

ECE 302

Motivation

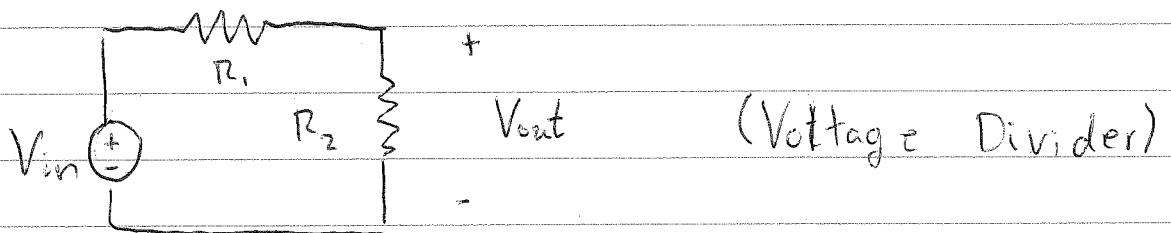
"Probability is common sense reduced to calculation." - Laplace

Why study Probability?

Engineers model and analyze physical (and virtual) systems in order to quantify the performance of designs and modifications.

Many processes are complex and ~~to~~ involve some level of uncertainty.

Most models you have discussed so far have been deterministic.



$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

In a deterministic model knowledge of the input and the model parameters completely specifies the output.

Is this a good approximation? \rightarrow Sometimes

In reality we observe

$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in} + \text{noise} \quad \leftarrow \text{(error)}$$

Can we obtain a better model if we "account" for the noise? \rightarrow YES

Applications

- Wireless Communication
- Voice, audio, video signals
- Machine Learning
(see chapter 1)

A probability model is a mathematical model of a random phenomenon.

Random Experiments

A random experiment is an experiment in which the outcome of the ~~experiment~~ experiment varies unpredictably when the experiment is repeated under identical conditions.

Ex Flip a coin once and observe the face it lands on.

Two possible outcomes: heads or tails
Usually write the set of outcomes in set notation.

$$S = \{H, T\}, \quad H = \text{heads}, \quad T = \text{tails}$$

Sometimes it is useful to talk about groups of outcomes that satisfy a certain condition. We call these groups events.

Ex Flip a coin twice and ~~observe~~ observe the sequence of faces the coin lands on.

Let H_i, T_i denote heads, tails on the i^{th} flip.

$$\text{Outcomes: } S = \{H_1, H_2, H_1, T_2, T_1, H_2, T_1, T_2\}$$

Event: "Heads on either flip"

$$A = \{H_1, T_2, T_1, H_2, H_1, H_2\}$$

Notice that the event A is a subset of the set of outcomes S .

We say that the event A occurs if the result of the random experiment falls in A .

An outcome is a result of a random experiment.

An event is a collection of one or more outcomes.

The set of all outcomes is called the sample space.

There are two types of sample spaces.

We say a sample space is discrete if the number of outcomes of the random experiment is finite or countable.

We say a sample space is continuous if the number of outcomes of the random experiment is uncountable.

Ex: Roll a six-sided die and observe the value rolled.

$$S = \{1, 2, 3, 4, 5, 6\}$$

6 outcomes \Rightarrow S is a discrete sample space

Ex Observe temperature of outdoors.

Let T be observed value.

$$T_{\min} < T < T_{\max}$$

$$S = (T_{\min}, T_{\max}) \leftarrow \text{interval in } \mathbb{R}$$

S is uncountable \Rightarrow S is a continuous sample space

Probability

A probability is a number assigned to an event that measures the likelihood of an event occurring.