Data Science and R

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Learning Objectives

- Introduction to Course
- Placing R in the context of data science.
- Chapter 1 in RDS

Data Science

Components of Data Science

- Statistics
- Domain Knowledge
- Computation

Statistics

- Inferring general properties given data.
- Causal inference.
- Modeling (generative and predictive).
- Quantifying uncertainty.
- STAT 615 (Regression), STAT 627 (Machine Learning), most of the STAT curriculum.

Domain Knowledge

- Expertise in an area of application.
- E.g. biology, psychology, economics, chemistry, etc. . .
- Allows you to understand data in context.
- Let's you ask interesting questions.
- Let's you spot problems with existing analysis pipelines.
- Various "Tracks" in the data science program.

Computation – This class

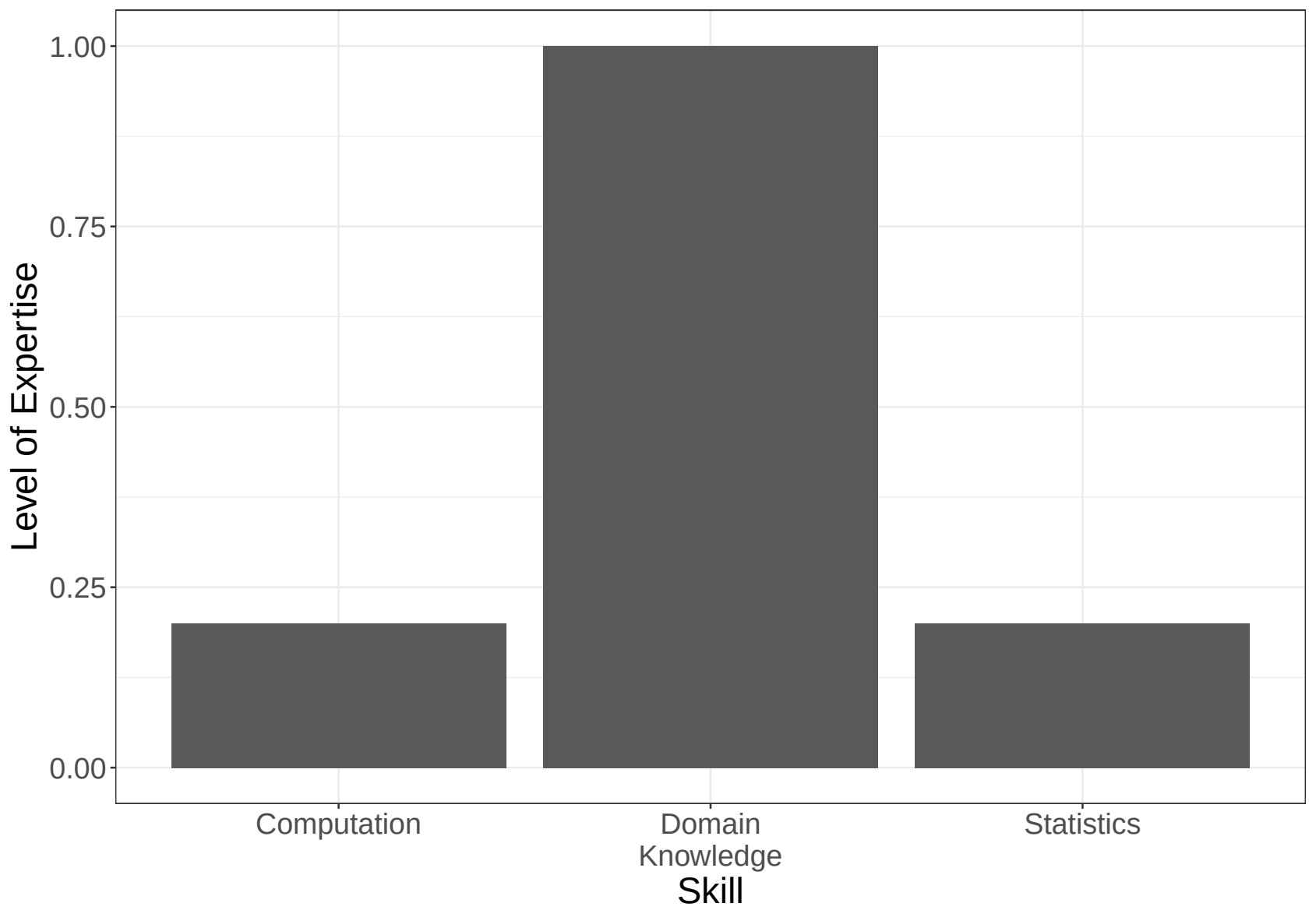
- Data gathering.
- Data preparation.
- Data exploration.
- Data transformation.
- Data visualization.
- STAT 612 (R programming), STAT 613 (Data Science), most of the CS curriculum.

Various Professions

What makes a data scientist?

- Lots of professions use those three skills to analyze data.
- My (very subjective) opinion is that these professions differ by their level of expertise.

Scientist


1.00
0.75
0.50
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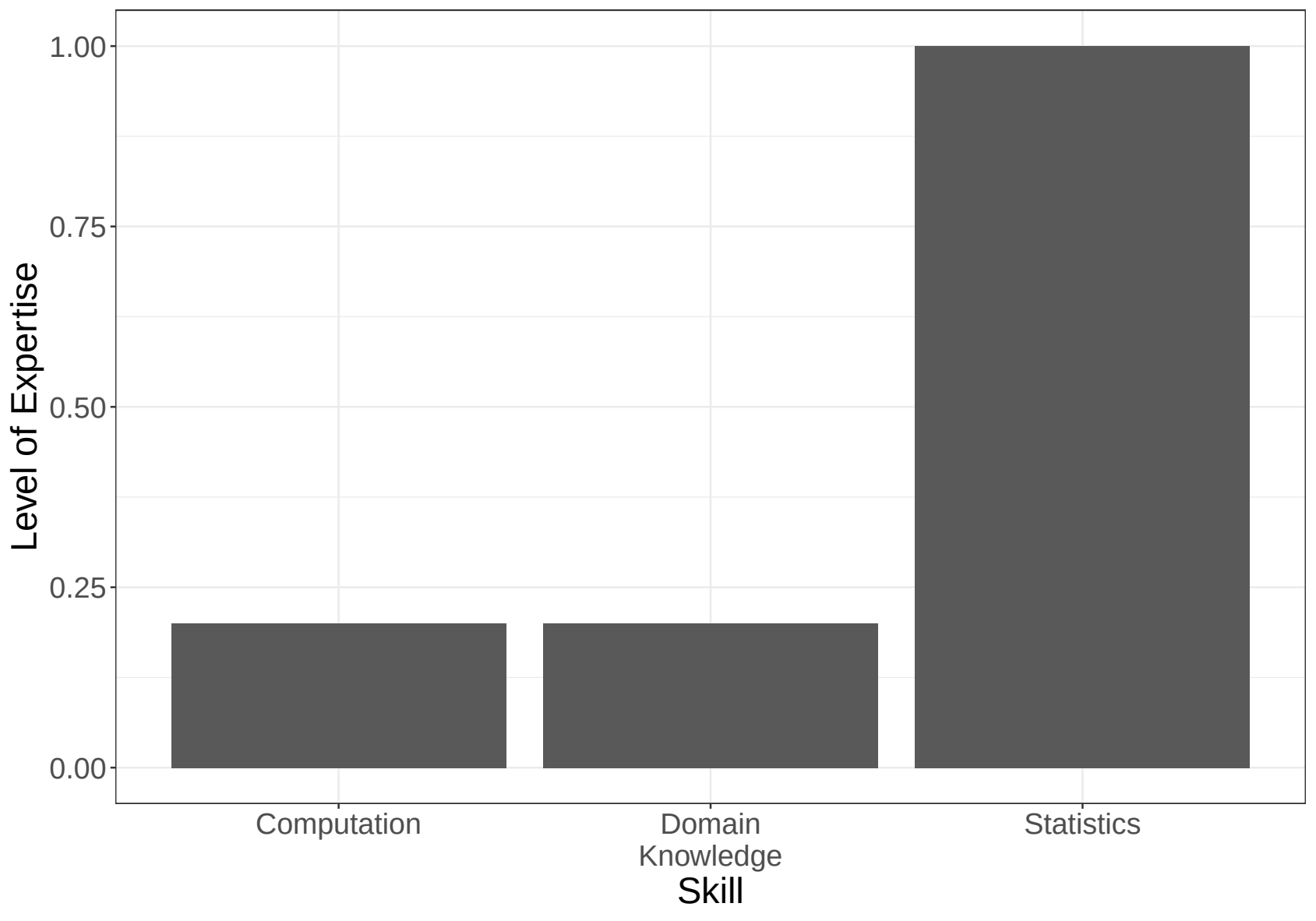
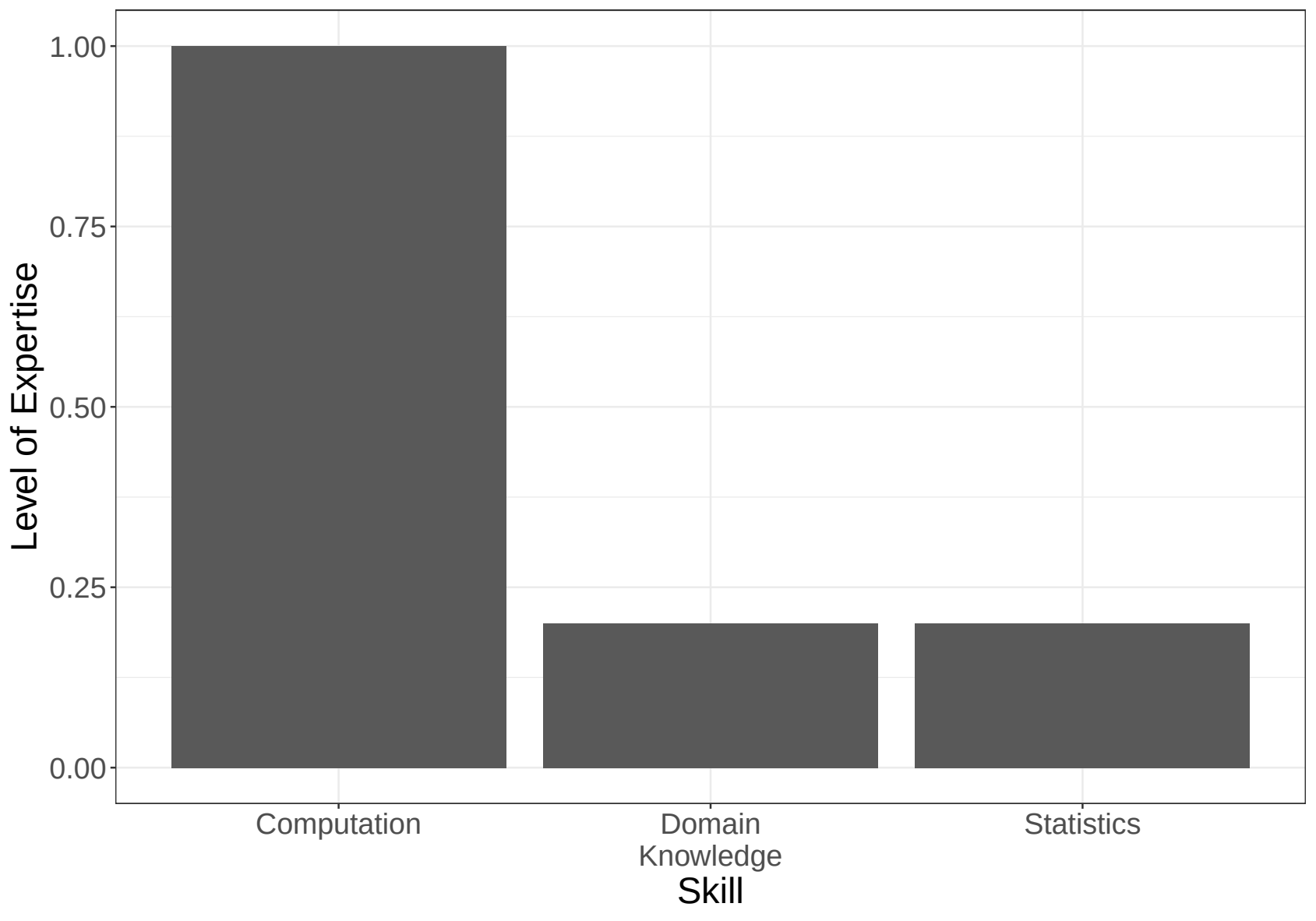
Level of Expertise
Computation
Domain Knowledge
Statistics
Skill

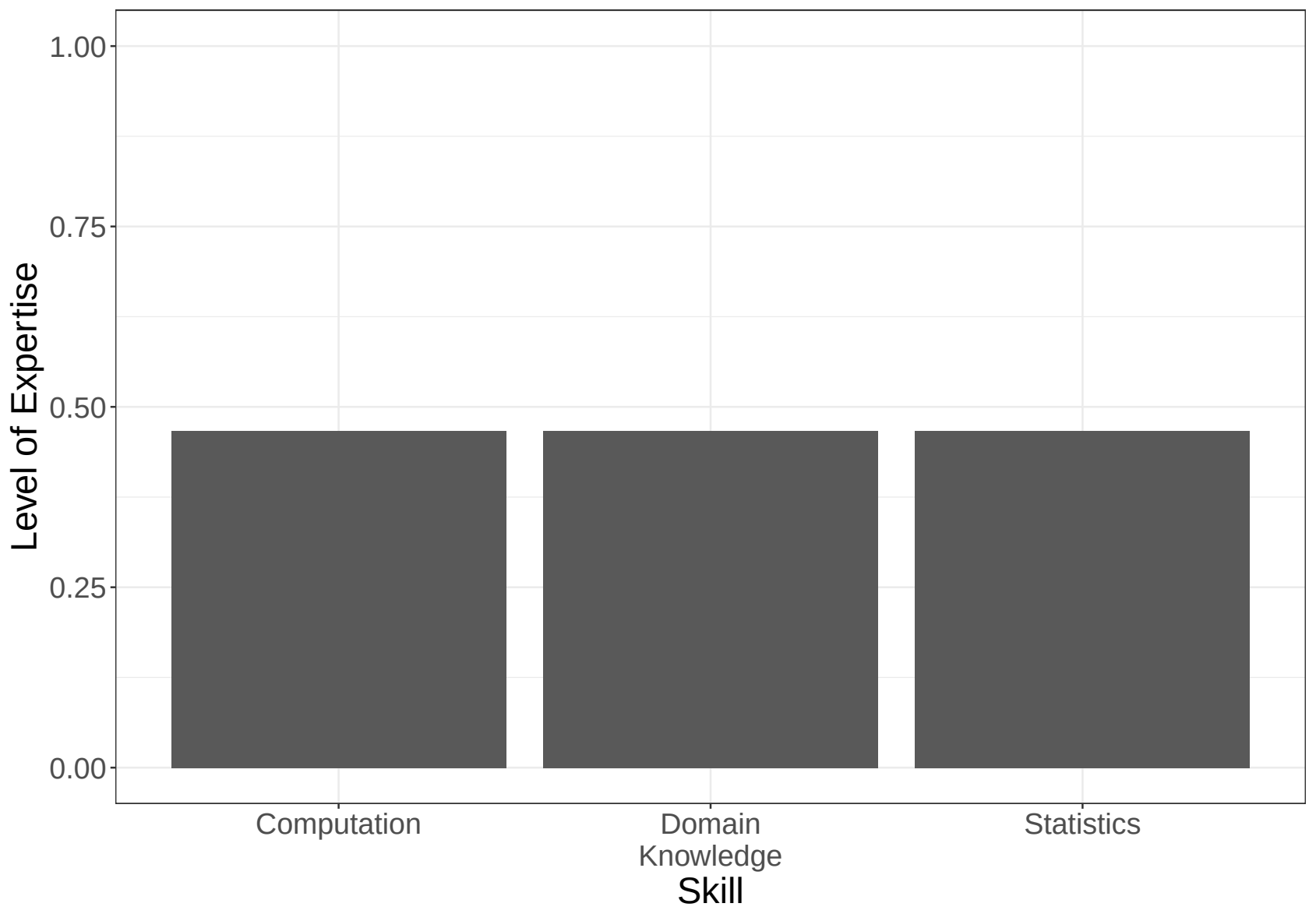
Statistician



Computer Scientist

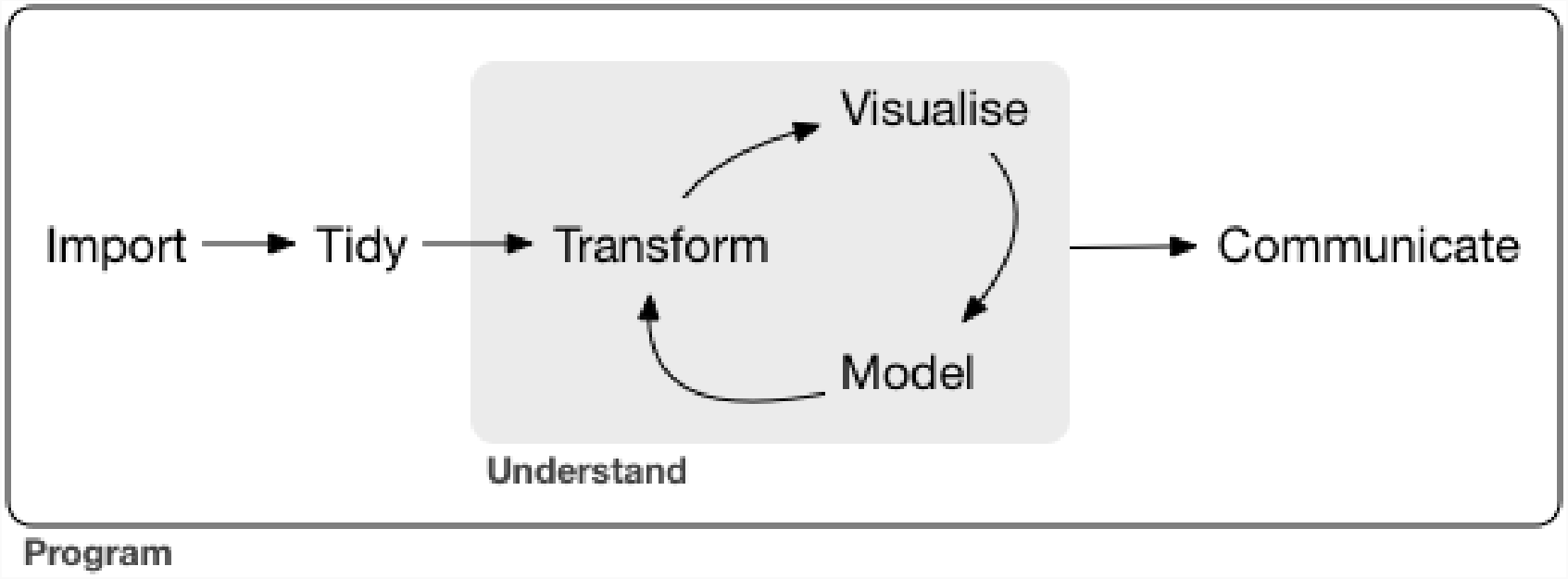


Data Scientist



The steps of an analysis and R

Steps of a data analysis



Tools

- Many tools exist for these steps:
- General data tools: R, Python, Julia, Matlab, STATA, SAS
- Other tools: SQL (data import), git (version control), map/reduce software (for big data).
- Advantages and disadvantages to each.

R

- R is a statistical scripting language.
- You write code (a series of commands) to perform some task.
- R can be used to perform **all** of the tasks of a data analysis.

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3. It's easy (especially graphics and data munging).
4. It makes reproducible research easy.
   - When part of the pipeline is copying and pasting excel spreadsheets, people make mistakes.
   - E.g. an excel mistake led countries to adopt austerity measures to increase economic growth.
   - In R, you can automate your analysis, reducing the chance for mistakes and making your analysis transparent to the wider research community.

Could Also Learn Python

- Python is also a very good tool for data science.
- Computer scientists tend to prefer it because its syntax is more like a standard computer language. But I think this makes it harder to learn for a non-programmer.
- Main reason to use either tool is based on what your collaborators use.

Two main flavors of R

- There are two flavors of R programmers: Base R users and tidyverse users.
- Base R is more general (not fighting against the system when you want to accomplish a unique task that isn't designed to fit within the tidyverse).
- tidyverse is much more convenient for the vast majority of tasks as long as you drink the kool aid.

This Class

Tentative Schedule

- Week 1: Intro (chapters 1–2), R basics (chapter 4), data frames (chapter 10), R Markdown (chapter 27)
- Week 2: R Programming (pipes, functions, R scripts) (Chapters 6, 17–19)
- Week 3: Data Visualization (chapter 3)
- Week 4: Manipulating data frames with dplyr (chapter 5)
- Week 5: dplyr lab (chapter 5)
- Week 6: Exam 1
- Week 7: Data import and exploratory data analysis: (chapters 7, 11)
- Week 8: tidyr (chapter 12)
- Week 9: tidyr lab (chapter 12)
- Week 10: Exam 2
- Week 11: Relational Data (chapter 13)
- Weeks 12/13: Strings (Chapter 14)
- Week 14: Factors

Books and Resources:

- All material used in this course is free online.
- R for Data Science: https://r4ds.had.co.nz/
- Tidyverse Style Guide: https://style.tidyverse.org/
- Rstudio Cheat Sheets: https://www.rstudio.com/resources/cheatsheets/
- Hands-on Programming with R: https://rstudio-education.github.io/hopr/

Grading

- Assignments: 40% for grad students, 50% for undergrads
- 2 midterms: 12% each
- Final exam: 16%
- Grad students: Final Project: 20%
- Undergrads: Attendance/participation: 10%

Exams

- The exams will be in-class coding assignments. You will have 2.5 hours to complete some coding questions.

Curve

- No curve for individual assignments/exams/projects.
- Curve your overall grade at the end of the semester.
- Curve the median up to 85%.
- Usual cutoffs for A/A-/B+/B/B-/C+/C/C-/D/F.
- My classes usually finish with the pre-curve median being around 75%.

One last note

- The course notes will **not** contain everything you need for the assignments.
- You will need to use Google. Just make sure you understand any support you get and cite your sources.
- This is how most people learn how to code now.