Lecture 09: Statistical Arguments

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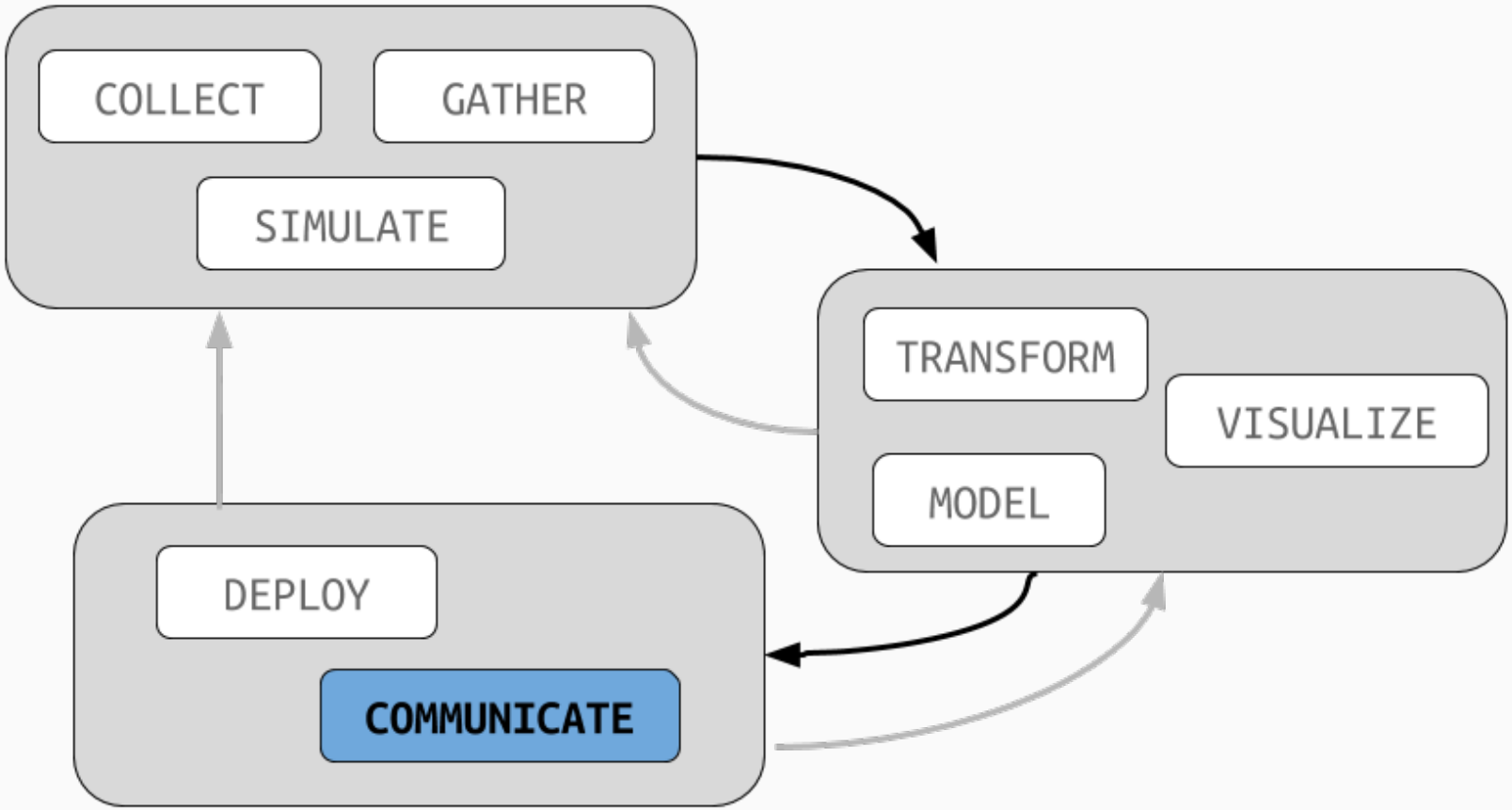
Statistical Arguments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argument types

There are two basic approaches to making logical arguments, both of which have a place in making arguments from data. These are:

- deductive reasoning
- inductive reasoning

I find that while most students have heard of these distinctions, rarely can they concisely describe them. As each requires a fairly distinct rhetorical approach, let's cover these briefly.

deductive reasoning

In deductive reasoning we start with general assumptions and show that certain conclusions logically follow from them. A classic example is:

> *Socrates is a man. All men are mortal. Therefore, Socrates is mortal.*

If the assumptions of this statement (first two sentences) are true, the conclusions **must** be true.

deductive reasoning - statistics

Deductive reasoning occurs in statistics when some of our facts (assumptions) are derived from an analysis of a dataset. Generally this occurs when we are drawing data from a **population**.

For example, say we are looking at election results from every county in the United States. The following is a deductive argument:

> *A presidential candidate that has more than 270 electoral votes wins the election (assumption). Candidate A had 300 elector votes in 2020 (assumption derived from data). Therefore, candidate A won the election.*

Notice that often not **all** facts are derived from data, but importantly some are.

inductive reasoning

Inductive reasoning, in contrast, builds a conclusion by inferring based on patterns seen in particular examples. For instance:

> *I have taught a total of 700 students over the past 5 years. I enjoyed teaching all 700 of them. Therefore, I enjoy teaching all students.*

While the data provides strong evidence for the conclusion, it does not guarantee its validity even if the assumption and logic is infallible.

inductive reasoning - statistics

Inductive reasoning usually occurs in statistics when sampling from a larger population or observing a random process. For example:

> *Only 1 of the 1000 patients injected with the vaccine had serious side-effects. Therefore, the vaccine is safe for distribution.*

While inductive reasoning is more traditionally associated with statistics, the deductive case is quite common in both industry and academia.

hybrid approach in statistics

Often, in an analysis of data I have observed a hybrid approach. Namely, deductive reasoning is used to draw concrete conclusions from data. These conclusions are then used as part of a larger inductive reasoning.

For example, assume that you are a statistician working for a large company and analyzing financial data. Using the data, you may confirm that the company has increased year-over-year profits by 232% (by deductive reasoning). From this evidence, the company decided to proceed with an IPO (by inductive).