# Decision Making

BUS 735: Business Decision Making and Research

**Goals and Agenda**

| Learning Objective | Active Learning Activity |
|---|---|
| Learn how to simulate probability distribution | Example problem in Excel. |
| Learn how to simulate inventory systems. | Example problem in Excel. |
| Learn how to simulate queuing systems. | Example problem in Excel |
| More practice. | Read Chapter 14, Homework exercises. |

**Simulating Probability Distributions**

- **Simulation:** drawing random numbers from a probability distribution.
- **Monte Carlo Simulation:** Use simulated data to simply compute means, standard deviations, etc.
- More complicated computations can be made based on the simulated data.
  - Create linear combinations of variables.
  - Take ratios!

**Example**

- Suppose the MacGuys sell somewhere between 0 and 4 computers each week from their store, according to the probability distribution to the right.
- Computers sell for $4,300 each.
- Analytically compute the mean and standard deviation for weekly demand for computers.
- Analytically compute the mean and standard deviation for weekly revenue.
- Simulate data for a number of weeks, and compute these same statistics.

ProbabilityDistribution:

| Demand | Prob. |
|---|---|
| 0 | 0.2 |
| 1 | 0.4 |
| 2 | 0.2 |
| 3 | 0.1 |
| 4 | 0.1 |

**Something More Complicated**

- Suppose there is an inventory cost of \$50 per computer.
- If the company falls short, the company not only fails to make a sale, but is estimated to loose \$500 in future revenue per computer, due to making a customer unhappy.
- Suppose the company orders 1 computer per week.
- Simulate demand for two years (104 weeks), simulate inventory for each week:

$$\text{Inventory}_t = \max(\text{Inventory}_{t-1} - \text{Demand}_{t-1}, 0) + 1.$$

- Simulate revenue, adjusting for \$50 inventory cost, \$500 shortage cost.

$$\begin{aligned}\text{Revenue}_t = {} & (\$4, 300)\ \min(\text{Inventory}_t, \text{Demand}_t) \\ & -(\$50)\ \text{Inventory}_t - (\$500) \max(\text{Demand}_t - \text{Inventory}_t, 0)\end{aligned}$$

**Queuing System Example**

- A denim manufacturing facility receives yarn at varying time intervals (according to the probability distribution in the following slide).
- Then it dyes the yarn, which takes varying amounts of time according to the second probability distibution (according to the second probability distribution on the following slide).
- If a batch of yarn arrives at the facility, it is possible it must wait for the previous batch to complete.
- It is possible that facility sits not utilized while it waits for another batch of yarn to arrive.
- Calculate the mean and std dev for the total time in the facility (waiting time + dying time).
- Calculate the mean and std dev for the waiting time.
- Calculate the average number of days per month the facility is idle.

**Queuing System Probability Distributions**

**Distribution of Arrival Intervals:**

| Arrival Interval | Probability |
|---|---|
| 1 day | 0.2 |
| 2 days | 0.4 |
| 3 days | 0.3 |
| 4 days | 0.1 |

**Distribution of Dying Times:**

| Dying Time | Probability |
|---|---|
| 0.5 days | 0.2 |
| 1 day | 0.5 |
| 2 days | 0.3 |

**Queuing System Equations**

Compute the following:

1. Simulate $\text{Interval}_i$.
2. $\text{Arrival}_i = \text{Arrival}_{i-1} + \text{Interval}_i$.
3. $\text{Waiting}_i = max(\text{Finish}_{i-1} - \text{Arrival}_i, 0)$
4. $\text{Idle}_i = max(\text{Arrival}_i - \text{Finish}_{i-1}, 0)$
5. Simulate $\text{Dying}_i$.
6. $\text{TimeSystem}_i = \text{Waiting}_i + \text{Dying}_i$
7. $\text{Finish}_i = \text{Arrival}_i + \text{TimeSystem}_i$

**Homework**

- End of Chapter 14 (pages 665-666), problems 7 and 8.
- Due Tuesday, November 6, before class.
- Type up answers in a Microsoft Word file, include your Excel file.
- Upload to D2L dropbox.