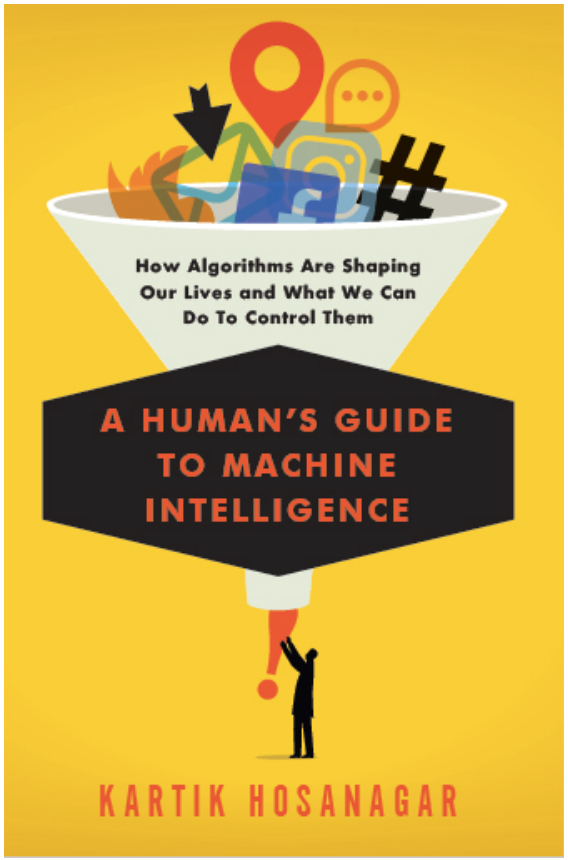
AI for Business

Professor Kartik Hosanagar

Bio

- **Teaching**
  - Professor, Technology & Digital Business
- **Research**
  - Internet & mobile commerce/media/marketing
  - Algorithms and decisions
- **Industry**
  - Cofounder: Yodle Inc.
  - Startups: Milo, Springboard, Stitch, …
  - Consulting/Exec Ed: Google, Amex, Nokia
- **Author**
  - *A Humans Guide to Machine Intelligence: How Algorithms Are Shaping Our Lives and How We Can Stay in Control*



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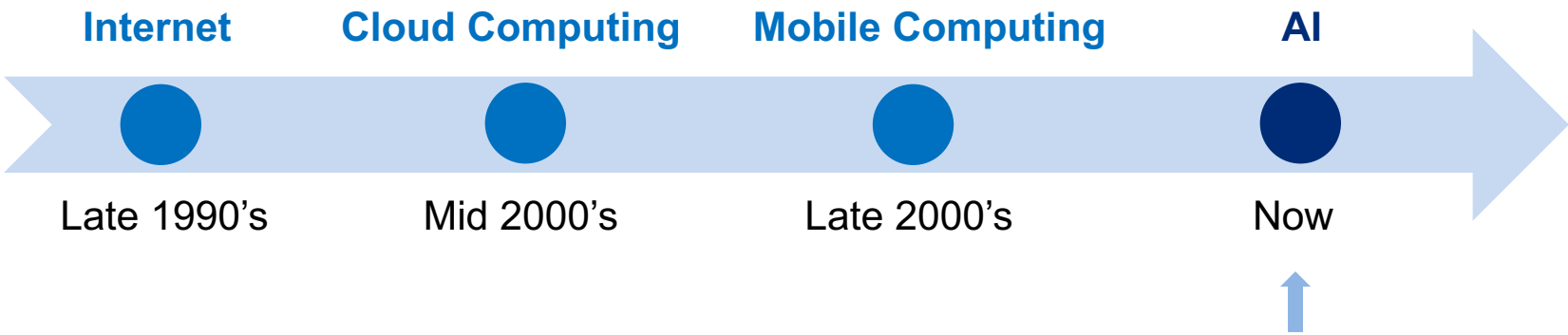
AI and Business

- Artificial intelligence (AI) is about getting computers to do things that require human intelligence.
- AI is increasingly being seen as the next phase of digital transformation.

Digital Transformation Timeline

- Multiple digital technologies have helped transform business.
- Companies that were slow to react paid the price.



- AI is likely to be equally transformative and can potentially be viewed as a general-purpose technology.

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What are General-Purpose Technologies (GPTs)?

- GPTs are “characterized by the potential for pervasive use in a wide range of sectors and by their technological dynamism” (Bresnahan & Trajtenberg)
  - GPTs stimulate innovation and economic growth.
  - GPTs inform products strategy & organizational design/strategy.
- 3 factors can indicate that a new technology shows promise as a GPT:
  1. Widespread use of the technology across many industries
  2. High volume of research jobs related to the technology
  3. Research jobs widespread across many industries

Content/quotes from: “Could Machine Learning Be a General-Purpose Technology? Evidence from Online Job Postings” by Goldfarb, Taska & Teodoridis
Note: the Bresnahan & Tajtenberg quote is from the above paper. The authors of that paper had quoted this definition from Bresnahan & Tajtenberg

How does AI show promise as a GPT?

Research by Goldfarb et al (2019)

Technology	Total Jobs	Total Research Jobs	Percent Research Jobs
Machine Learning	**370,572**	**57,150**	**14.6%**
GIS Software	142,645	8,993	5.8%
CRISPR	6,716	5,250	78.4%
Quantum Computing	6,355	1,348	17.4%
Fracking	2,957	141	2.8%
Robotics	284,474	22,448	7.3%
Nanotechnology	4,883	2,519	46.0%
Internet-of-things	124,506	5,750	4.3%
Cloud Computing	1,415,289	29,392	2.2%

High volume of jobs and research jobs.

Research jobs are a particularly important indicator of GPTs because they demonstrate that a technology is “capable of ongoing improvement” and could have significant future potential, beyond what is currently recognized.

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Content/quotes from: “Could Machine Learning Be a General-Purpose Technology? Evidence from Online Job Postings” by Goldfarb, Taska & Teodoridis

ML's promise as a GPT (cont.) → Jobs widespread across industries

Table A3.1. Number of jobs in data by industry and technology (2015-2018)

Industry NAICS2	AI	GIS	Quantum	Fracking	Robotics	Nanotech	IoT	CRISPR	Cloud	Total
Accommodation and Food Services	5,389	883	4	5	1,516	5	828	2	15,090	5,594,113
Admin & Support & Waste Mgmt & Remediation Srvcs.	4,142	2,099	0	75	2,363	6	1,836	9	26,763	2,237,225
Agriculture, Forestry, Fishing and Hunting	820	1,388	0	3	384	0	146	0	2,310	97,644
Arts, Entertainment and Recreation	437	917	0	2	925	7	109	0	2,591	578,889
Construction	335	2,406	1	45	2,330	22	361	0	3,709	850,081
Educational Services	12,467	6,836	246	62	10,868	1,764	1,503	1,384	17,848	4,018,454
Finance and Insurance	40,261	3,871	26	32	7,809	7	4,569	35	98,700	5,787,861
Health Care and Social Assistance	102,401	34,512	158	612	114,965	734	28,477	1,793	481,770	38,700,000
Information	32,613	4,483	189	26	6,213	85	17,079	2	130,353	2,229,564
Management of Companies and Enterprises	348	302	0	4	160	2	108	0	1,156	80,359
Manufacturing	37,215	7,738	257	144	73,053	582	24,472	1,733	96,368	6,307,396
Mining	674	1,098	0	828	489	2	257	0	1,736	216,880
Other Services (except Public Administration)	1,614	1,695	0	77	2,314	12	181	5	5,786	1,120,323
Professional, Scientific, & Technical Services	97,704	39,478	5403	395	36,715	1,550	33,912	1,683	435,035	7,333,834
Public Administration	4,838	21,175	41	29	3,467	70	680	46	13,446	2,448,184
Real Estate Rental and Leasing	2,086	3,302	5	16	3,815	0	500	1	8,000	1,293,048
Retail Trade	21,705	1,220	14	132	11,214	21	5,917	2	54,247	8,720,486
Transportation and Warehousing	3,411	2,639	1	398	2,803	6	1,236	2	11,433	4,668,538
Utilities	801	3,896	0	51	886	6	493	1	2,877	333,522
Wholesale Trade	1,311	2,680	10	21	2,185	2	1,842	18	6,071	620,793
Total	370,572	142,645	6,355	2957	284,474	4,883	124,506	6,716	1,415,289	93,237,194

ML's promise as a GPT (cont.) → Research jobs also widespread across industries

Table A3.2. Number of research jobs in data by industry and technology (2015-2018)

Industry NAICS2	AI	GIS	Quantum	Fracking	Robotics	Nanotech	IoT	CRISPR	Cloud	Total
Accommodation and Food Services	438	24	1	0	43	2	32	2	214	13,410
Admin & Support & Waste Mgmt & Remediation Srvcs.	506	56	0	3	69	1	55	9	472	16,768
Agriculture, Forestry, Fishing and Hunting	243	220	0	0	24	0	6	0	130	9,847
Arts, Entertainment and Recreation	51	110	0	0	12	4	10	0	57	7,823
Construction	53	76	0	0	68	1	13	0	69	6,204
Educational Services	3,991	1,785	71	14	1,979	682	139	1,095	1,023	267,403
Finance and Insurance	6,409	271	15	3	309	2	249	29	2,132	114,244
Health Care and Social Assistance	11,974	1,905	63	21	8,186	366	895	1,393	7,299	1,078,322
Information	6,148	144	19	0	584	21	404	1	3,383	53,490
Management of Companies and Enterprises	42	7	0	0	6	0	9	0	19	1,061
Manufacturing	7,682	382	103	35	6,024	248	1,598	1,363	3,306	357,069
Mining	108	51	0	25	34	1	70	0	37	4,251
Other Services (except Public Administration)	273	162	0	3	102	2	3	0	104	15,440
Professional, Scientific, & Technical Services	13,595	1,423	1,048	23	3,704	1,134	1,798	1,305	8,845	391,943
Public Administration	728	1,544	17	5	401	33	55	37	287	149,862
Real Estate Rental and Leasing	371	544	2	1	83	0	30	0	193	9,976
Retail Trade	3,599	129	9	2	570	14	290	2	1,470	35,200
Transportation and Warehousing	643	98	0	1	95	1	27	1	188	13,639
Utilities	99	28	0	5	29	5	19	0	36	5,762
Wholesale Trade	197	34	0	0	126	2	48	13	128	16,492
Total	57,150	8,993	1,348	141	22,448	2,519	5,750	5,250	29,392	2,568,206

Impact of AI as a GPT

- AI (specifically ML) shows early indicators of being a general-purpose technology.

- Implications for firms if ML is a GPT:
  - Recognize that most industries are likely to change
  - Be patient: the transformative impact may come with a lag

  - To effectively leverage the opportunities, managers need to understand the technology and its applications, and make changes to their "business models, technology infrastructure, organizational processes, and culture."

Content from: "Could Machine Learning Be a General-Purpose Technology? Evidence from Online Job Postings" by Goldfarb, Taska & Teodoridis
Content/quote from: https://www.simplilearn.com/introduction-to-digital-transformation-tutorial

Course Objectives

- To appreciate and understand the fundamentals of AI as it relates to business
  - Broad overview of Big Data and ML
  - Business Applications of AI
  - AI Strategy
- To develop a vision of what lies ahead

Notable Quotations

- "Computers in the future may weigh no more than 1.5 tons.“
  – Popular Mechanics, forecasting the relentless march of science, 1949

- "There is no reason anyone would want a computer in their home.”
  – Ken Olson, president, chairman and founder of Digital Equipment Corp., 1977

- “I think there is a world market for maybe five computers.”
  – Thomas Watson, chairman of IBM, 1943

- “Most of the IT innovation that had to occur has already occurred. I am staying out of tech.”
  – MBA student, circa 2005 (overheard)

AI for Business Course Outline

This course will help you understand AI from a business perspective.

1. **Introduction to Big Data**
   - What big data is, How to work with it, What questions it can help you answer
2. **Introduction to Artificial Intelligence (AI)**
   - What is AI, How it differs from machine learning (ML), Types and methods of ML
3. **Business Applications of Machine Learning (ML)**
   - E.g., Personalization, ML in finance, Driverless cars
4. **AI Strategy**
   - Business transformation, Project portfolios, AI- related retraining, Org. structure
   - AI ethics and risks, Governance framework (audits, transparency, control)
   - Vision of what lies ahead (discussions & projects)

What this course is not:
An engineering/Stats course on ML

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Course Logistics

- TAs
  - Alex Miller
  - Daehwan Ahn
- Modules on Canvas
- Course description
- Readings
- **Prerequisites**
  - None. Well build the concepts bottom up.
  - Tech background helpful but not necessary

Course Design for Online

- Design principles:
  - Lecture format is not ideal for online
  - Use time already blocked on calendar for recorded content
  - Minimize homework and “exams”
  - Self-paced learning needs regular assessments
  - Find opportunities to learn in groups
  - Be forgiving of each other; expect disruptions;
- Grading
  - Quizzes: multiple choice questions (80%)
  - Term paper (group of 4-5): Sample projects available (20%)
  - Group simulation game: not graded (experimental)
  - Participation: Needed for Pass grade

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Classroom Policies

Which of the following lowers your measured IQ the most:

A. Smoking marijuana before taking test.

B. Responding to email/texting while taking test.

C. Losing a nights sleep before taking test.

Answer: B (According to a study of 1,100 workers by researchers at the Institute of Psychiatry at King's College, London)

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Classroom Policies

- Zoom norms
  - Punctuality
  - All students on mute during the call
  - “Raise your hand” if you’ve questions
  - Avoid chat, if feasible
  - Try to be in a private place; focus as you’d in a physical classroom
  - Keep videos on (default) but OK to temporarily mute

Quick Survey of Background

Introduction to Big Data

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What is Big Data?

- Data that “exceeds the capacity or capability of…conventional methods and systems” (National Institute of Standards and Technology).

- But big data is not only about volume of data, it is also about:
  - the structure of the data set
  - the speed at which it is created
  - the tools you need to analyze it
  - what you can do with the data set

Quote from: https://www.technologyreview.com/s/519851/the-big-data-conundrum-how-to-define-it/
Additional content from: “Big Data” by Victor Mayer- Schonberger and Kenneth Cukier and https://www.sas.com/en_us/insights/big-data/what-is-big-data.html

Big Data Characteristics

- New data characteristics created by today's digitized marketplace:

"Terabytes to petabytes of existing data to process."

"Structured, unstructured, text, multimedia."

"Streaming data, milliseconds to seconds to respond."

"Uncertainty due to data inconsistency & incompleteness, ambiguities, latency, deception, model approximations."

Image from: https://www.cbpr.me/big-data-and-public-relations/4vs/
Additional quotes from another diagram found at https://www.datasciencecentral.com/profiles/blogs/data-veracity

What does Big Data Change?

- Big data allows you to:

1. Ask new questions

2. Answer same questions better

- This can be done across industries
  - Healthcare, Education, Transportation, and more

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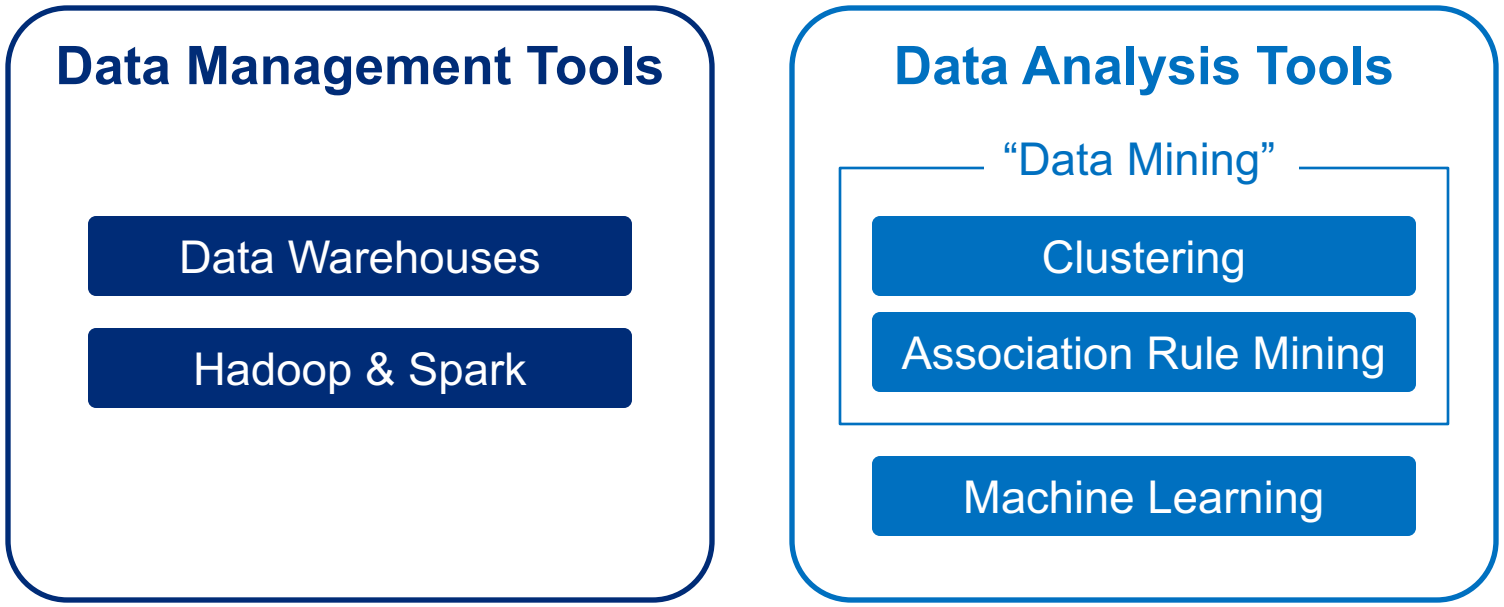
Choosing a Big Data Tool

- Two broad categories of big data tools to choose from, depending on whether you are trying to manage the data or analyze it.



What is a Data Warehouse?

- **Database:**
  - "A structured collection of data"
  - Example: an Excel spreadsheet
- **Database Management System (DBMS):**
  - "Allows user to access and manage the database"
  - Examples: Excel, Oracle, MongoDB
  - Often also referred to as a database
- **Data Warehouse:**
  - A particular kind of DBMS, "specialized in the data it stores- historic data from many sources- and the purpose it serves- analytics"
  - Azure SQL Data Warehouse, Google BigQuery, Snowflake, Amazon Redshift

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Content/quotes from: https://www.dremio.com/what-is-a-data-warehouse/

How Do Data Warehouses Work?

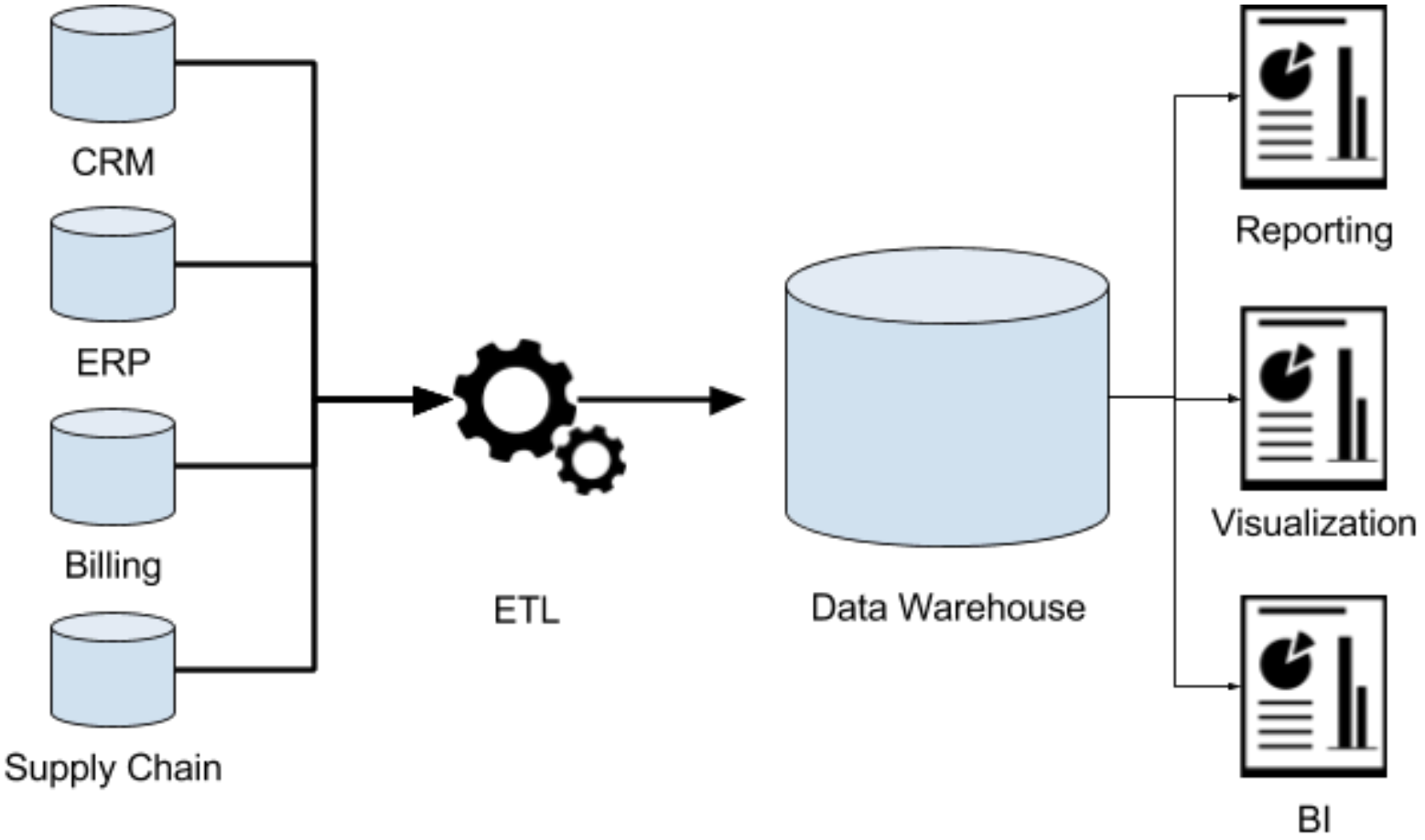

Diagram from: https://www.dremio.com/what-is-a-data-warehouse/

Value of Data Warehouses

Data warehouses provide:

- “A single point of access for data”
- “An assurance of data quality”
- “A history of the data they store”
- “A separation of operations and analytics”
- “A standard set of semantics around data”

Allowing answers to questions like:

- “How much revenue has each product line brought in per month over the last 10 years, broken out by city & state?”
- “What is the average transaction size at our ATMs, broken out by time of day & customer assets?”
- “What is the % employee turnover for the past year in stores that have been open for at least 3 years. How many hours did those employees work per week?”

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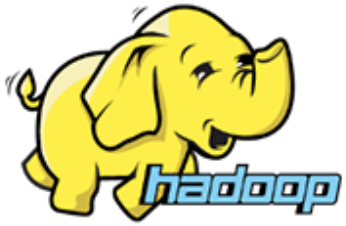
All information quoted from: https://www.dremio.com/what-is-a-data-warehouse/

Big data tools: Hadoop & Spark

- Big data tools like Hadoop solve 2 problems:
  - Storage of lots of data (usually in a distributed manner). E.g. HDFS
  - Processing big data, which usually involves (i) distributed processing (1000s of servers), (ii) parallelization. E.g. MapReduce
- Popular Hadoop distribution: Cloudera
- Spark: Better version of Hadoop and the dominant replacement
  - Databricks is the dominant company built around Spark



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Content (on 4 steps of Hadoop w/ MapReduce) from: https://hci.stanford.edu/courses/cs448g/a2/files/map_reduce_tutorial.pdf

Agenda for Module 1

- **Big data overview**
  - What is big data is, how is it being generated, and why it matters
- **Big data skills**
  - Approach to analysis, analytics competencies, and broad skillset needs
- **Big data tools**
  - Data management tools and data analysis tools
- **Extracting intelligence from big data**
  - Predictive analytics and implications for business strategy

Quiz 01 covers module 01 (first 2 sessions)

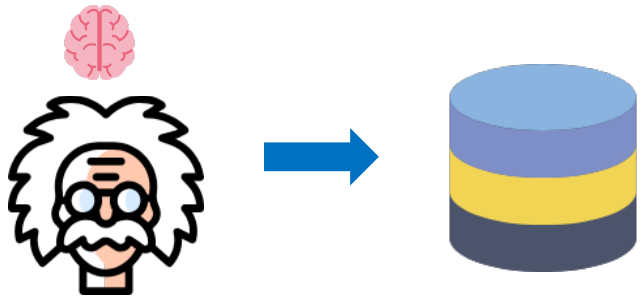
What is Artificial Intelligence (AI)?

- Definition of AI
  - "the theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages." – Merriam Webster

At its core, AI is about getting computers to do things that require human intelligence.

How to Build AI: Expert Systems vs ML

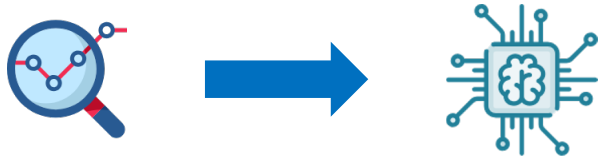
- Expert systems are an older approach to AI that involves transferring knowledge from experts to a knowledge base.



- Limitations of expert systems: tacit knowledge
  - Doctors arrive at diagnoses in seconds based off pattern matching, not rules.
  - Drivers cannot articulate all the rules they use to drive cars
  - Drivers can't articulate all their rules for driving, but videos can capture their actual driving behavior.
- Machine learning (ML) is a newer approach to AI that addresses the limitations of expert systems.

What is Machine Learning?

- ML is a subfield of AI
  - ML methods are characterized by their ability to learn from data without being explicitly programmed.
  - ML is most concerned with making predictions.



PREDICTION TASKS

Structured Data: "Is a transaction fraudulent?"

Text: "Is an email spam?"

Images: Image recognition in driverless cars

Audio: Speech recognition

APPLICATIONS OF ML

Healthcare: Automated medical diagnosis

HR: Which applicants are best suited for a job

Tech: Voice interfaces, Autonomous cars, personalization

Finance: Investing

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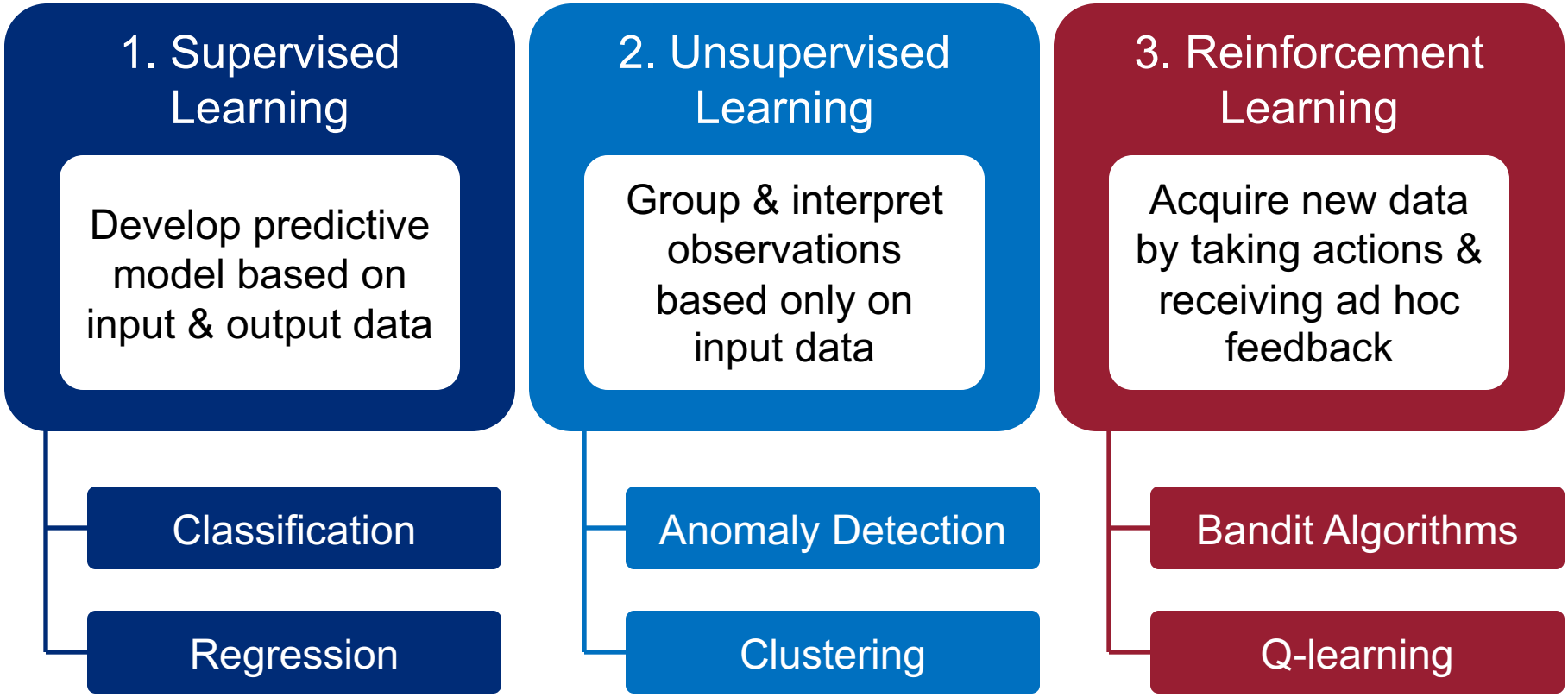
Three Types of Machine Learning



Agenda for Module 02

- **Artificial Intelligence (AI) Overview**
  - What AI is, types of AI, history of AI and the expert systems approach
- **Machine Learning (ML) Overview**
  - How ML differs from AI and the three types of ML (supervised, unsupervised, and reinforcement learning)
- **Detailed View of ML**
  - ML at 30,000 feet and factors that influence accuracy in ML
- **Specific ML Methods: A Deep Dive**
  - Logistic regression, decision trees & random forests, and neural networks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