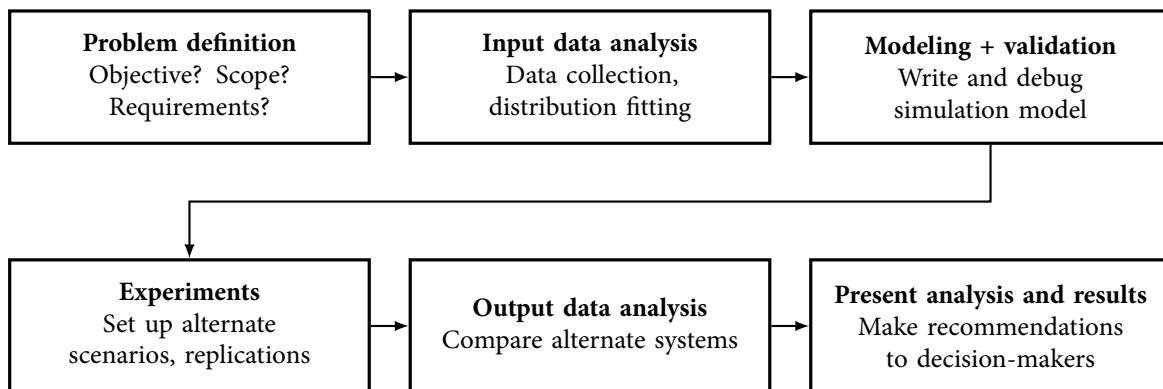# Lesson 1. Introduction

1   What is simulation?

- **Simulation** is the imitation of a real-world system in order to obtain data that can be used to evaluate and improve the system's performance

- In this course, we will focus on simulations that are

  ○ **stochastic**: some aspects of the system are modeled using random variables
  ○ **discrete-event**: state of the system changes at discrete points in time triggered by **events**, e.g. the arrival of a customer, the completion of an activity

2   Why simulate?

- Real-world trial-and-error approaches are expensive, time consuming and disruptive

- Complex systems are often resistant to analytical models and solutions
  (e.g. limitations of mathematical programming, queueing theory)

3   A typical simulation study

Problem definition Objective? Scope? Requirements?	**Input data analysis** Data collection, distribution fitting	**Modeling + validation** Write and debug simulation model

Experiments Set up alternate scenarios, replications	**Output data analysis** Compare alternate systems	**Present analysis and results** Make recommendations to decision-makers

4   In this course...

- We will learn how to perform all of the different parts of a simulation study

- We will also focus on writing reports that professionally present your analysis and results

- We will use the following tools in tandem:

  ○ **JaamSim** is a free and open source software for discrete-event simulation
  ○ **R** is an open source programming language for statistical analysis

- Note that there are many other tools for simulation and statistical analysis, e.g.

  ○ Arena, ProModel, Simio for simulation
  ○ SPSS, Stata, Pandas/SciPy/Python, for statistics

- Many of these are similar in functionality and even usage

- Learning one tool will help you learn others in the future

5 A sample simulation study

The Nimitz Coffee Bar (NCB) cafe has a line where customers wait to place their order with the cashier. Once they have ordered, one or more baristas complete their order. Order completion is conducted on a first-in, first-out (FIFO) basis.

NCB is thinking about adding more baristas to improve its customer service. NCB has hired you as a consultant to answer this question. You have been provided with data on the arrival times, cashier times, and service times.

- Let's get this sample simulation study up and running

- We will cover the details over the next several lessons

Step 1. Prepare a folder for all the things

- We will put all the software together in one folder for easy access

- In this example, we will use 🗀 `C:` ‣ `Users` ‣ `uhan` ‣ `Desktop` ‣ `SA421`

Step 2. Install R Portable

- Download the installer here:

  `https://sourceforge.net/projects/rportable/files/R-Portable/3.4.1/R-Portable_3.4.1.`
  `paf.exe/download`

- Run the installer

- Select 🗀 `C:` ‣ `Users` ‣ `uhan` ‣ `Desktop` ‣ `SA421` ‣ `R-Portable` as the destination folder

- Click ⬚Extract⬚

Step 3. Install RStudio

- Download the zip file of RStudio here: `https://download1.rstudio.org/RStudio-1.0.153.zip`

- Right-click on the zip file and select ⬚Extract All...⬚

- Select 🗀 `C:` ‣ `Users` ‣ `uhan` ‣ `Desktop` ‣ `SA421` ‣ `RStudio-1.0.153` as the destination folder

- Click ⬚Extract⬚

Step 4. Install JaamSim

- Download JaamSim here:

  `https://github.com/jaamsim/jaamsim/releases/download/v2017-09/JaamSim2017-09.jar`

- Move the jar file to 🗀 `C:` ‣ `Users` ‣ `uhan` ‣ `Desktop` ‣ `SA421` ‣ `JaamSim`

Step 5. Point RStudio to right version of R

- Launch RStudio. You should find it here:

    🗁 `C:` ‣ `Users` ‣ `uhan` ‣ `Desktop` ‣ `SA421` ‣ `RStudio-1.0.153` ‣ `bin` ‣ `rstudio.exe`

- Select `Tools` ⟫ `Global Options...`

- Click on `Change...` under "R version"

- Click on `Browse` and navigate to 🗁 `C:` ‣ `Users` ‣ `uhan` ‣ `Desktop` ‣ `SA421` ‣ `R-Portable` ‣ `App` ‣ `R-Portable`

- Click `Choose Folder`

- Select the 64-bit version

- Exit the Global Options dialog and restart RStudio

Step 6. Install some R packages we'll need

- In the RStudio console, execute the following:

```
install.packages("readxl")
install.packages("fitdistrplus")
install.packages("dplyr")
install.packages("knitr")
install.packages("rmarkdown")
install.packages("formatR")
```

Step 7. Download the files for the simulation study

- Download the zip files containing the simulation study files here:

    `https://github.com/sa421-usna/nimitz-cafe/zipball/master`

- Right-click on the zip file and select `Extract All...`

- Select 🗁 `C:` ‣ `Users` ‣ `uhan` ‣ `Desktop` ‣ `SA421` as the destination folder

- Open the newly extracted folder (rename it if you want), and open `nimitz-cafe-analysis.Rmd` in RStudio

Step 8. Run the simulation study

- Change the line that runs the simulation study to reflect where you put JaamSim:

```
# Run simulation
system('java -jar "/Applications/jaamsim/JaamSim2017-09.jar" "nimitz-cafe-simulation.cfg"
-b')
```

- Select `Run` ⟫ `Run All`

- Once the study is runs from start to finish, look at the user-friendly version of the report by clicking `Preview Notebook` (might be under `Knitr`)