Lesson 2. Simulation Using Excel

1 Sampling a discrete random variable

- Last time, we worked with a **discrete random variable** – interarrival time – with the following probability distribution

Interarrival time (min)	1	2	3	4	5
Probability	0.1	0.1	0.3	0.3	0.2

- We used 10 cards, shuffled and randomly drawn, to sample values from this discrete random variable
- Instead of using cards, what if we could sample a random variable U uniformly distributed on $[0,1]$?
  - Recall: pdf of random variable U uniformly distributed on $[a,b]$

- Idea: assign interarrival times to intervals on $[0,1]$:

  - Sample a value of U
  - Interval that U lies in corresponds to interarrival time
  - For example:
    - $\mathbb{P}(\text{interarrival time} = 4) =$
    - $\mathbb{P}(\text{interarrival time} = 5) =$

2 Sampling interarrival and service times in Excel

- In this lesson's spreadsheet, we have a table that corresponds to the interarrival time probability distribution, laid out as intervals on $[0,1]$ as above
- We also have this for the service time probability distribution
- For convenience's sake, let's name these two tables `interarrival` and `service`, respectively
- Using the `RAND` function, we can sample a random variable U uniformly distributed on $[0,1]$
- Using the `VLOOKUP` function, we can then figure out what interval U lies in to get the corresponding interarrival time or service time

- VLOOKUP(lookup_value, table_array, col_index_num)
  - lookup_value = value to search for in the first column of table_array
  - table_array = range or name of table
    - table_array should be sorted in ascending order of the first column
  - col_index_num = column in table_array from which the matching value should be returned

3 Simulating the drive-in example

- Using our observations from last time, we can compute the arrival time, begin service time, departure time, and total time at bank for the first and second customers
  - Often, the behavior of the first or first few entities (e.g. customers) in a simulation will be slightly different
- Using Copy and Paste allows us to quickly do the same for the third and any subsequent customers
- By default, the values from RAND are automatically recalculated every time the spreadsheet is updated
- Pressing the F9 key or Formulas → Calculate Now will execute the simulation again
- To turn off automatic recalculation, select Formulas → Calculation Options → Manual

4 Submitting files on Google Drive

- URL: `https://drive.google.com/a/usna.edu`
- Click on Shared with me in the left pane
- You should now see your SA421 submission folder in the right pane
  - It should be named SA421 Lastname, Firstname
  - Don't rename this folder, since it renames it for me as well! I need to be able to reliably figure out which folder is yours.
- For each quiz/exam/etc., create a new folder
  - You can do this by clicking on the folder with a plus sign near the top of the window
- You can upload files using the upload button (red, next to CREATE in the left pane), or via drag-and-drop (may not work, depending on your browser)
- Try it now:
  - Create a new folder called test
  - In the test folder, upload the spreadsheet you worked on for today's lesson