Practical Data Science I: Wrangling Data and Answering Questions

Adriane Fresh & Nick Eubank

What is Data Science?

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1. What (in theory) do we think Data Science should be?

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1. What (in theory) do we think Data Science should be?
2. What (empirically) is Data Science?

What (in theory) should Data Science be?

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Study of how to solve problems

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Study of how to solve problems by answering questions

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    - Data Science is an *applied* discipline!

What (in theory) should Data Science be?

Study of how to solve problems by answering questions using quantitative data.

- Problem-first approach.
  - Data Science is an *applied* discipline!
- The tool you use should be dictated by the question you seek to answer

What (empirically) is Data Science?

How did Data Science become a thing?

Over the past several decades:

1. Availability of data $\uparrow$
2. Computational power $\uparrow$

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$\Rightarrow$ Huge proliferation and increase in sophistication of computational methods

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- Academic research is organized into silos:

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  - Computer Science
  - Statistics
  - Economics
  - Political science
  - Engineering

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$\Rightarrow$ Development of new tools occurred *within* each silo.

Where are we today?

Very little cross-pollination across silos

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- Lots of duplication of development.

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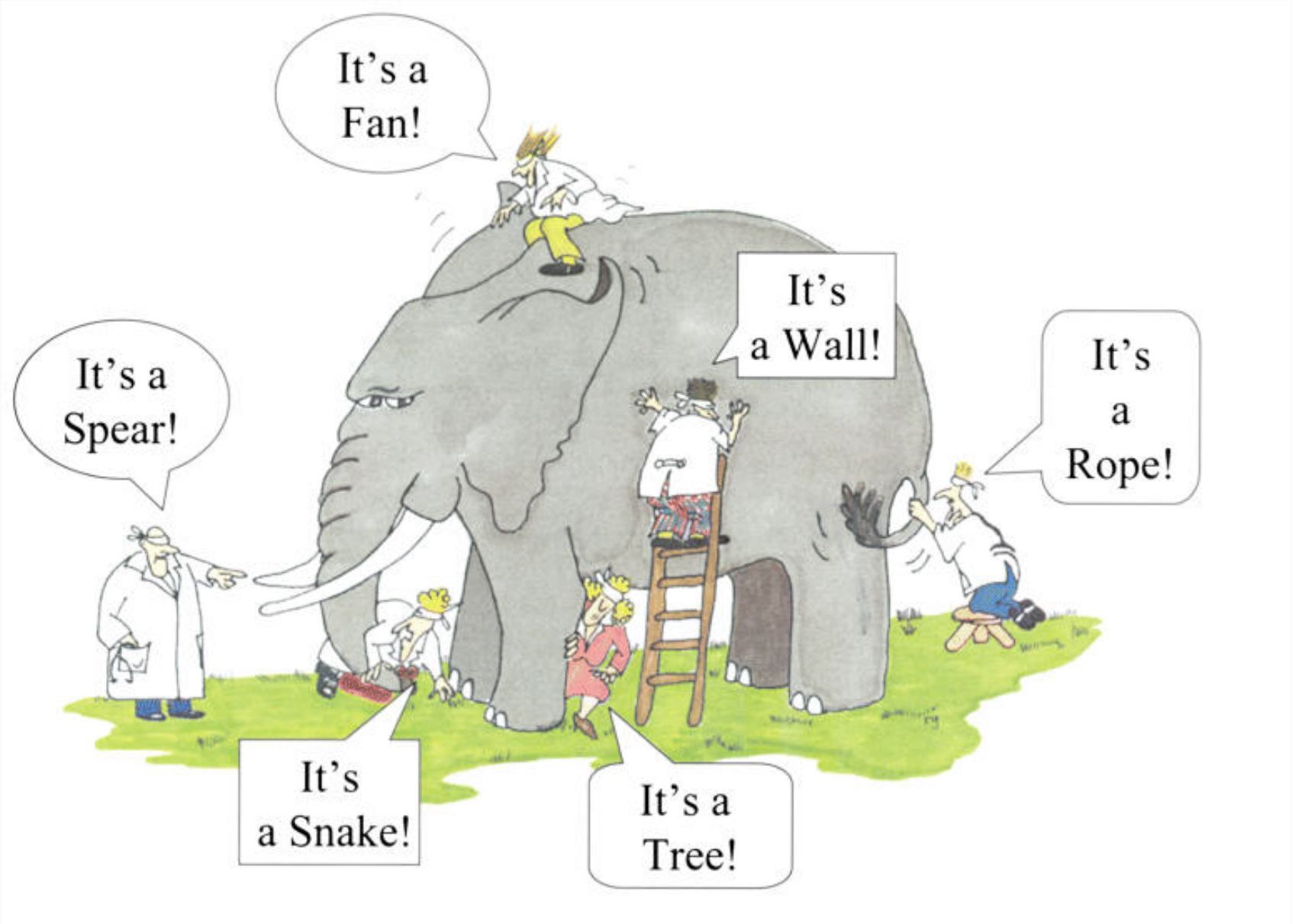
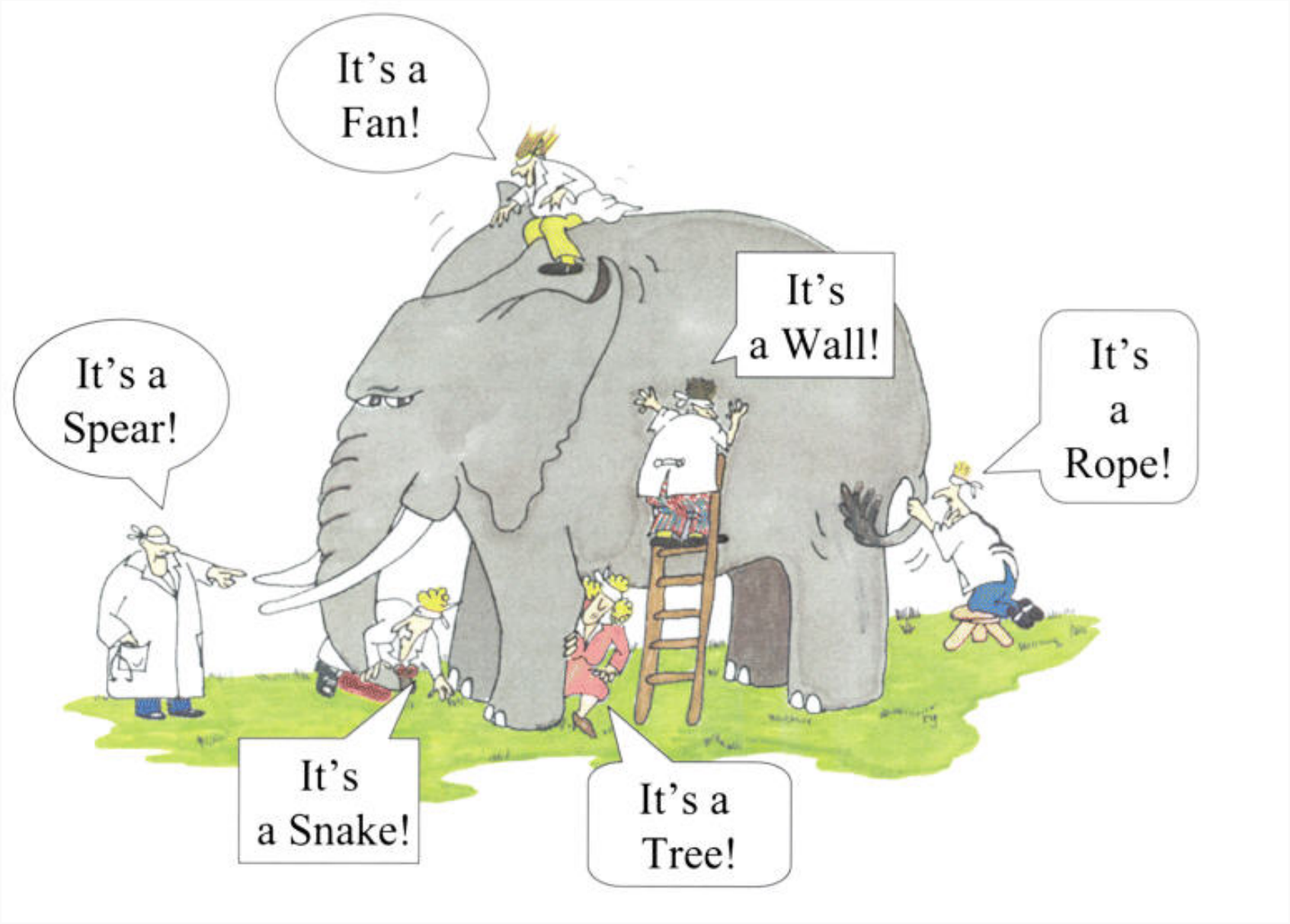
- Each silo has focused on the aspects most relevant to their applications. e.g.:
  - CS likes to classify things and make predictions, don't care how model works
  - Social scientists like to make causal statements, don't care about predictive power


It's a Fan!
It's a Spear!
It's a Wall!
It's a Rope!
It's a Snake!
It's a Tree!



$\Rightarrow$ This is where we are *now.*

What is (empirically) Data Science?

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An effort to unify the development of quantitative methods

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An effort to unify the development of quantitative methods

$\rightarrow$ Recognize the elephant

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- Most current researchers learned their skills in a silos.
  In many ways, *you* will have better perspective than your professors.
- Expect fragmentation in both software and vocabulary.
  The fact things don't always seem coherent isn't because you're missing something.

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  - That's why we have faculty from many fields.

This Class

"The Python Class"

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- *Data Science* Python

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    - Python standard library, numpy, pandas, scikit-learn, matplotlib, statsmodels

“The Everything-That-Comes-Before-Data-Analysis Class”

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In this course, you will learn:

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All through hands-on experience.

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but this isn't a class *about* Python.
$\Rightarrow$ Emphasis on generalizable data science skills

This Class

By the end of this class:

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- Find and organize data *on your own*.

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By the end of this class:

- Find and organize data *on your own*.
- Understand how to clean, merge, and manipulate real-world data.
- Know how to approach organizing a full project.

Why Python?

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And why not:

- Stata
- R (Tidy-Verse)
- R (Base-R)

?

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  Excellent for tabular data, some text
- R (Tidy-Verse)

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  Excellent for tabular data, some text
- R (Tidy-Verse)
  Excellent for tabular data
- R (Base-R)
  Good for tabular, network, geospatial, some text and ML

?

Why Python?

Python:

- Tabular data
- Network data
- Geospatial data
- Natural Language Processing (NLP)
- Neural Networks
- Using with Cloud Compute
- Big Data
- Large Language Models
- All Machine Learning
- ...

Why?

Language Intrinsics:

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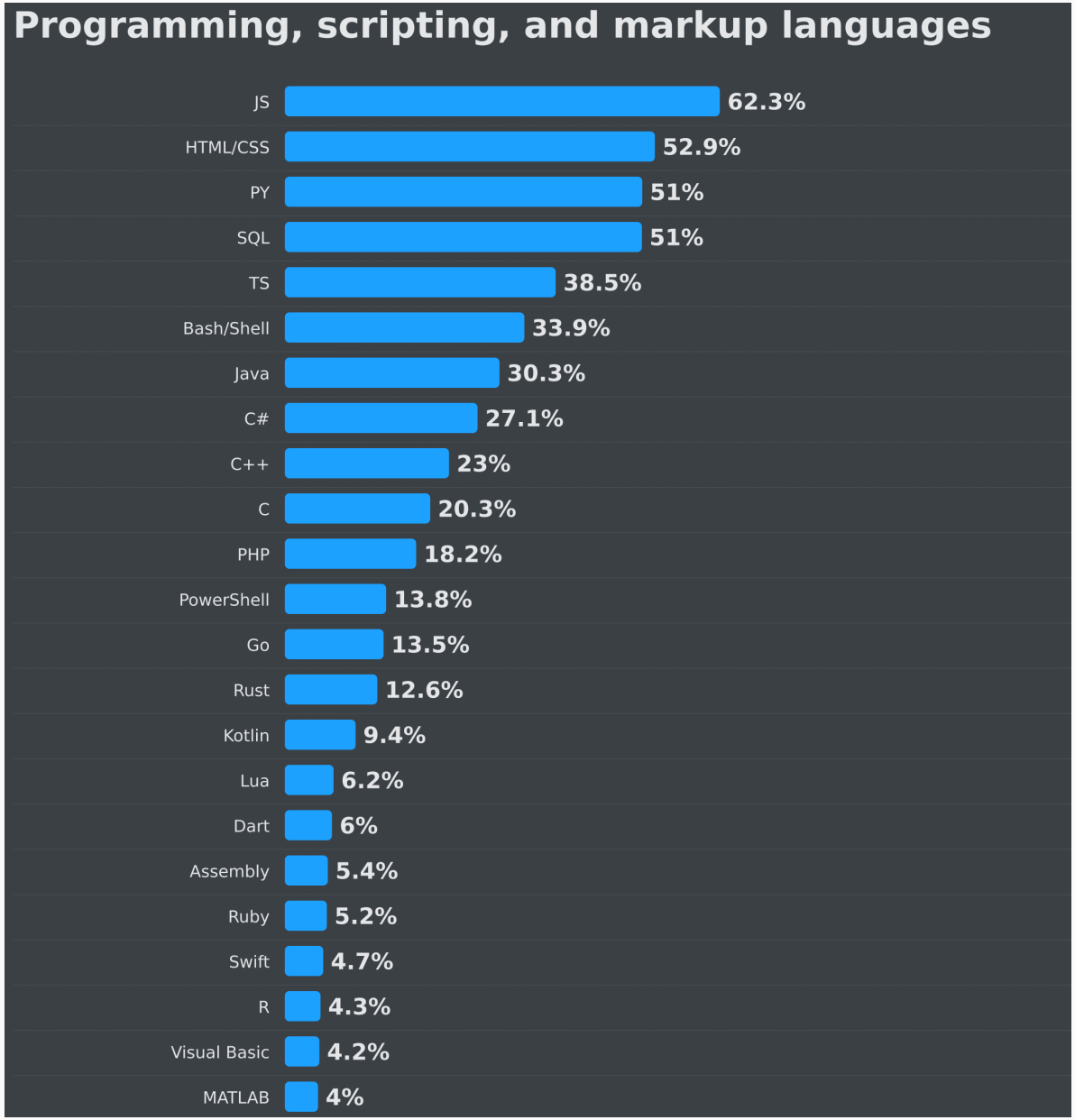
Network Effects:

- 90s and 2000s (even 2010s): most social scientists used Stata or R, developed for Stata and R.
- 2010s and 2020s: Businesses, computer scientists and software engineers moved to data science.
  - Wanted a fully-featured, general purpose language (ideally one they know).

Stack Overflow Developer Survey 2024



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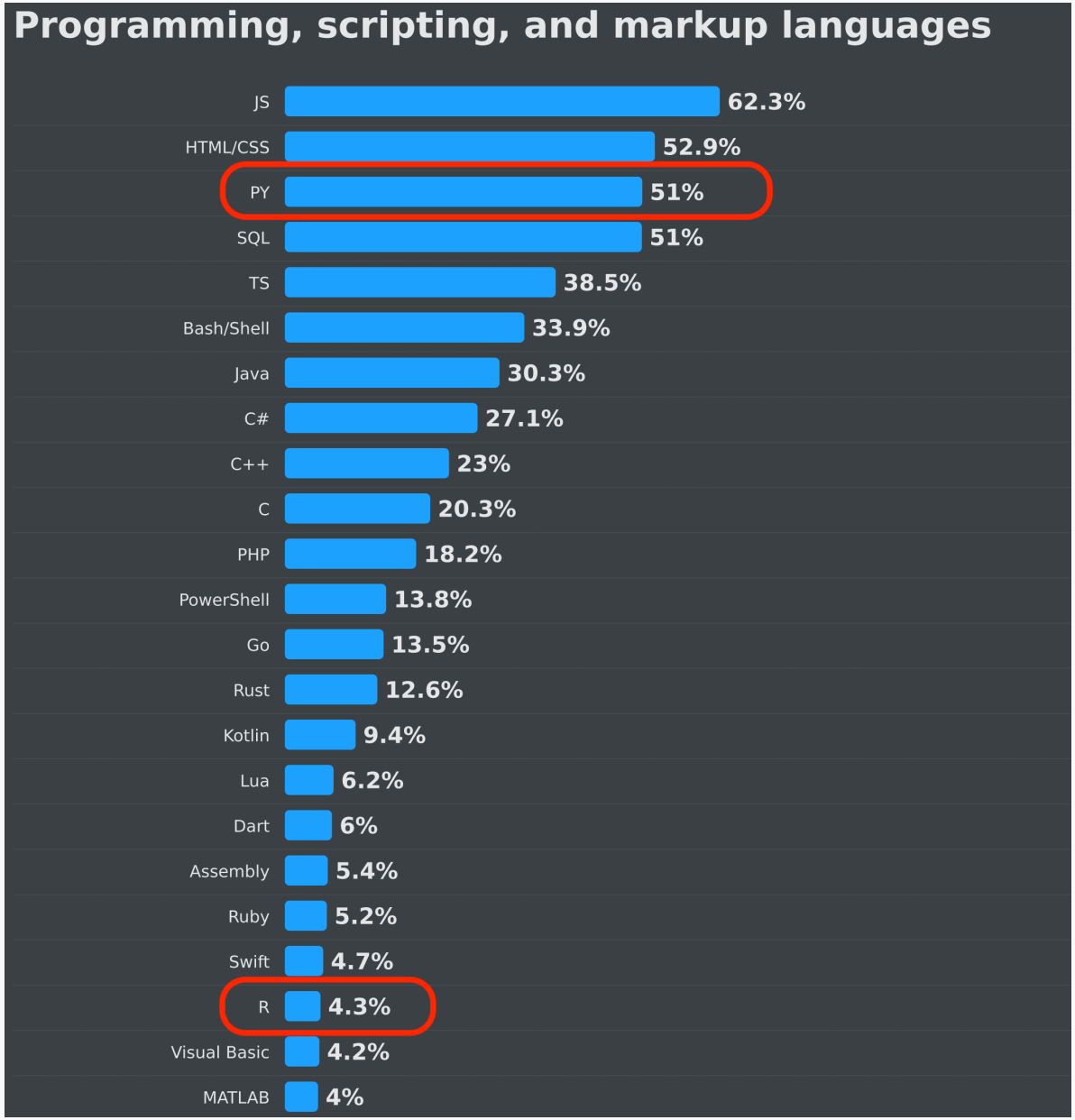
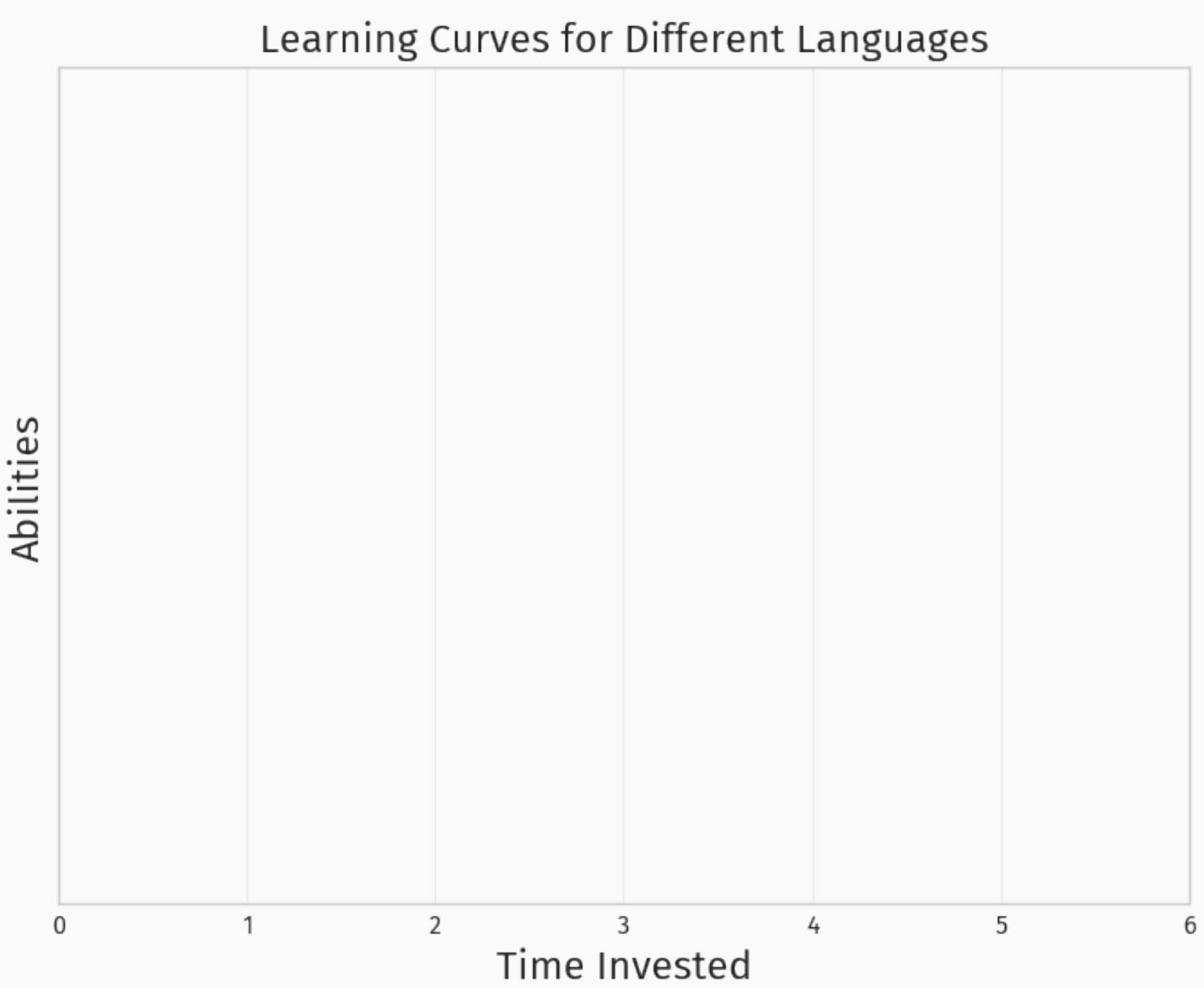
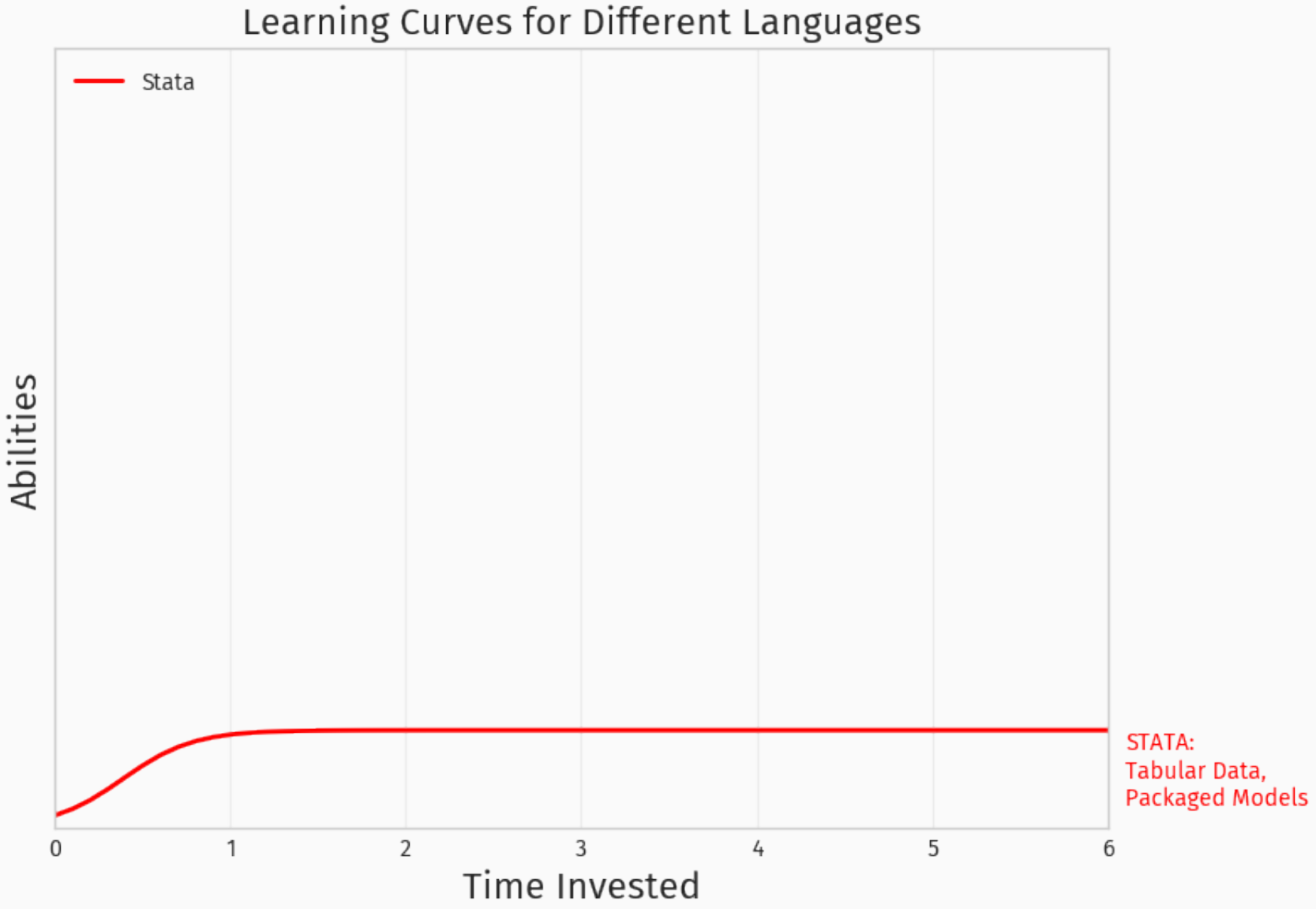



Learning Curves for Different Languages
Abilities
0
1
2
3
4
5
6
Time Invested


Learning Curves for Different Languages
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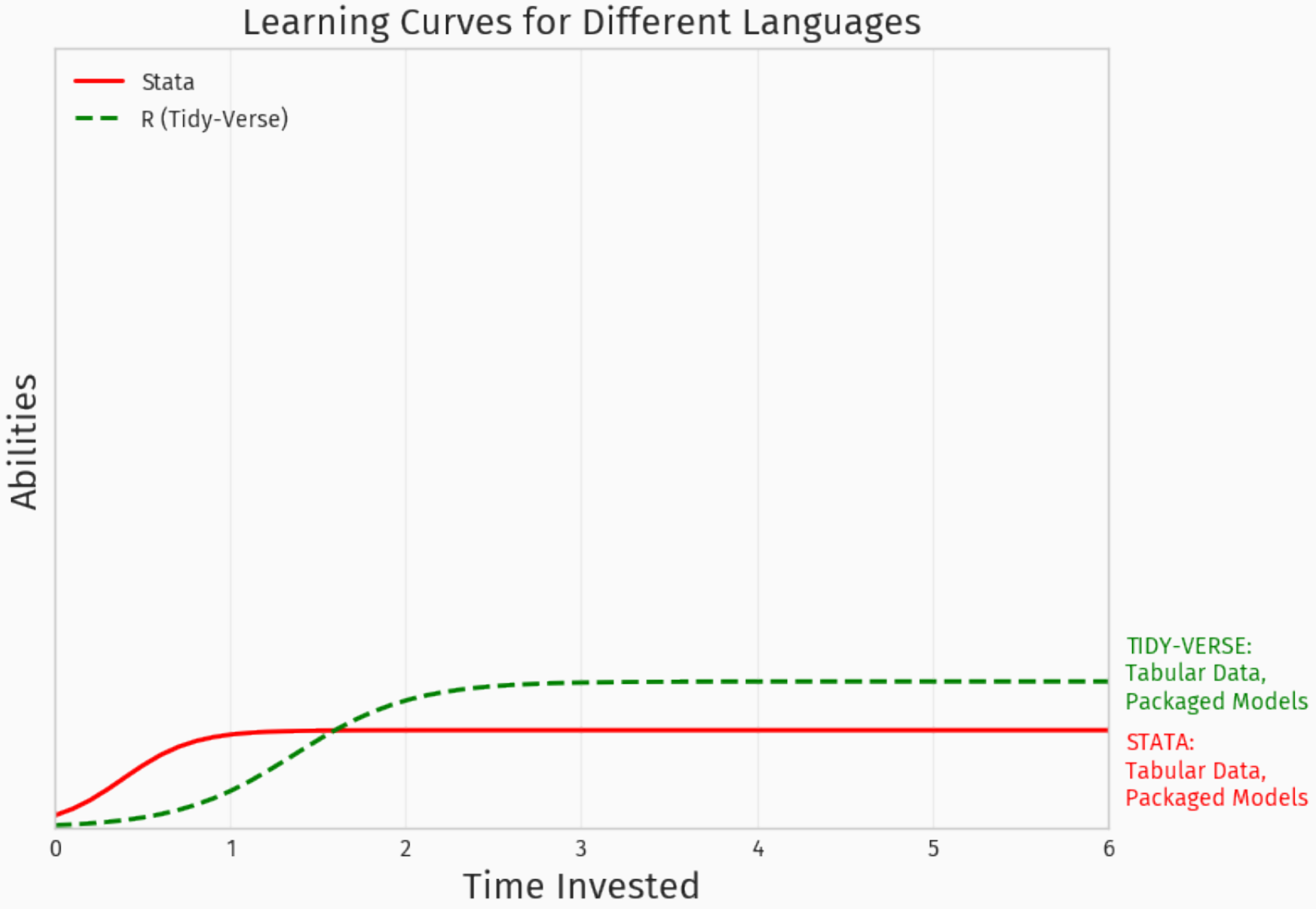
Time Invested
STATA:
Tabular Data,
Packaged Models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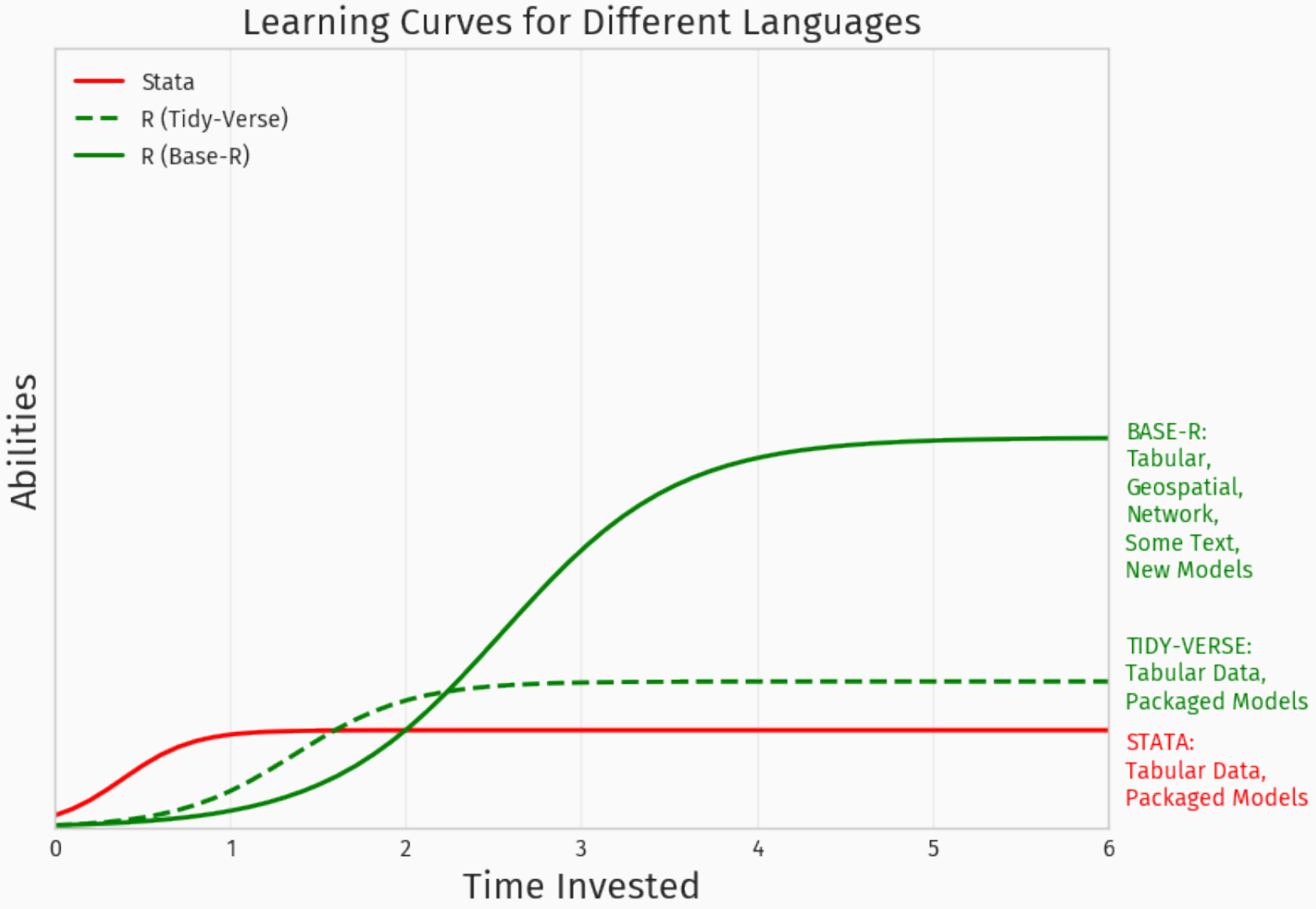
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Time Invested
BASE-R:
Tabular,
Geospatial,
Network,
Some Text,
New Models
TIDY-VERSE:
Tabular Data,
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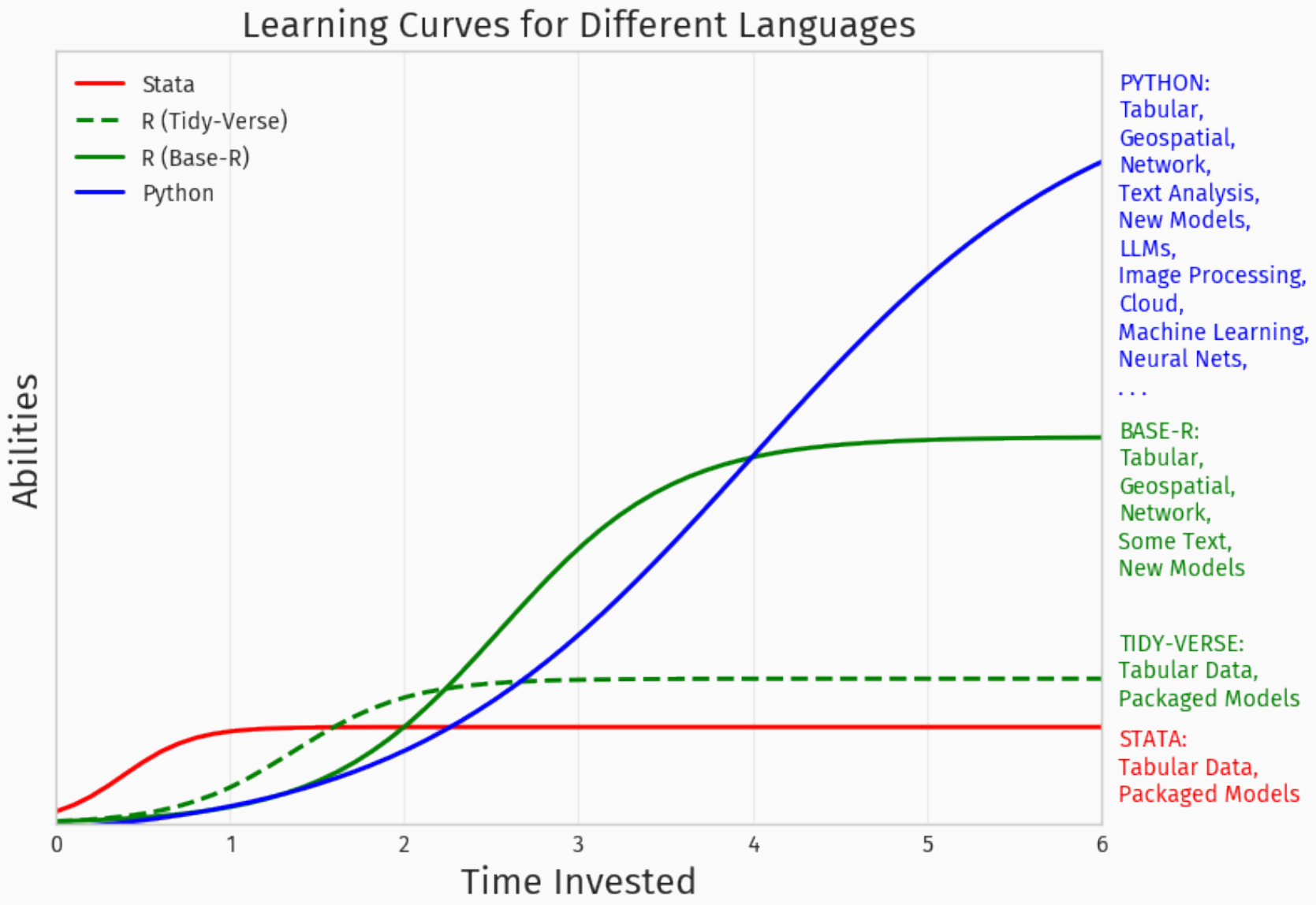
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PYTHON:
Tabular,
Geospatial,
Network,
Text Analysis,
New Models,
LLMs,
Image Processing,
Cloud,
Machine Learning,
Neural Nets,
. . .
BASE-R:
Tabular,
Geospatial,
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TIDY-VERSE:
Tabular Data,
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STATA:
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So what?

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  - You're not wrong!

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  - (Also easier ways in Python!)

So what?

- "This is so much easier to do in [Stata/R]"
  - You're not wrong!
  - (Also easier ways in Python!)
- "This isn't what I want to learn."
  - Especially for the first 4 weeks.

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- Manipulating and cleaning US census data,

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- and more.

If you also take IDS 591...

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- Work with big (terabyte sized) datasets,
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You will have a strong understanding of computational thinking and Python
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instead of feeling limited by what existing packages make easy.

About Us: Adriane Fresh

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- I study a diverse set of historical time periods and country contexts including the Industrial Revolution in Britain, the enfranchisement of Black people in the U.S., regime change in Chile, and contemporary U.S. election administration. I am particularly interested in causal inference and natural language processing using large corpuses of historical and historiographical text.

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- Testing theories about how social networks shape political behavior using cell-phone meta-data to map social networks of entire countries (Zambia and Venezuela).
- Studying whether political elites in the US South turned to using incarceration to prevent black voters from exercising political influence after the Voting Rights Act removed their ability to use Jim Crow restrictions.

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