~ electronic circuits

The - - - frequency of a certain microprocessor or the input impedance of an electronic amplifier may vary because of design imperfections.

Parameter estimation and Confidence Intervals are used to

model such variabilities by observing an "enough" number of instances

Computer Networks: Markov Chains are used to model network traffic

Financial Engineering

Probability is vastly used to determine the risk and expected return of portfolios, analyze

stock market prices (through time series analysis), etc.

Reliability and Survival Analysis: Probability theory is heavily used to model the Mean-Time Between Failure (MTBF) of equipments, to measure their reliability, and to model their useful life.

Similar techniques are

used in determining the effect of a new drug on survival rates of (cancer) patients