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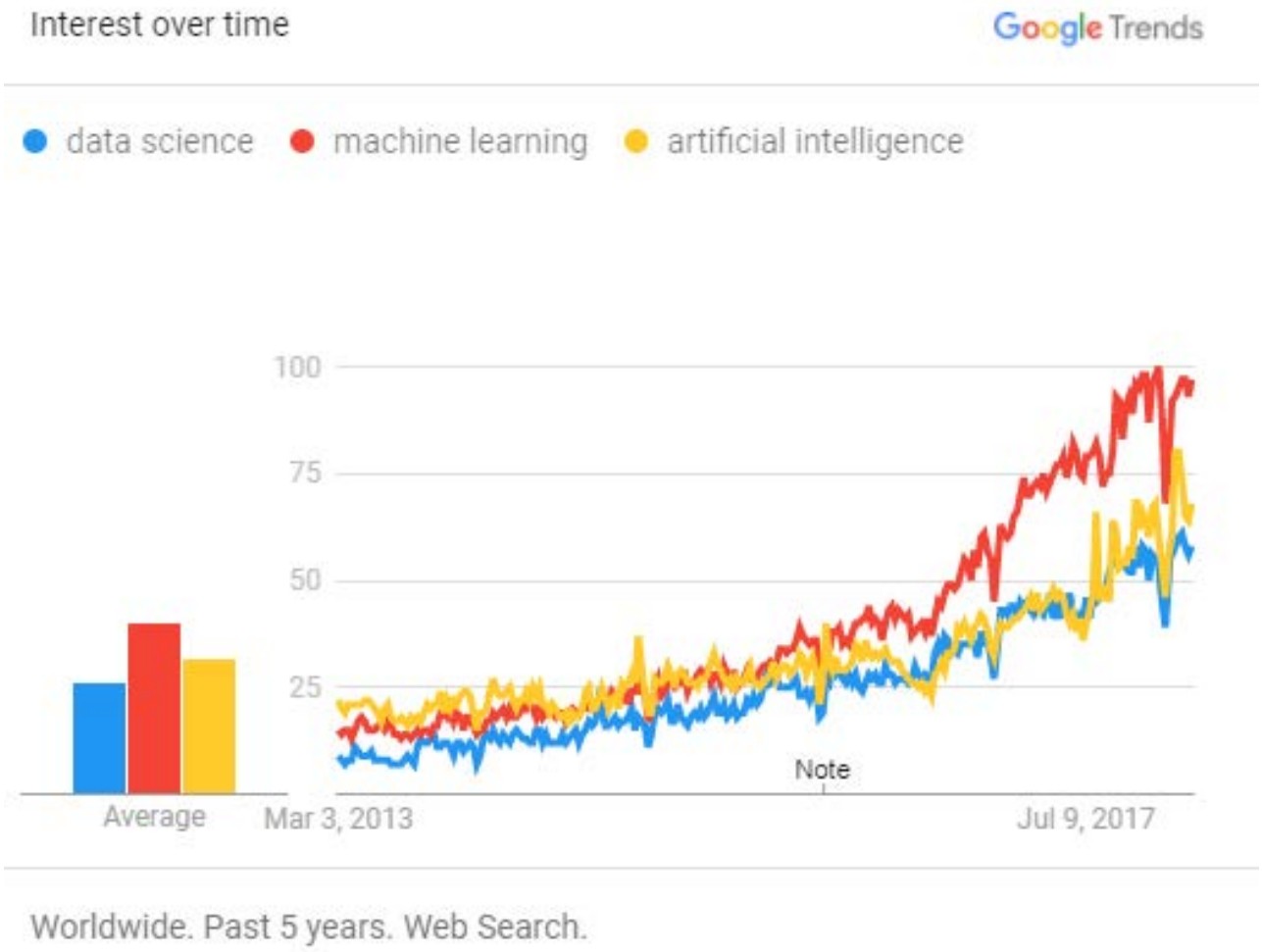
Insights, Predictions, and Actions

Descriptive Definitions of Data Science, Machine Learning, and Artificial Intelligence

Andrew Flack

The terms "Data Science," "Machine Learning," and "Artificial Intelligence" are increasingly common.



DoD must stay on the cutting edge in technology, culture, operations, and processes.

Defense Innovation Advisory Board

Recommendation 5: Catalyze Innovations in Artificial Intelligence and Machine Learning

“Textbook” definitions are not terribly helpful.

A GLOSSARY OF ARTIFICIAL-INTELLIGENCE TERMS

- ARTIFICIAL INTELLIGENCE

AI is the broadest term, applying to any technique that enables computers to mimic human intelligence, using logic, if-then rules, decision trees, and machine learning (including deep learning).

- MACHINE LEARNING

The subset of AI that includes abstruse statistical techniques that enable machines to improve at tasks with experience. The category includes deep learning.

- DEEP LEARNING

The subset of machine learning composed of algorithms that permit software to train itself to perform tasks, like speech and image recognition, by exposing multilayered neural networks to vast amounts of data.

http://fortune.com/ai-artificial-intelligence-deep-machine-learning/

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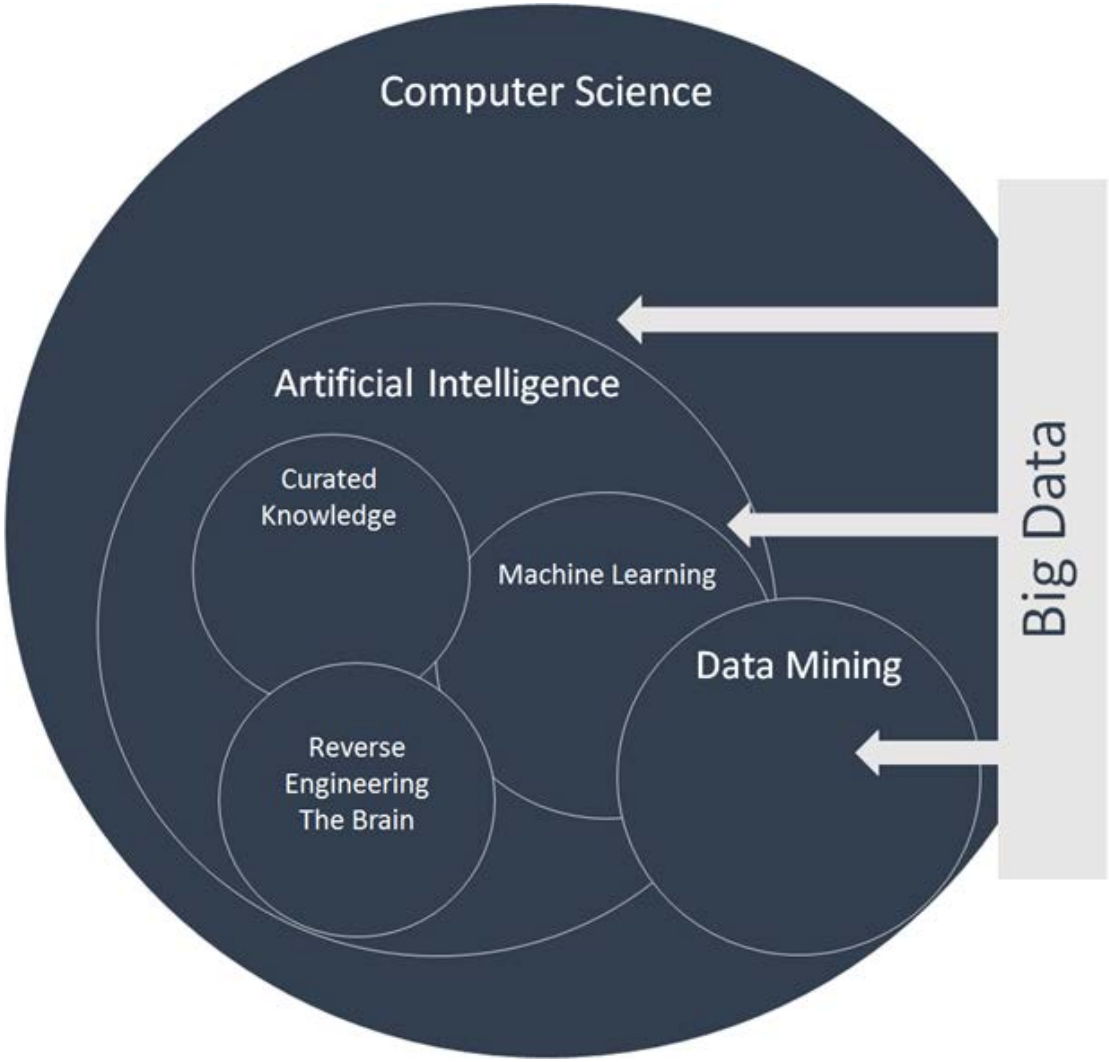
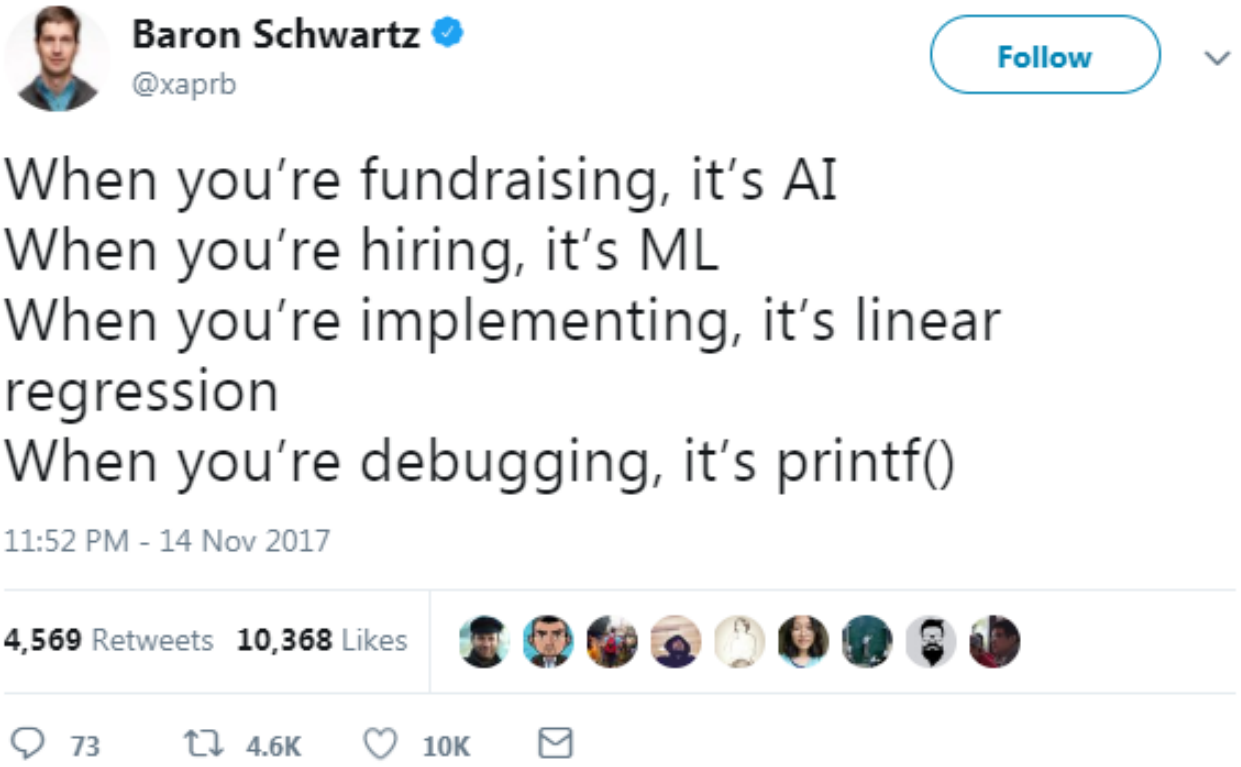


Is it just marketing?



Baron Schwartz
@xaprb

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When you're fundraising, it's AI
When you're hiring, it's ML
When you're implementing, it's linear regression
When you're debugging, it's printf()

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Forget the formal definitions and hierarchies.

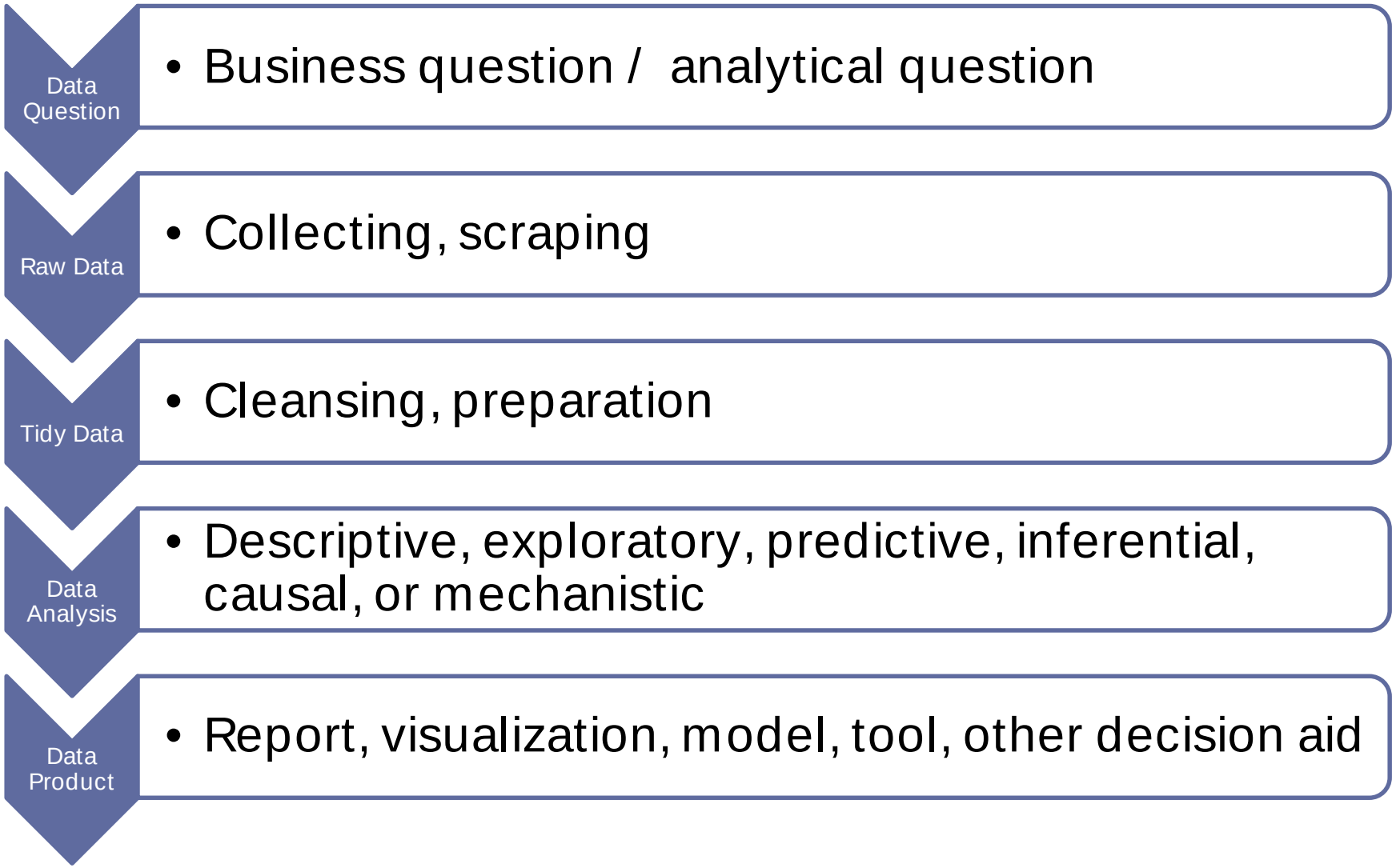
What does a practitioner in each discipline actually *do*?

Data Science Produces Insights

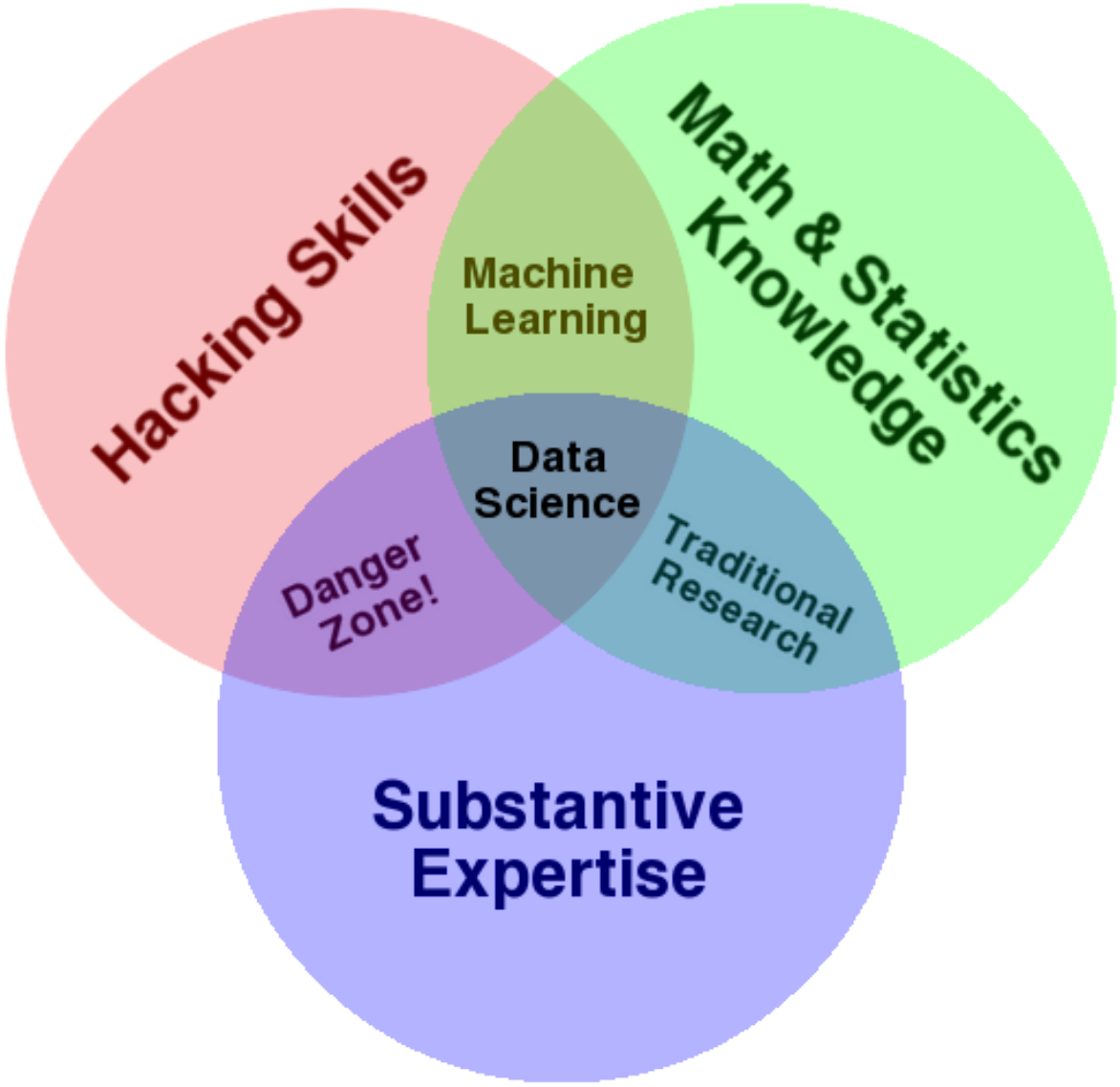
Machine Learning Makes Predictions

Artificial Intelligence Produces Actions

Data science is the process of obtaining, transforming, analyzing, and communicating data to answer a question.



Who is a data scientist?



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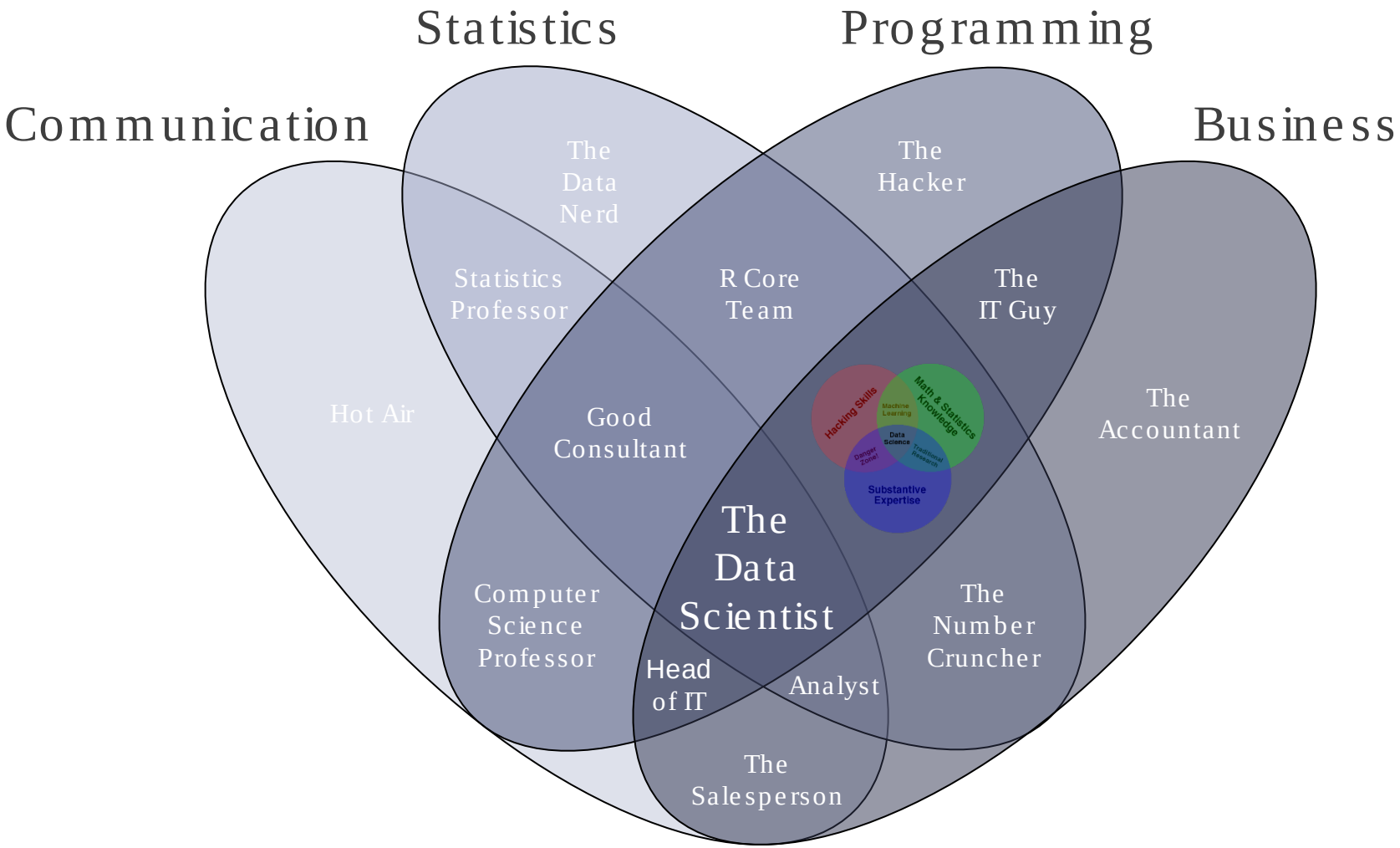
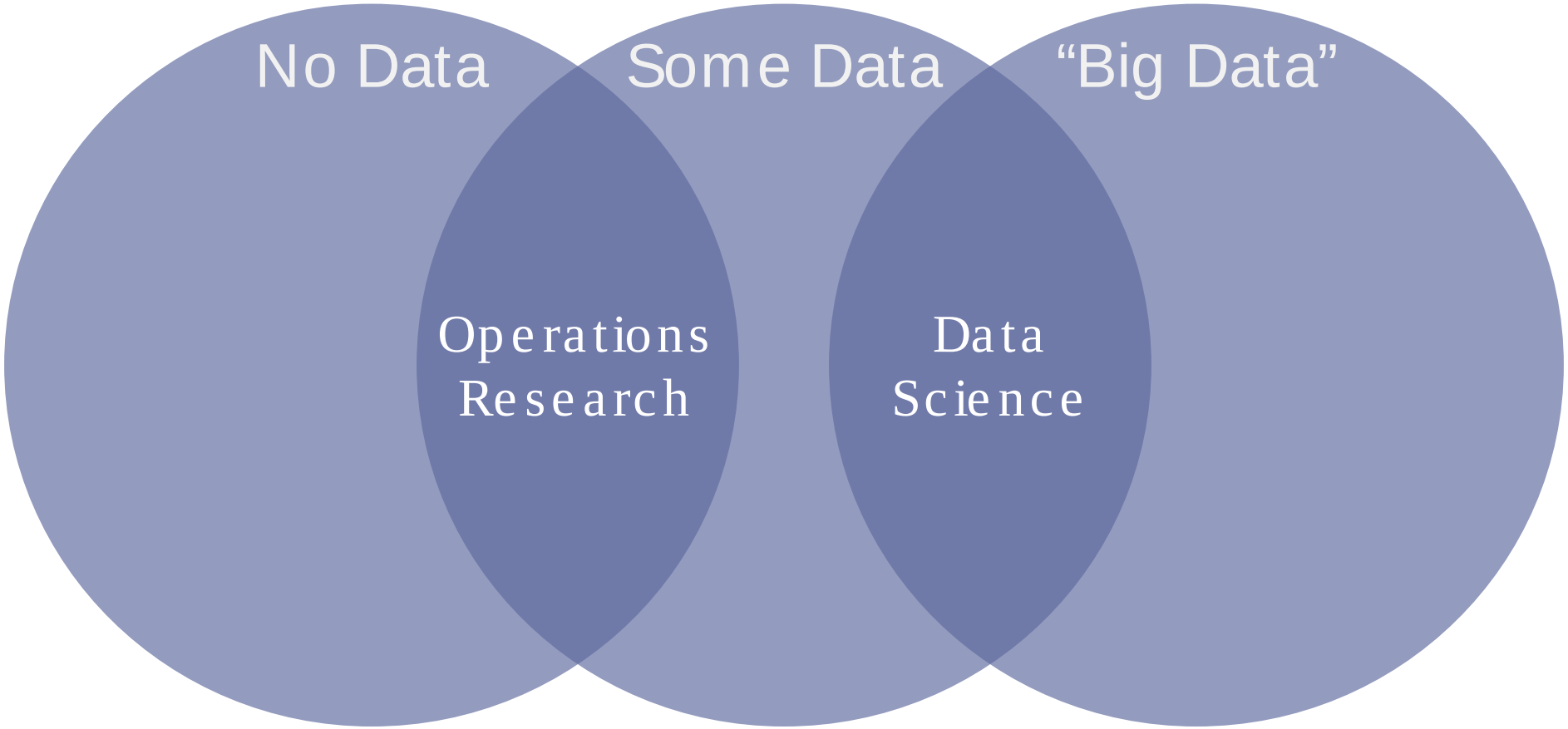


Isn't this just an Operations Research / Systems Analyst (ORSA)? Not quite …



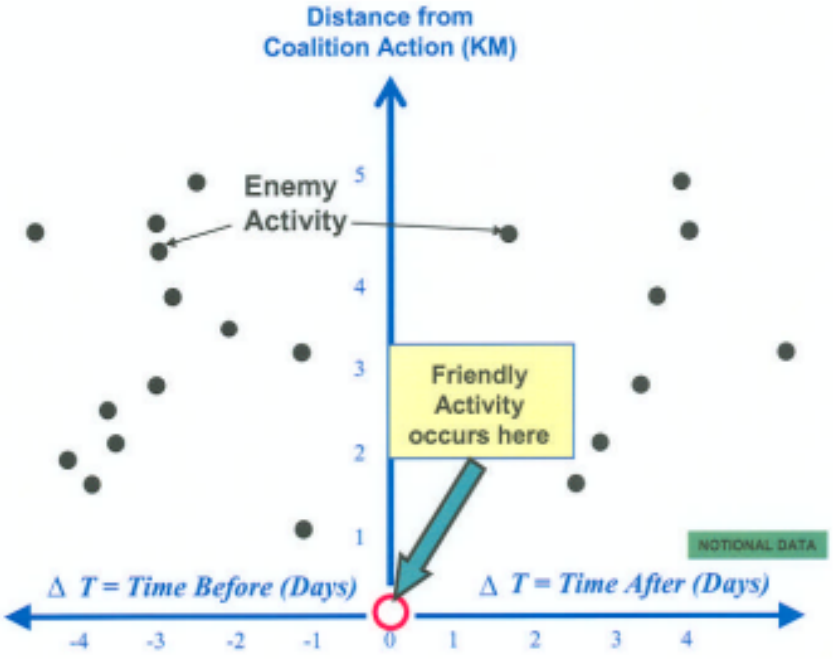
“Data Science” in Defense

Is this friendly activity (cordon and search, raid, road block, etc.) reducing enemy activity?

Compare the number of enemy events, before and after a friendly activity, to see if there is a significant difference.

Data Science in Defense

The friendly activity indicated here could be "militia disarmed" or "curfew emplaced" or "presence patrol", as long as a database exists from which to draw these friendly and enemy events.



Results indicate not only how effective friendly activity is at reducing enemy activity, but also the distance in space and time that it remains effective.

Data Science in the wild

Who are the most profitable customers?

Is there really a difference between profitable customers and the average customer?

Can I characterize customers in some way?

Data Science Produces Insights

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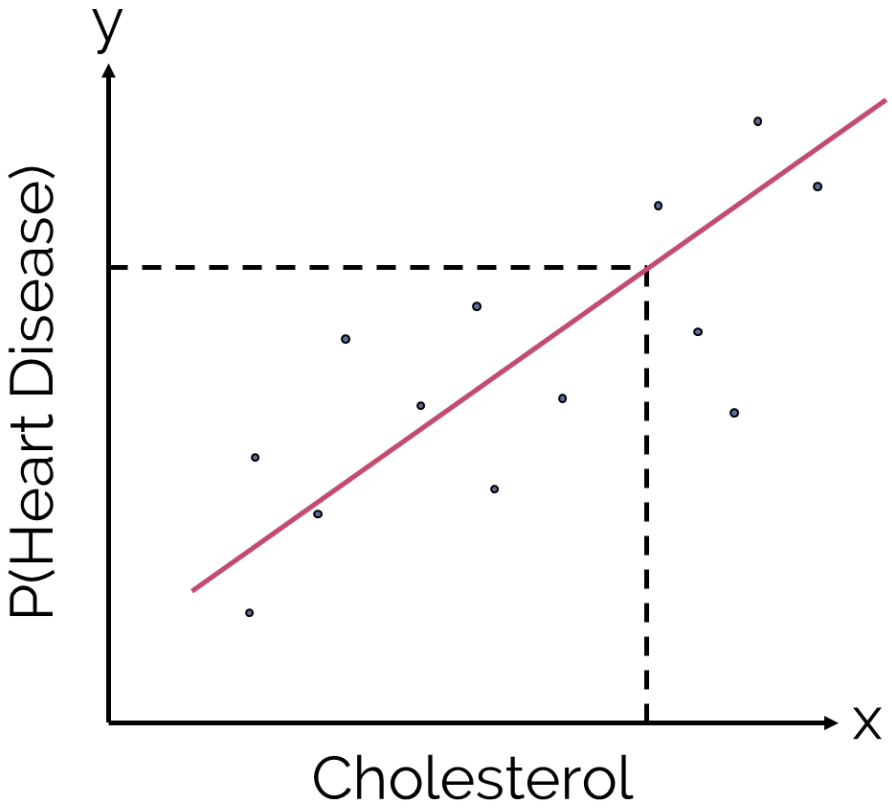
Discover a function $y=f(x)$ that best predicts the value of y associated with each value of x.

If the response variable is numeric, we're doing regression.*

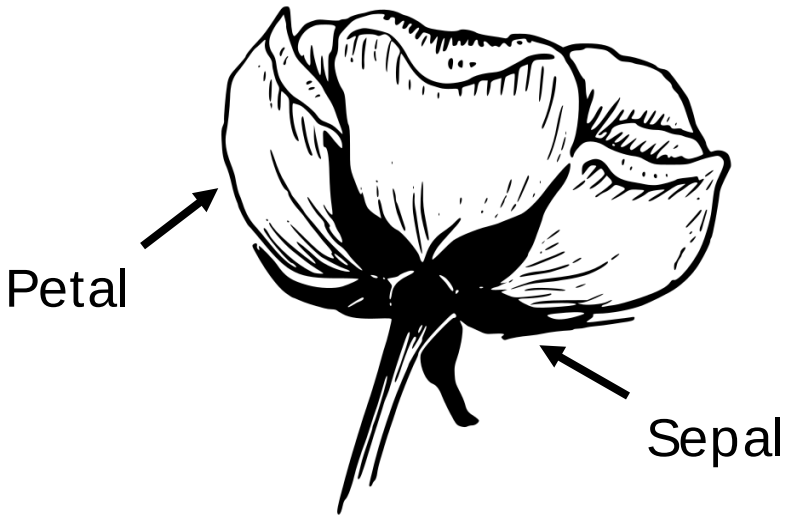


* In this context, we're using regression to PREDICT, not to EXPLAIN.

See Shmueli, G. 2010. "To Explain or to Predict?," Statistical Science (25:3), pp. 289-310.

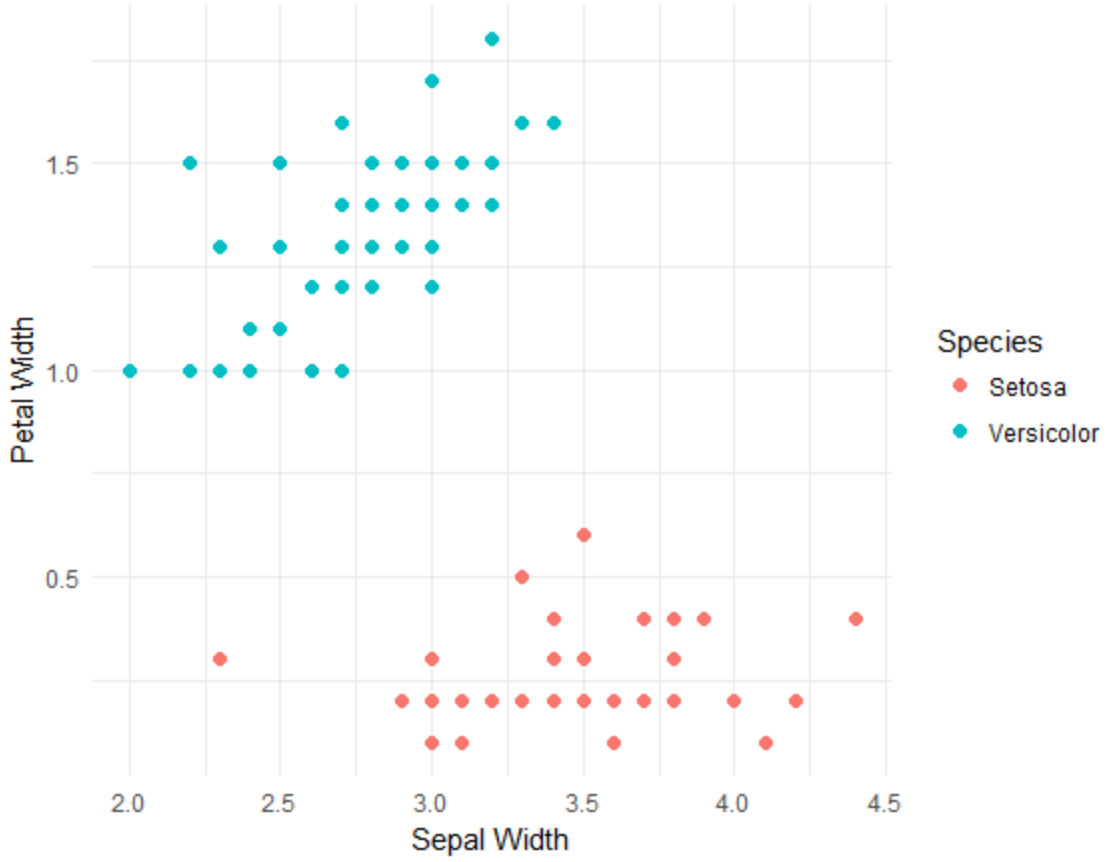
If the response is categorical, it is a classification task.

Iris Setosa

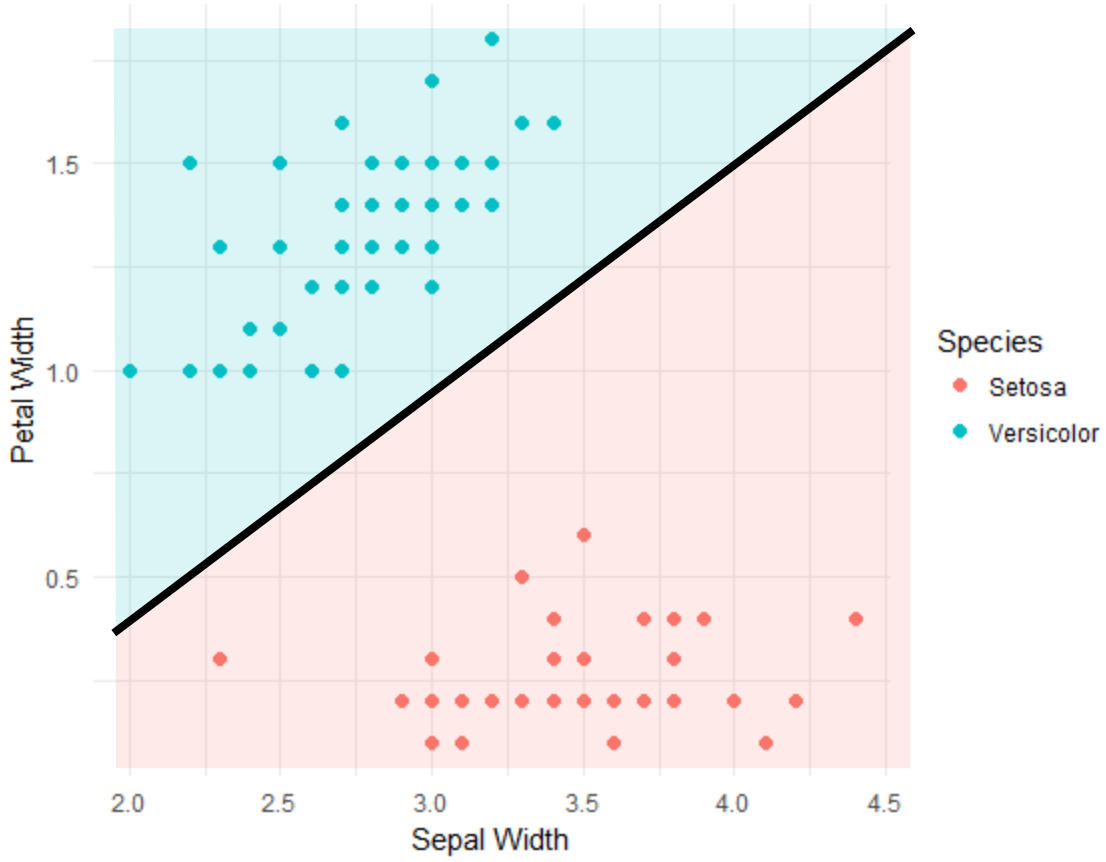


Iris Versicolor

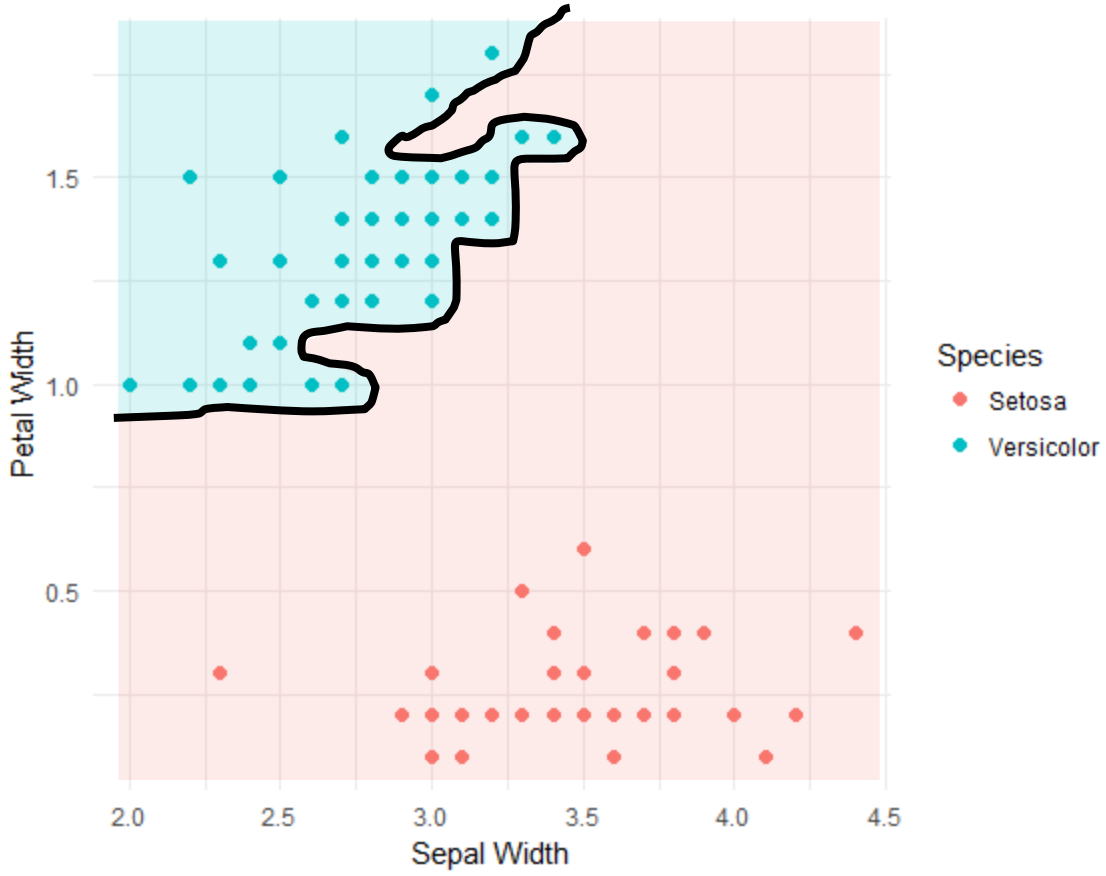
Find a function that maps each attribute set to one of the predefined class labels.



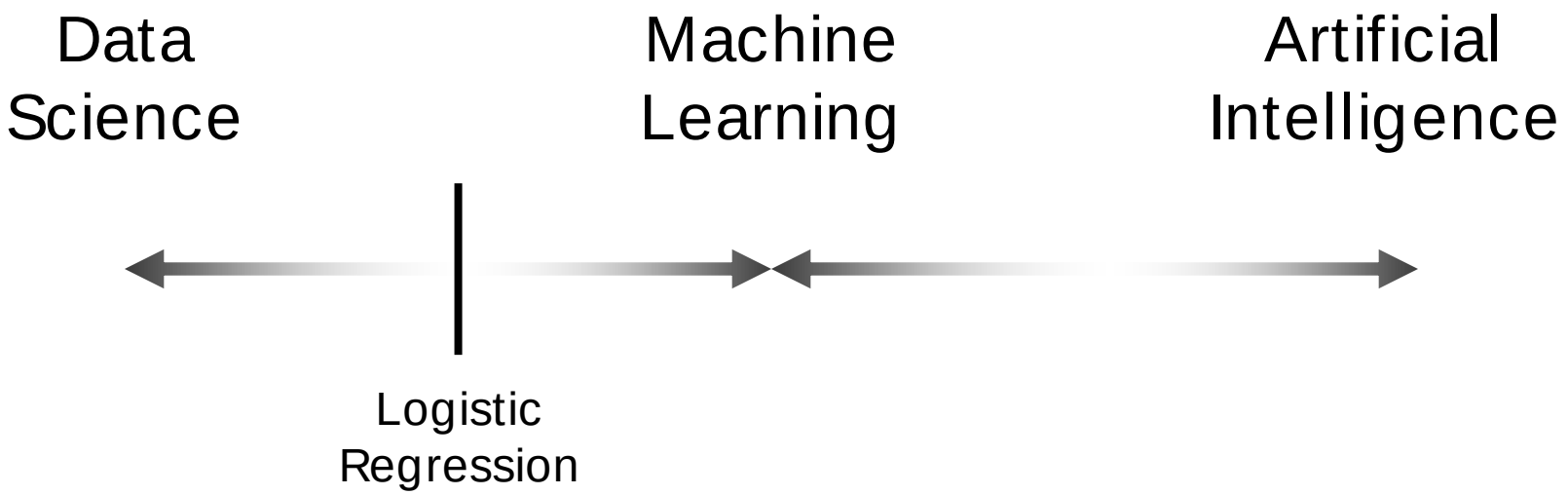
~~Find~~ "Learn" a function that maps each attribute set to one of the predefined class labels …



…and generalizes to make accurate predictions on previously unseen data.



Separation between these disciplines is blurry.



Machine Learning in Defense

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APR 26 2017

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Establishment of an Algorithmic Warfare Cross-Functional Team (Project Maven)

As numerous studies have made clear, the Department of Defense (DoD) must integrate artificial intelligence and machine learning more effectively across operations to maintain advantages over increasingly capable adversaries and competitors. Although we have taken tentative steps to explore the potential of artificial intelligence, big data, and deep learning, I remain convinced that we need to do much more, and move much faster, across DoD to take advantage of recent and future advances in these critical areas.

Accordingly, I am establishing the Algorithmic Warfare Cross-Functional Team (AWCFT) to accelerate DoD's integration of big data and machine learning. The AWCFT's objective is to turn the enormous volume of data available to DoD into actionable intelligence and insights at speed.

The AWCFT's first task is to field technology to augment or automate Processing, Exploitation, and Dissemination (PED) for tactical Unmanned Aerial System (UAS) and Mid-Altitude Full-Motion Video (FMV) in support of the Defeat-ISIS campaign. This will help to reduce the human factors burden of FMV analysis, increase actionable intelligence, and enhance military decision-making. AWCFT will: 1) organize a data-labeling effort, and develop, acquire, and/or modify algorithms to accomplish key tasks; 2) identify required computational resources

Machine Learning in Defense

"..augment or automate Processing, Exploitation, and Dissemination (PED) for tactical Unmanned Aerial System (UAS) and Mid-Altitude Full-Motion Video (FMV) ..".

"38 classes of objects the department needs to detect"

Machine Learning in the wild

Data Science Produces Insights

Machine Learning Makes Predictions

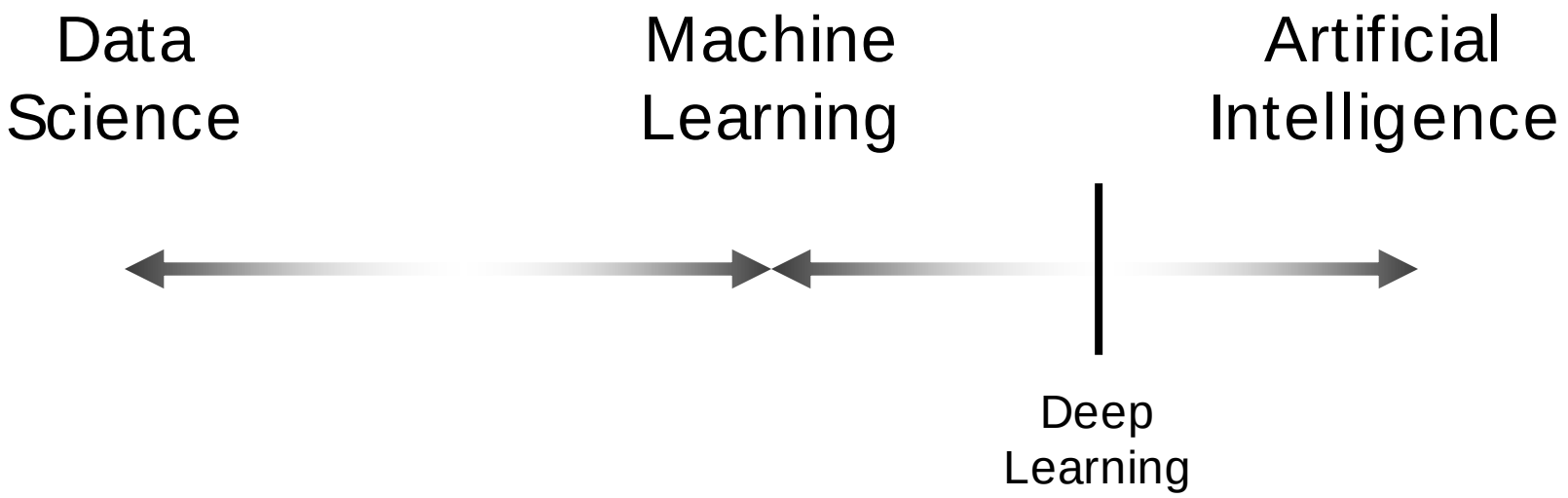
Artificial Intelligence Produces Actions

Rather than teaching computers how to do everything, teach them to learn for themselves.

Arthur Samuel, a pioneer in Artificial Intelligence, created a program to play checkers.

He was the first to develop a machine that surpassed his ability in a task that he taught it.

Again, separation between these disciplines is blurry.



Artificial Intelligence in the wild

ARTICLE

doi:10.1038/nature24270

Mastering the game of Go without human knowledge

David Silver[1]*, Julian Schrittwieser[1]*, Karen Simonyan[1]*, Ioannis Antonoglou[1], Aja Huang[1], Arthur Guez[1], Thomas Hubert[1], Lucas Baker[1], Matthew Lai[1], Adrian Bolton[1], Yutian Chen[1], Timothy Lillicrap[1], Fan Hui[1], Laurent Sifre[1], George van den Driessche[1], Thore Graepel[1] & Demis Hassabis[1]

A long-standing goal of artificial intelligence is an algorithm that learns, *tabula rasa*, superhuman proficiency in challenging domains. Recently, AlphaGo became the first program to defeat a world champion in the game of Go. The tree search in AlphaGo evaluated positions and selected moves using deep neural networks. These neural networks were trained by supervised learning from human expert moves, and by reinforcement learning from self-play. Here we introduce an algorithm based solely on reinforcement learning, without human data, guidance or domain knowledge beyond game rules. AlphaGo becomes its own teacher: a neural network is trained to predict AlphaGo's own move selections and also the winner of AlphaGo's games. This neural network improves the strength of the tree search, resulting in higher quality move selection and stronger self-play in the next iteration. Starting *tabula rasa*, our new program AlphaGo Zero achieved superhuman performance, winning 100–0 against the previously published, champion-defeating AlphaGo.

Data Science Produces Insights

Machine Learning Makes Predictions

Artificial Intelligence Produces Actions

IDA