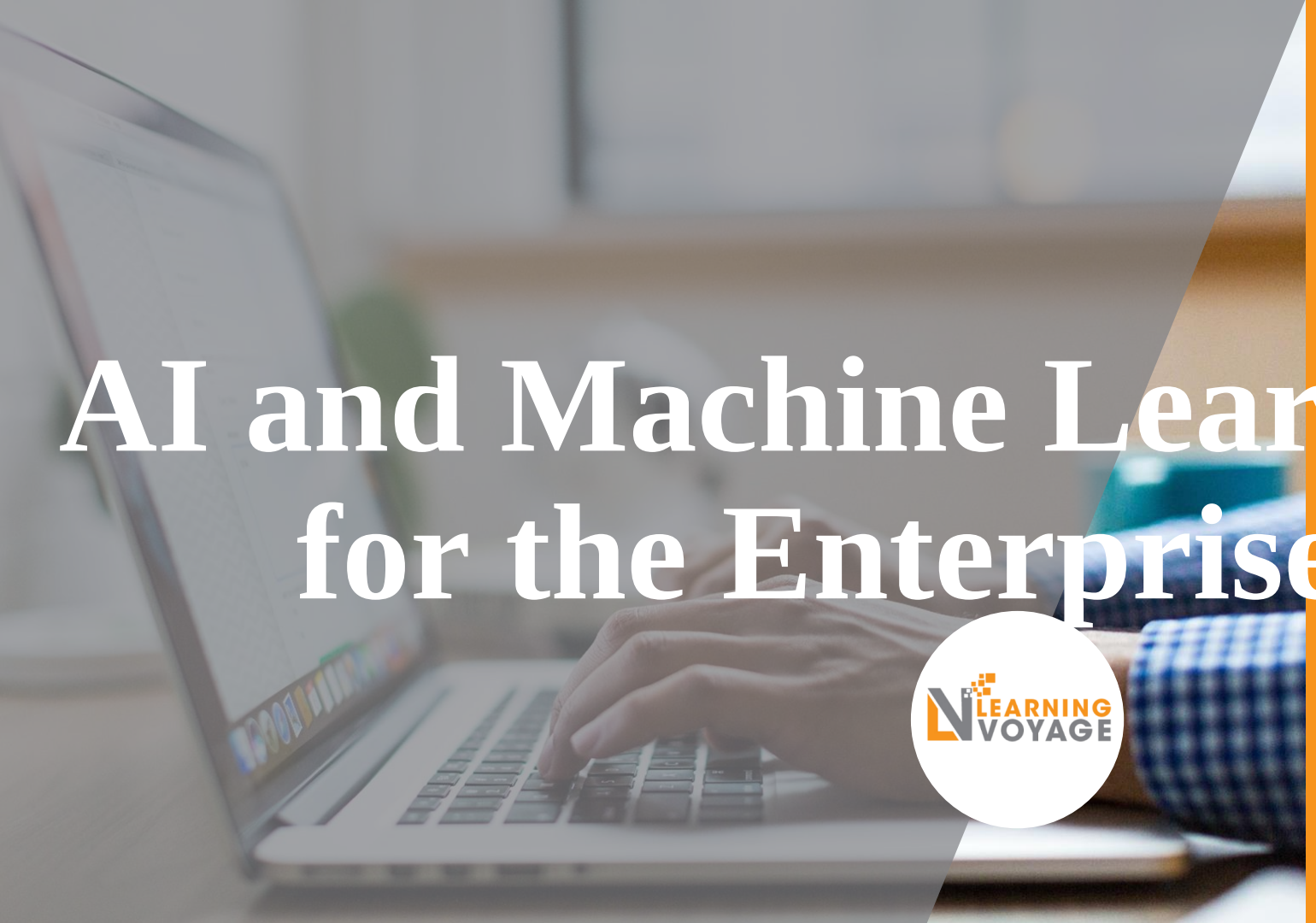


AI and Machine Learning for the Enterprise

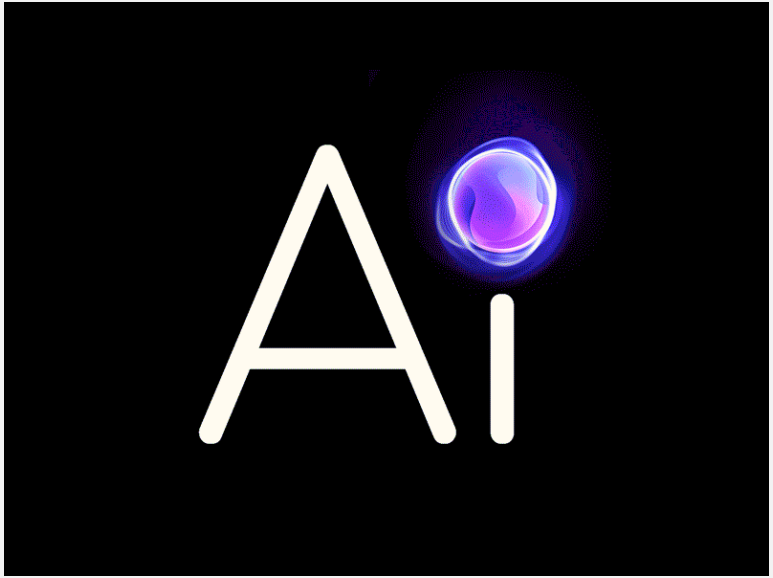
LEARNING VOYAGE

What is AI? Introduction

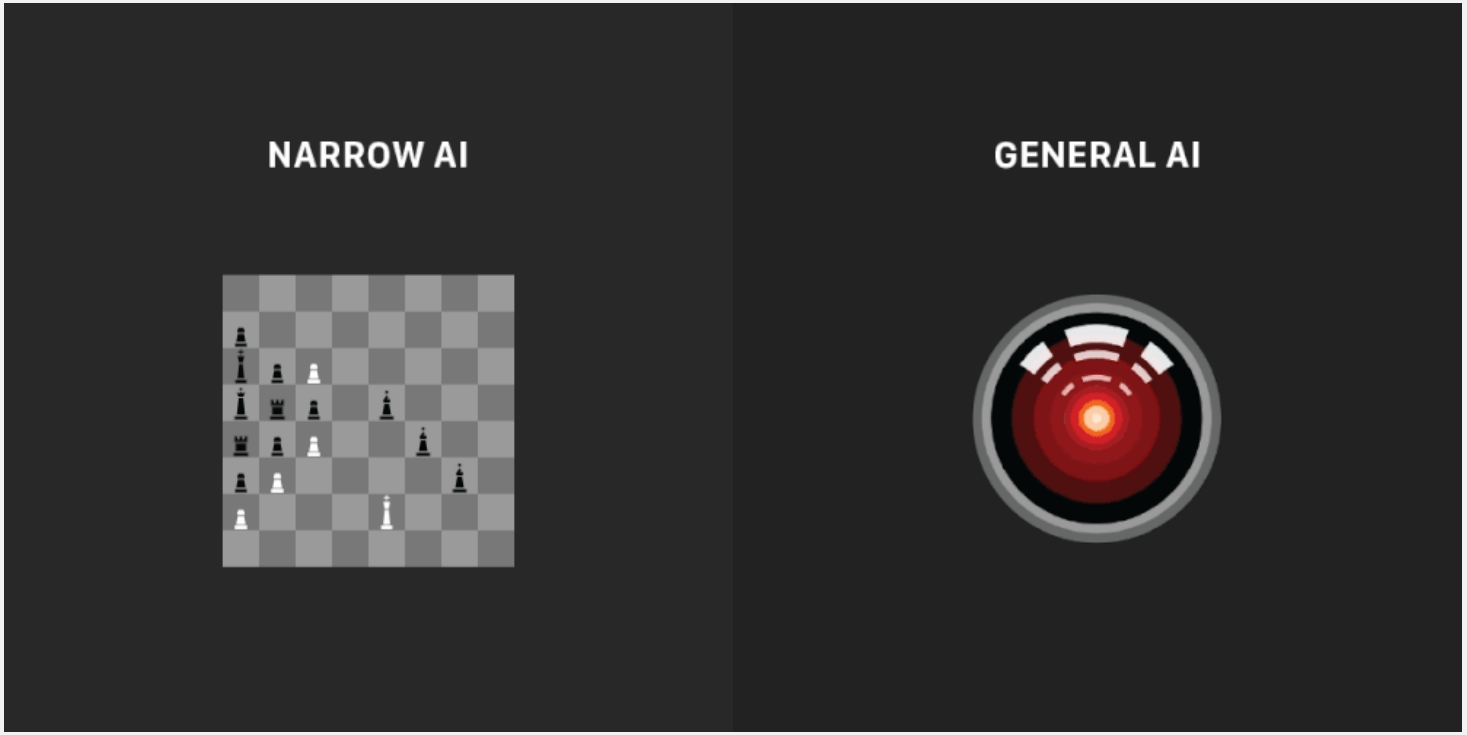
LEARNING VOYAGE

Introduction

- AI is creating tremendous amounts of value in every industry
- In sectors such as retail, travel, transportation, automotive, materials, manufacturing and so on.



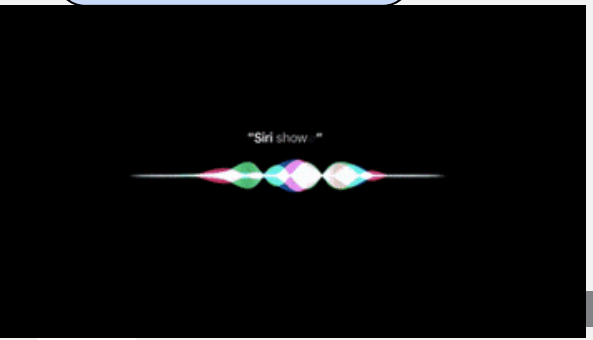
Introduction



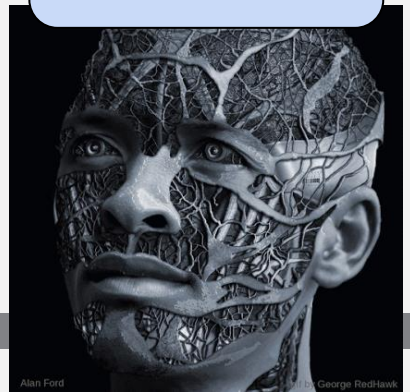
Introduction

AI

ANI



AGI

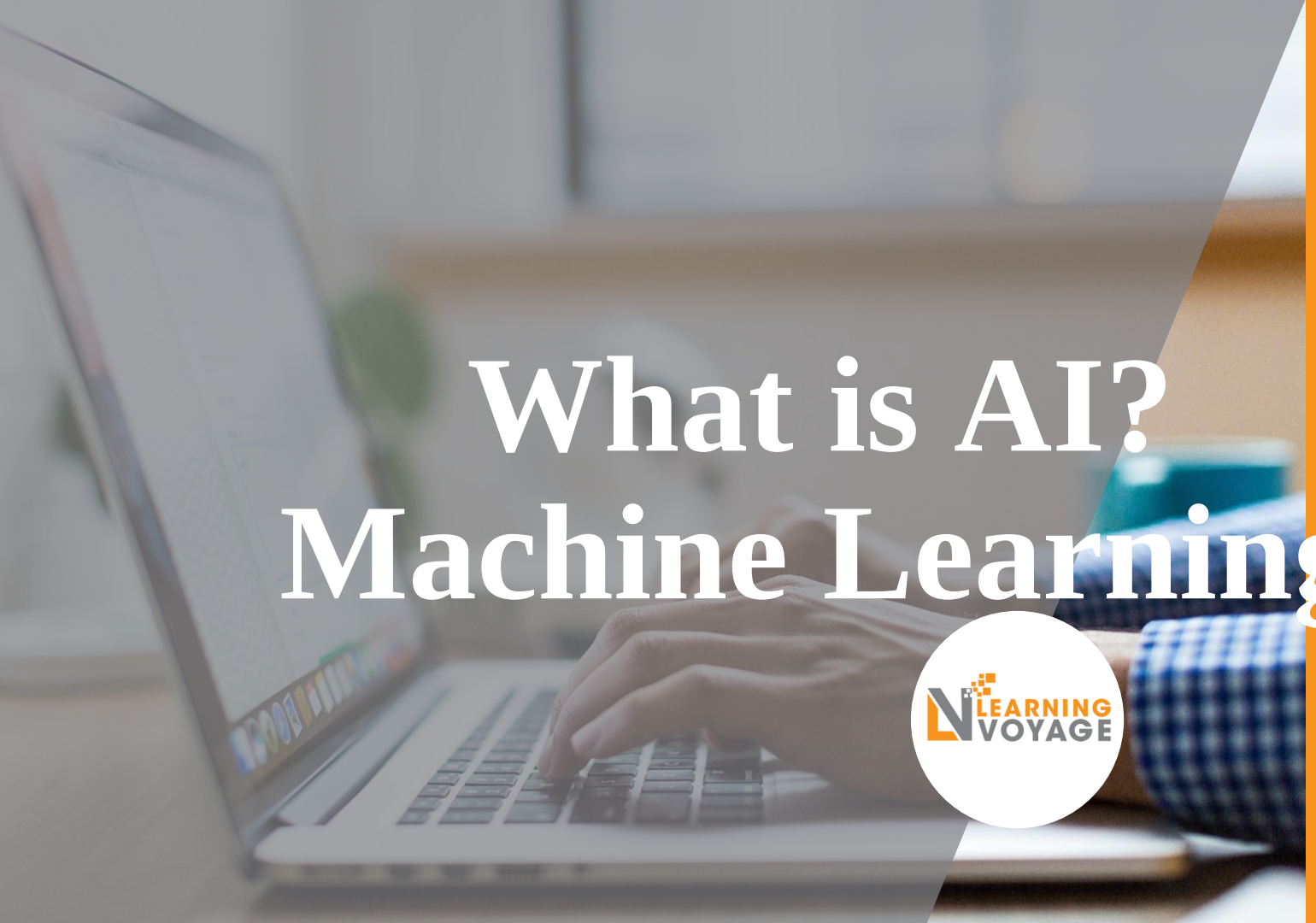


ASI

What you'll learn

What is Data Analytics/Data Science

- **Machine Learning**
- **Data**
- **AI Organizations**
- **What can you really do with this?**
- **Deep Learning**



What is AI?
Machine Learning

LEARNING VOYAGE

Introduction

Machine Learning

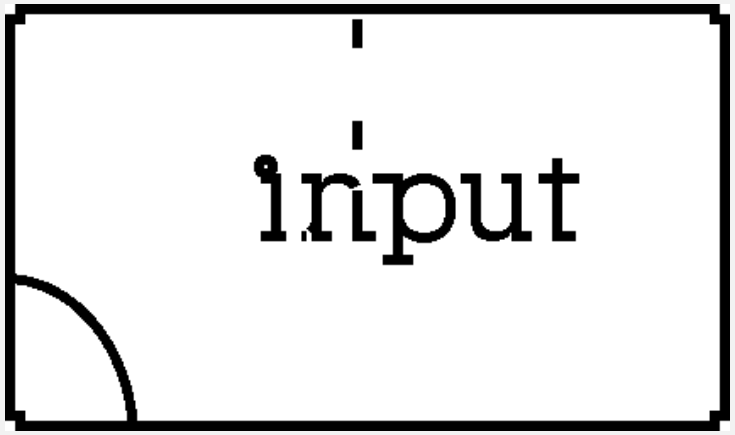
- The rise of AI has been largely driven by one tool in AI called machine learning.

- In this you'll learn what machine learning is, so that by the end, you will start thinking how machine learning might be applied to your company or to your industry.

Supervised Learning

A

B

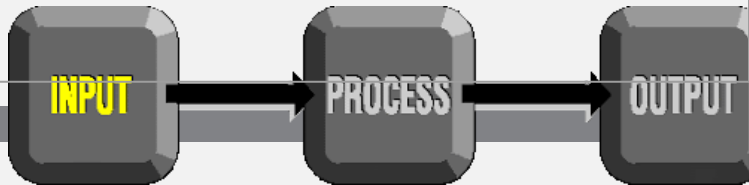


Input

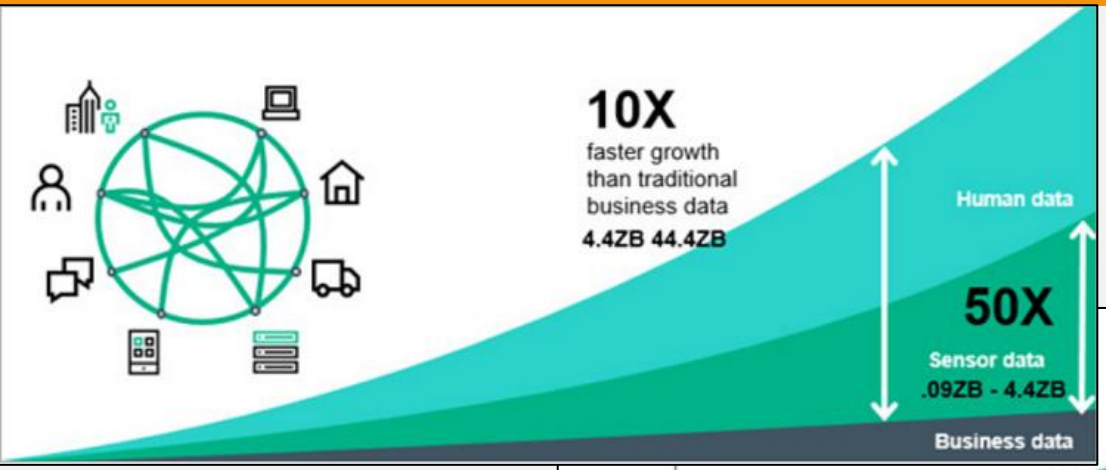
Output

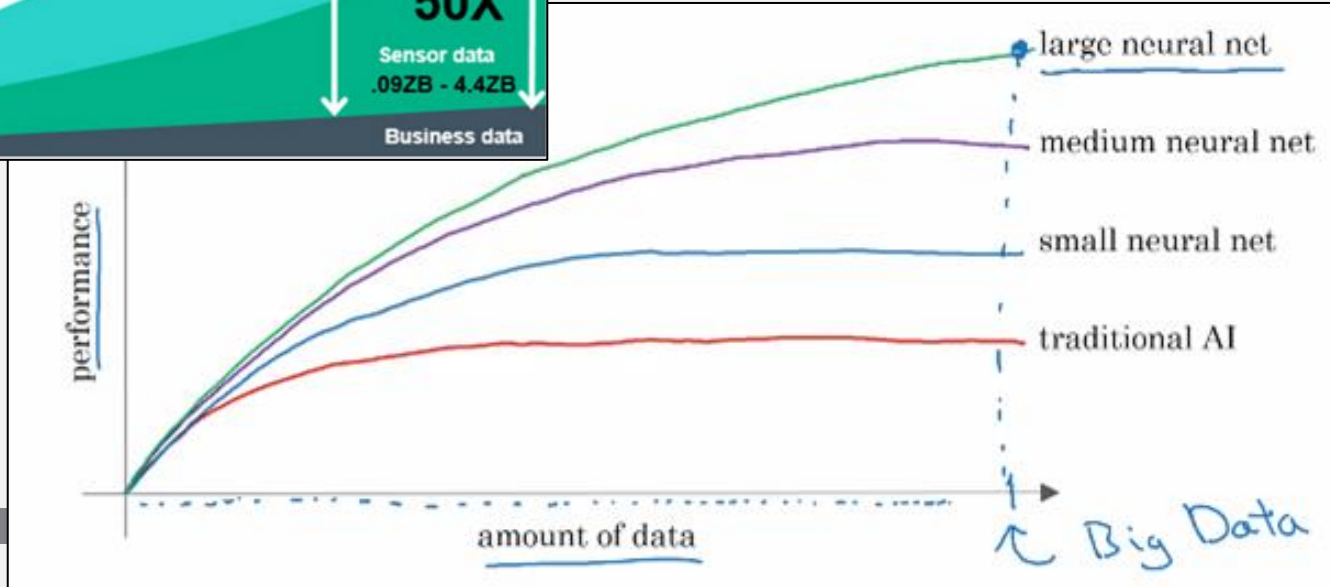
Machine Learning

Input → Process → Output	**Use Cases**
User Information → MODEL → Click?	Social Media. Online Advertising
email → Model → Spam	Spam Filter
Video → Model → Transcript	Speech Recognition
Shopping History → Model → Offers	Recommender Systems
English → Model → Spanish	Speech Translation
Product Image → Model → Defective	QA



Why Now


10X
faster growth
than traditional
business data
4.4ZB 44.4ZB
Human data
50X
Sensor data
.09ZB - 4.4ZB
Business data

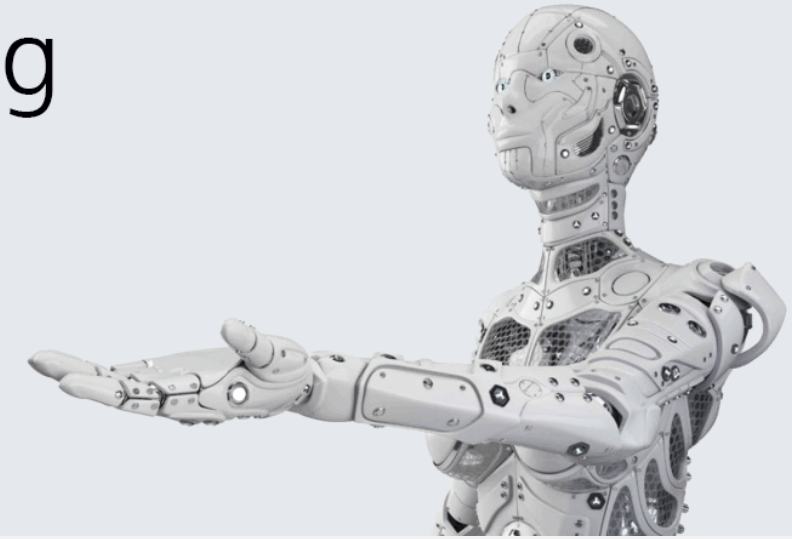

large neural net
medium neural net
small neural net
traditional AI
performance
amount of data
Big Data

Machine Learning

- What enables AI to work really well is data.

AI's coming of age

The progress into the AGI phase and the beginning of true autonomy.



What is AI?
What is data?

LEARNING VOYAGE

Example of Table Of Data (dataset)

Age	Income	Loan Status
21	20000	Rejected
37	55000	Approved
29	35000	Approved
23	17000	Rejected
34	70000	Approved
47	84000	Rejected
25	30000	Approved

Input	Image Label
	Dog
	Dog
	Cat
	Dog
	Cat
	Cat
	Dog

Acquiring Data

- Manual labeling

 cat

 not cat

 cat

 not cat

- From observing behaviors

user ID	time	price ($)	purchased
4783	Jan 21 08:15.20	7.95	yes
3893	March 3 11:30.15	10.00	yes
8384	June 11 14:15.05	9.50	no
0931	Aug 2 20:30.55	12.90	yes

machine	temperature (°C)	pressure (psi)	machine fault
17987	60	7.65	N
34672	100	25.50	N
08542	140	75.50	Y
98536	165	125.00	Y

A B

- Download from websites / partnerships

Use and Mis Use Of Data

Don’t throw data at an AI team and assume it will be valuable.

Data is Messy

- Garbage in, garbage out

- Data problems
  - Incorrect labels
  - Missing values

- Multiple types of data

images, audio, text

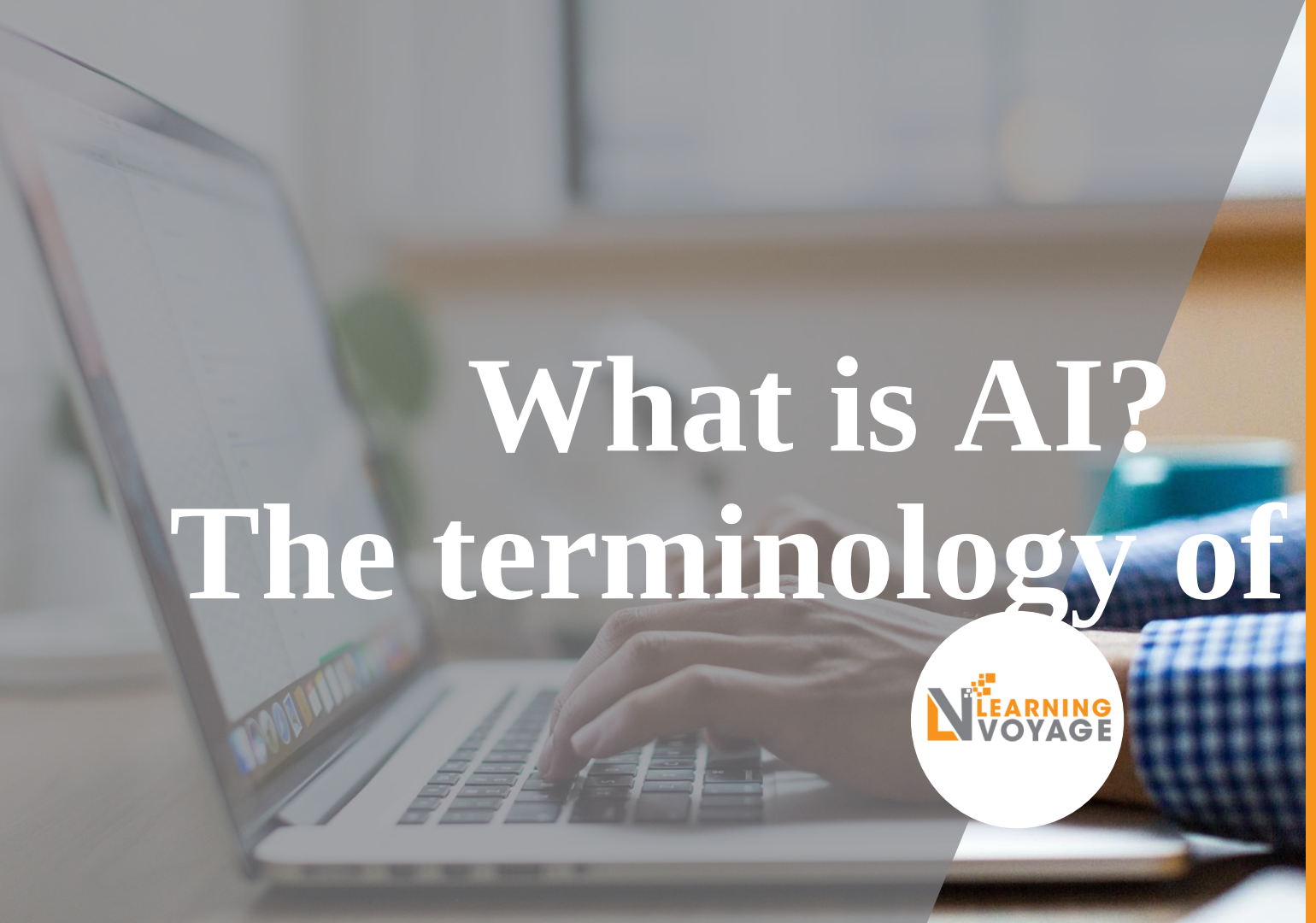
unstructured

size of house (square feet)	# of bedrooms	price (1000$)
523	1	115
645	1	0.001
708	unknown	210
1034	3	unknown
unknown	4	355
2545	unknown	440

structured

What is data?

- In this you learned what is data and you also saw how not to misuse data.
- Finally, you saw data is messy. But a good AI team would be the help you deal with all of these problems.
- Now, AI has a complicated terminology when people start throwing around terms like AI, Machine Learning, Data Science.



What is AI?
The terminology of AI

LEARNING VOYAGE

The terminology of AI

- You might have heard terminology from AI, such as machine learning or data science or neural networks or deep learning. What do these terms mean?

- In this, you'll see what is this terminology of the most important concepts of AI, so that you will speak with others about it and start thinking how these things could apply in your business.

Machine Learning VS Data Science

Home prices

size of house (square feet)	# of bedrooms	# of bathrooms	newly renovated	price (1000$)
523	1	2	N	115
645	1	3	N	150
708	2	1	N	210
1034	3	3	Y	280
2290	4	4	N	355
2545	4	5	Y	440

A

B

ML. A → B

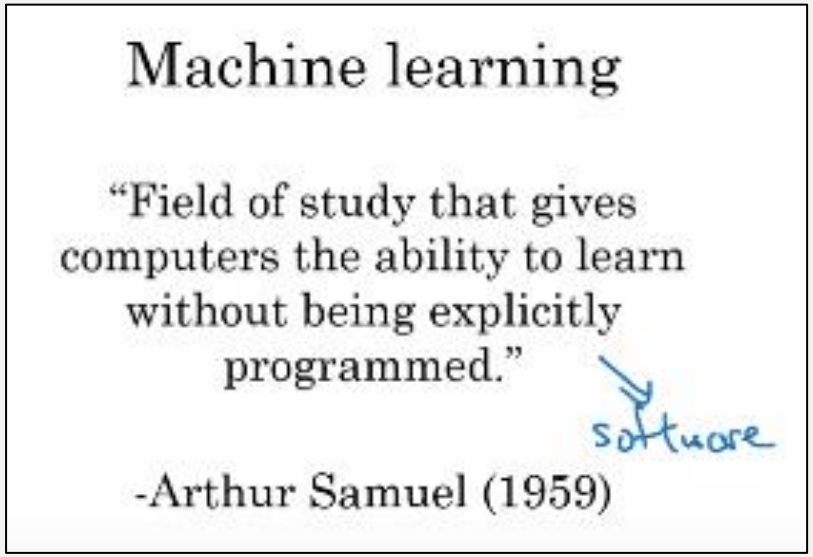
Running AI system
(e.g., websites / mobile app)

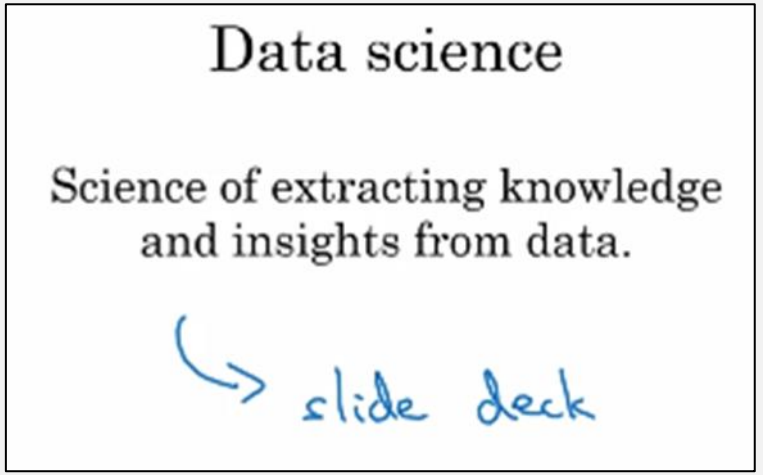
DS

Homes with 3 bedrooms are more expensive than homes with 2 bedrooms of a similar size.

Newly renovated homes have a 15% premium.

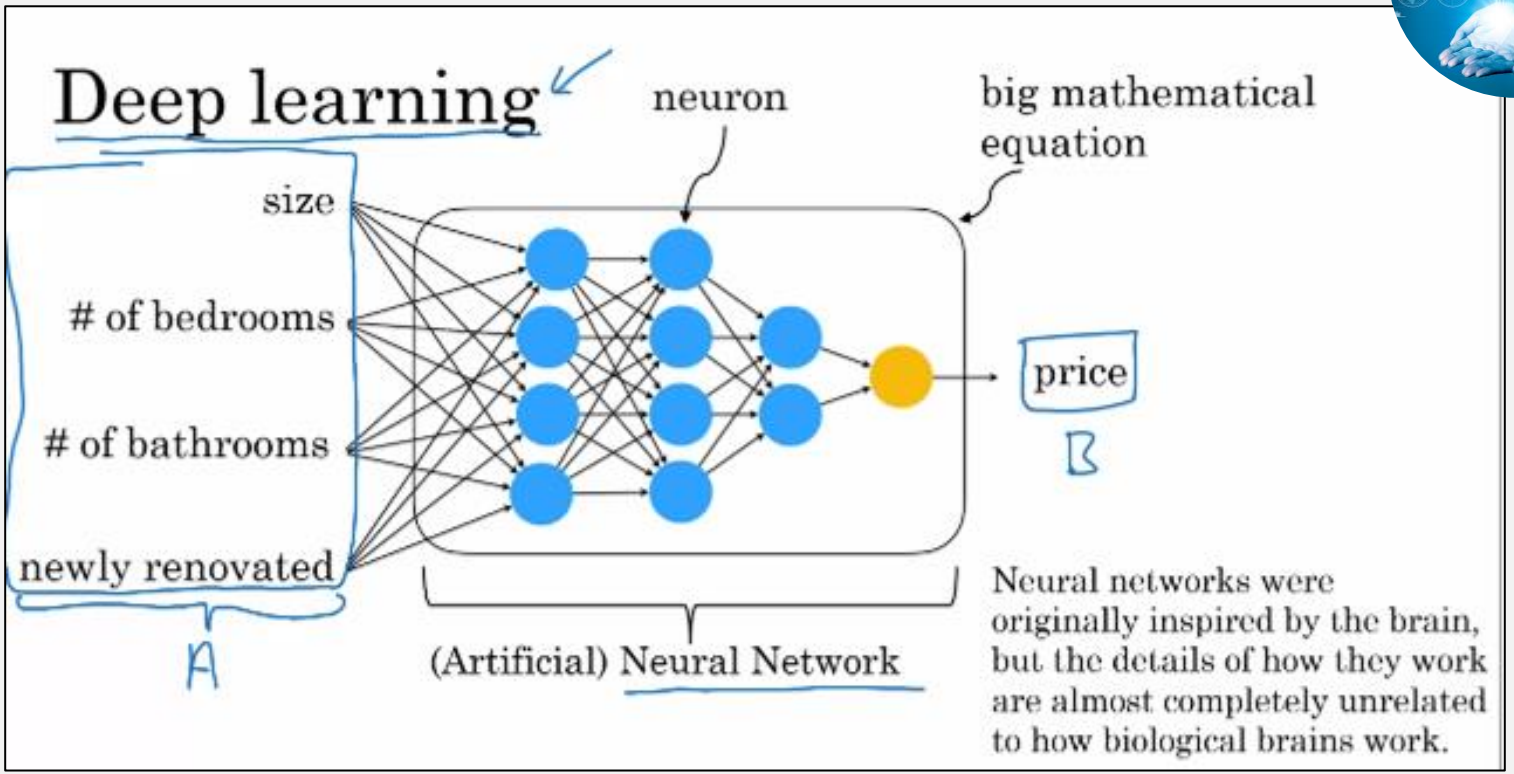
Machine Learning vs.Data Science





The terminology of AI

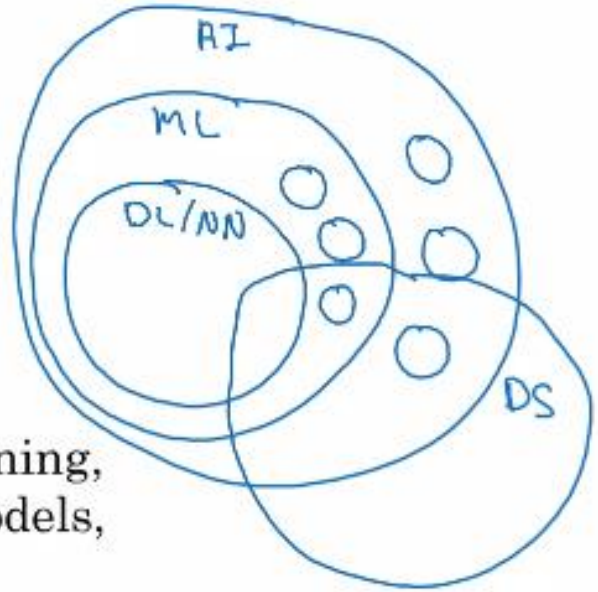
Deep Learning



The terminology of AI

AI has many tools

- Machine learning and data science
- Deep learning / neural network
- Other buzzwords: Unsupervised learning, reinforcement learning, graphical models, planning, knowledge graph, …



The terminology of AI

- In this lesson, you saw what is machine learning, what is data science, and what is deep learning and neural networks.
- I hope this gives you a sense of the most common and important terminology using AI, and you can start thinking about how these things might apply to your company.
- Now, what does it mean for a company to be good at AI? Let's talk about that in the next slides.

What is AI?
What makes an AI company?

LEARNING VOYAGE

What makes an AI company?

- What makes a company good at AI? Perhaps even more importantly, what will it take for your company to become great at using AI?

- So, what can you do for your company?
- This is the lesson I had learned by watching the rise of the Internet that I think will be relevant to how all of us navigate the rise of AI.

What makes an AI company?

A lesson from the rise of the Internet

Internet Era	AI era

What makes an AI company?

A lesson from the rise of the Internet

Internet Era	AI era
Shopping mall + website ≠ Internet company	Any company + deep learning ≠ AI company

What makes an AI company?

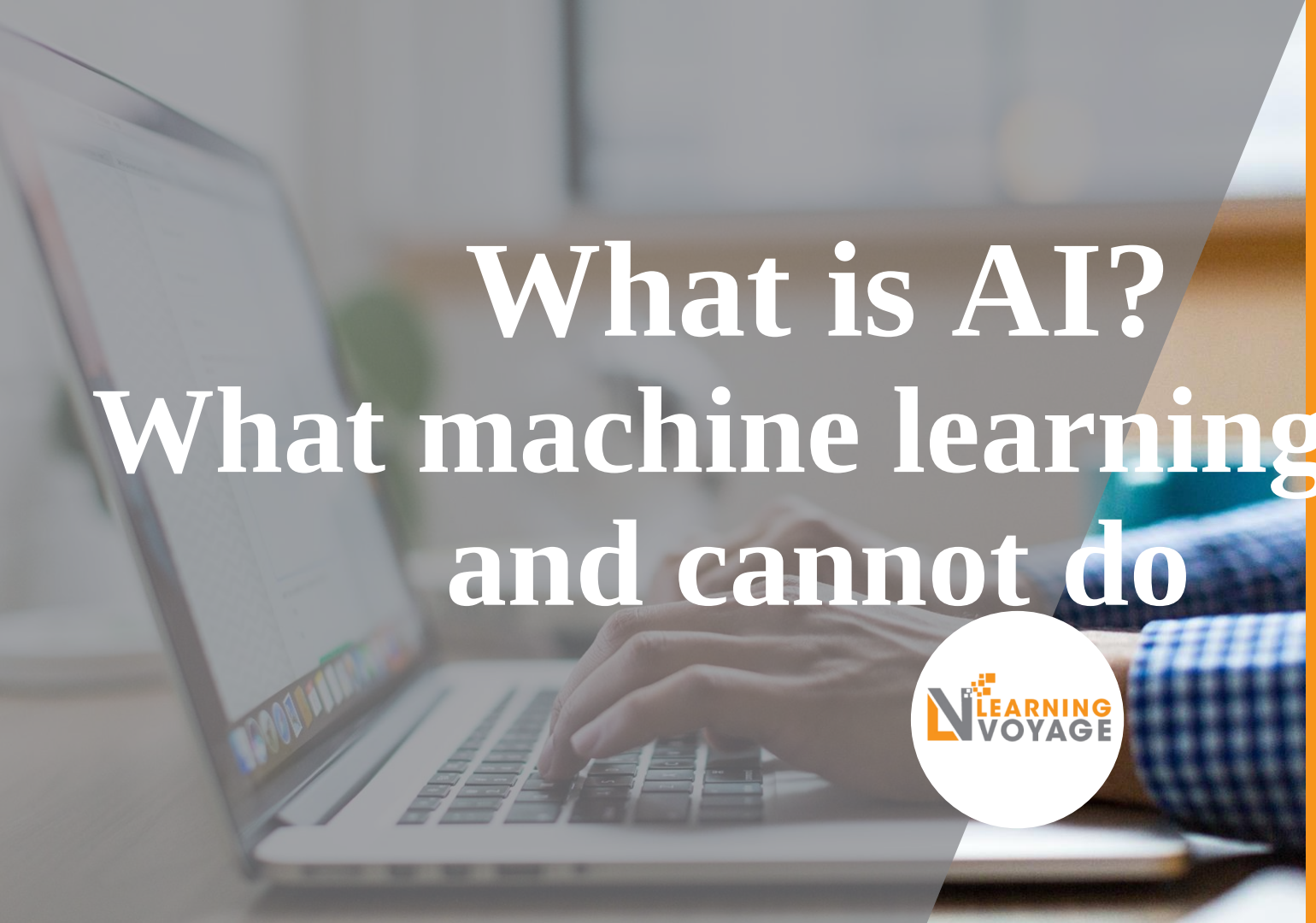
A lesson from the rise of the Internet

Internet Era	AI era
Shopping mall + website ≠ Internet company	Any company + deep learning ≠ AI company
- A/B testing - Short iteration time - Decision making pushed down to engineers and other specialized roles	- Strategic data acquisition - Unified data warehouse - Pervasive automation - New roles (e.g., MLE) and division of labor

What makes an AI company?

AI Transformation

1. Execute pilot projects to gain momentum
2. Build an in-house AI team
3. Provide broad AI training
4. Develop an AI strategy
5. Develop internal and external communications



What is AI?
What machine learning can and cannot do

LEARNING VOYAGE

What machine learning can and cannot do

- In these slides and the next slides, I hope to help you develop intuition about what AI can and cannot do. In practice, before I commit to a specific AI project, I'll usually have either myself or engineers do technical diligence on the project to make sure that it is feasible.

- This means: looking at the data, look at the input, and output A and B, and just thinking through if this is something AI can really do.

Supervised learning

Input (A)	Output (B)	Application
email	spam? (0/1)	spam filtering
audio	text transcripts	speech recognition
English	Chinese	machine translation
ad, user info	click? (0/1)	online advertising
image, radar info	position of other cars	Self-driving car
image of phone	defect? (0/1)	visual inspection

Anything you can do with 1 second of thought, we can probably now or soon automate.

What machine learning can and cannot do

The toy arrived two days late, so I wasn't able to give it to my niece for her birthday.
Can I return it?

"Refund request"

Input text → Refund/Shipping/Other

A → B

Oh, sorry to hear that.
I hope your niece had a good birthday.
Yes, we can help with....

What Happens If You Try?

Input (A)		Output (B)
User email	→	2-3 paragraph response
1000 examples		
"My box was damaged."	→	Thank you for your email.
"Where do I write a review?"	→	Thank you for your email.
"What's the return policy?"	→	Thank you for your email.
"When is my box arriving?"	→	Thank yes now your….

What makes an ML Problem Easier

1. Learning a "simple" concept

   ≤ 1 sec

2. Lots of data available

   A, B

   A → B

More examples of what machine learning can and cannot do

- One of the challenges of becoming good at recognizing what AI can and cannot do is that it does take seeing a few examples of concrete successes and failures of AI.

- If you work on an average of say, one new AI project a year, then to see three examples would take you three years of work experience and that's just a long time.

Self Driving Car

Can do

A → B

10,000

Cannot do

stop

hitchhiker

10,000

bike turn
left signal

1. Data
2. Need high accuracy

A → B

More examples of what machine learning can and cannot do

- Say you want to build an AI system to look at X-ray images and diagnose pneumonia. So, all of these are chest X-rays.
  - So, the input A could be the X-ray image and the output B can be the diagnosis.
- Does this patient have pneumonia or not?
  - So, that's something that AI can do.
- Something that AI cannot do would be to diagnose pneumonia from 10 images of a medical textbook chapter explaining pneumonia.

X Ray Diagnosis





Can do	Cannot do
Diagnose pneumonia from ~10,000 labeled images	Diagnose pneumonia from 10 images of a medical textbook chapter explaining pneumonia
A → B	A → B

Strengths and Weaknesses Of ML

ML tends to work well when:

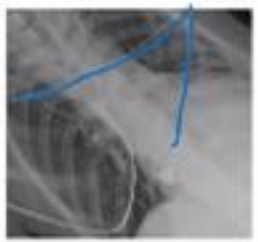
1. Learning a "simple" concept
2. There is lots of data available

ML tends to work poorly when:

1. Learning complex concepts from small amounts of data
2. It is asked to perform on new types of data

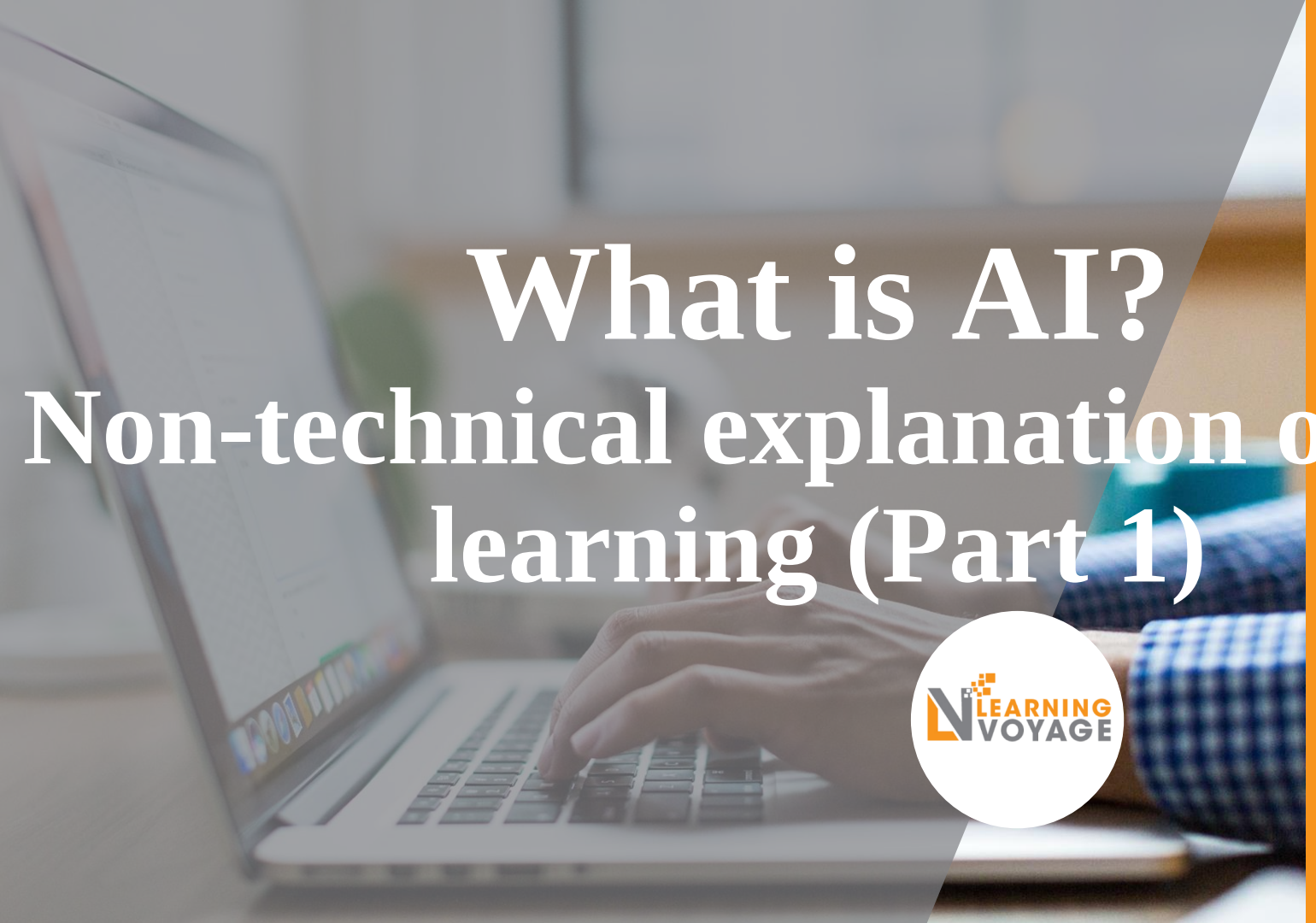
A→B



More examples of what machine learning can and cannot do

- I hope these examples are helping you hone your intuitions about what AI can and cannot do. In case the boundary between what it can or cannot do still seems fuzzy to you, don't worry.
- It is completely normal, completely okay. In fact even today, I still can't look at a project and immediately tell is something that's feasible or not.
- I often still need weeks or small numbers of weeks of technical diligence before forming strong conviction about whether something is feasible or not.

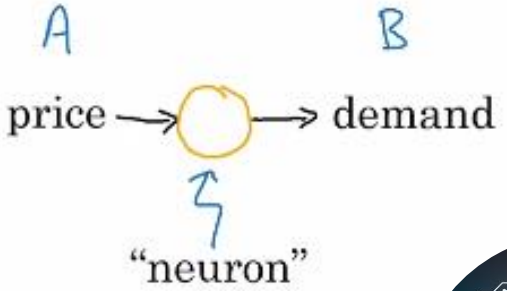


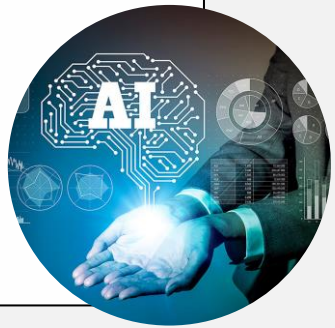
What is AI?
Non-technical explanation of deep learning (Part 1)

LEARNING VOYAGE

Non-technical explanation of deep learning (Part 1, optional)

Demand prediction



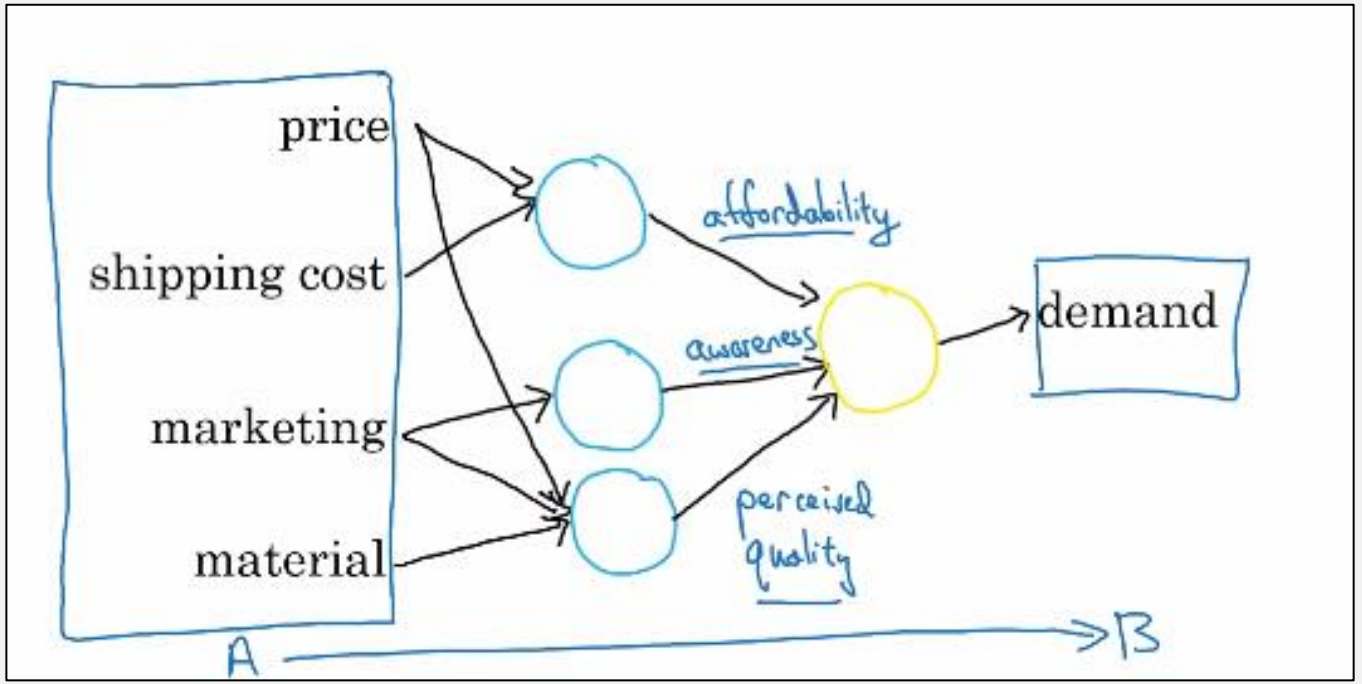


Demand Prediction

- Suppose that instead of knowing only the price of the product, you also have the shipping costs that the customers will have to pay to get the product.

- May be you spend more or less on marketing in a given week, and you can also make the product out of high quality material.

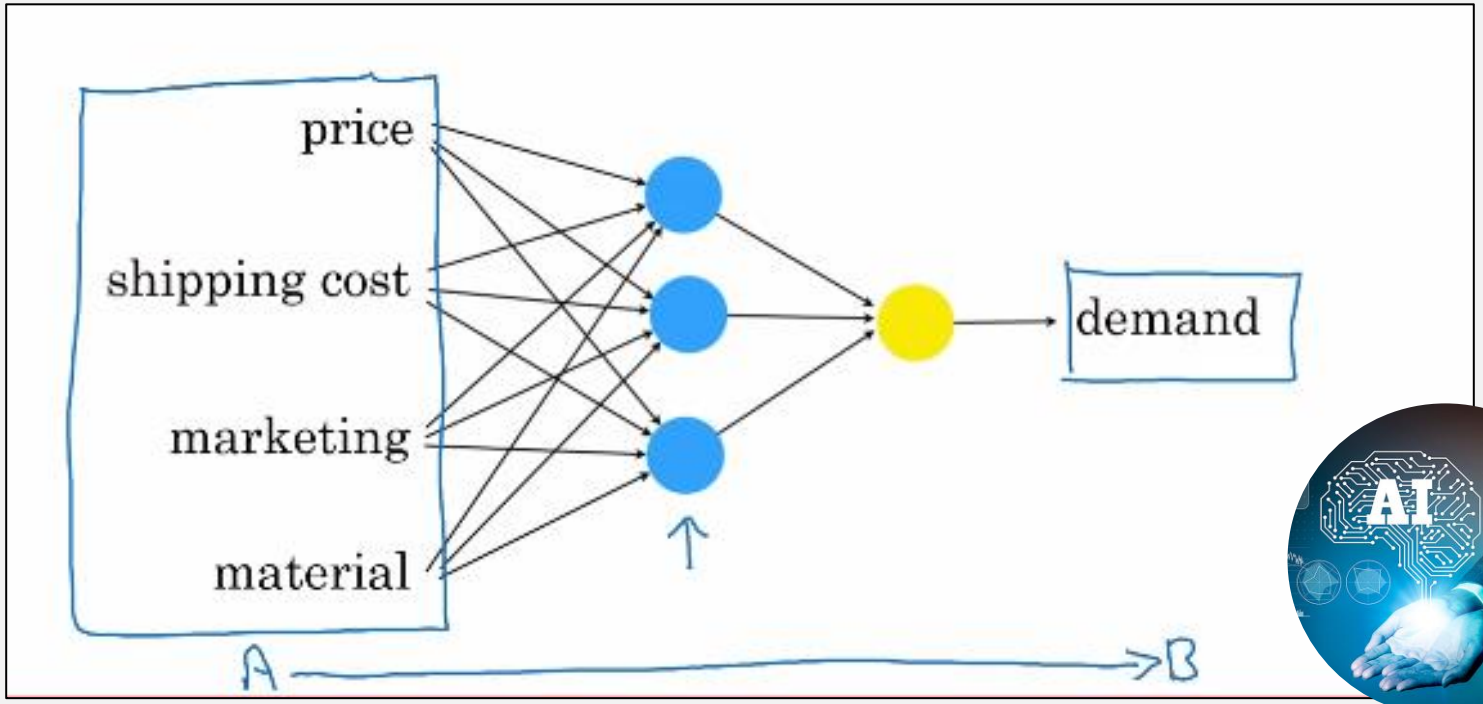
Demand Prediction



Non-technical explanation of deep learning (Part 1, optional)

- So It learns this input output or A to B mapping.
- This is a fairly small neural network with just four artificial neurons.
- In practice, neural networks used today are much larger, with easily thousands, tens of thousands or even much larger than that numbers of neurons.

Demand Prediction



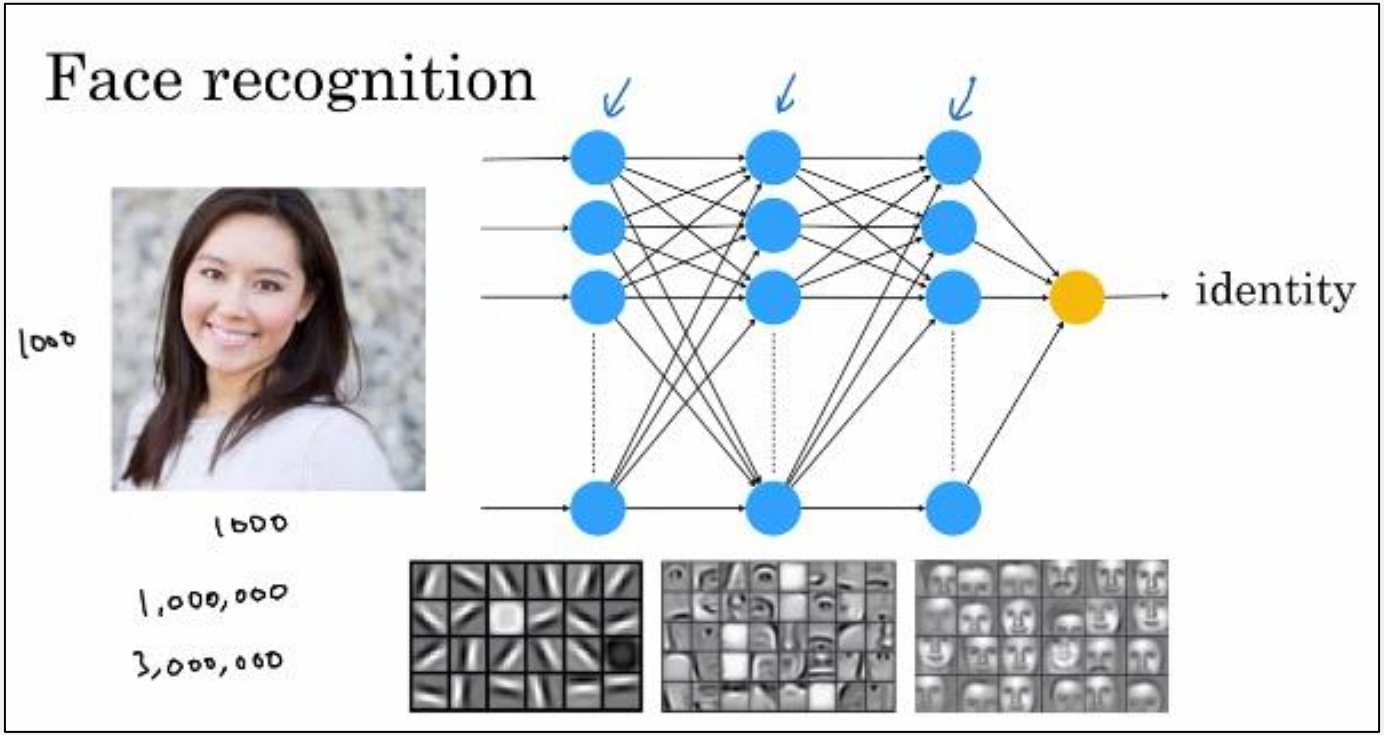
Non-technical explanation of deep learning (Part 1, optional)

- So that's a neural network, is a group of artificial neurons each of which computes a relatively simple function.
- But when you stack enough of them together like Lego bricks, they can compute incredibly complicated functions that give you very accurate mappings from the input A to the output B.
- Now, in this you saw an example of neural networks applied to demand prediction.

Face Recognition

30	32	22	12	10	10	12	33	35	30
12	11	12	234	170	176	13	15	12	12
234	222	220	230	200	222	230	234	56	78
190	220	186	112	110	110	112	180	30	32
49	250	250	250	4	2	254	200	44	6
55	250	250	250	3	1	250	245	25	3
189	195	199	150	110	110	182	190	199	55
200	202	218	222	203	200	200	208	215	222
219	215	220	220	222	214	215	210	220	220
220	220	220	220	221	220	221	220	220	222

Non-technical explanation of deep learning (Part 2, optional)



Building AI Projects? Introduction

LEARNING VOYAGE

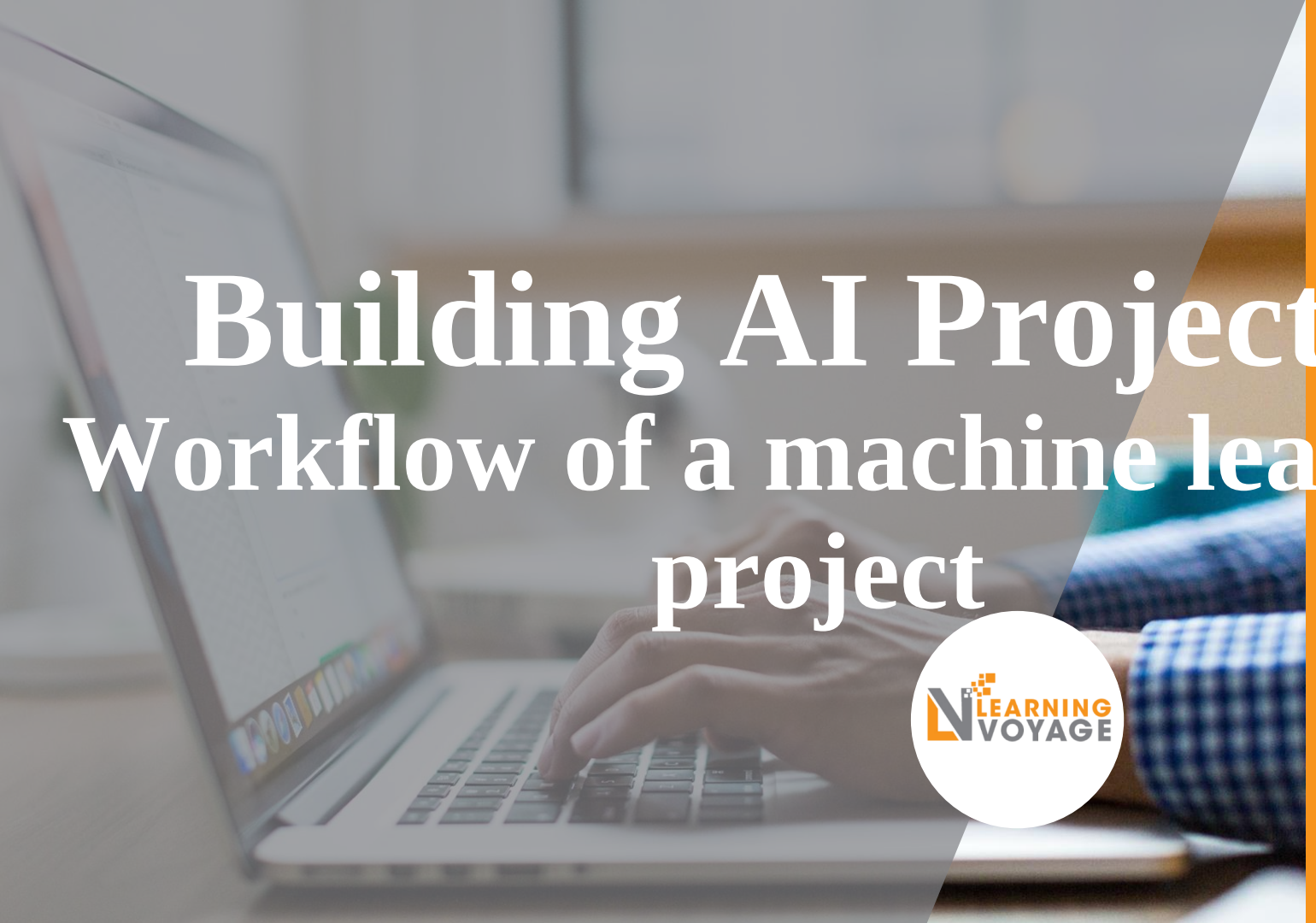
Introduction

- Welcome back. Previously, you learned about the basics of AI and machine learning technology.
- But how do you use this technology in a project, either if you want to do a project in your proverbial garage or if you want to do your project in a bigger company, or maybe even have something that builds up to align with your corporate strategy?

Introduction

Starting an AI project

- Workflow of projects
- Selecting AI projects
- Organizing data and team for the projects



Building AI Projects?
Workflow of a machine learning project

LEARNING VOYAGE

Workflow of a machine learning project

- Machine learning algorithms can learn input to output or A to B mappings.
  - So, how do you build a machine learning project?

- In this, you'll learn what is the workflow of machine learning projects. Let's take a look.

Workflow of a machine learning project

Example: Speech recognition

Amazon
Echo / Alexa

Google
Home

Apple
Siri

Baidu
DuerOS

Workflow of a machine learning project

- Let's go through the key steps of a machine learning project. Just for simplicity, I'm going to use Amazon Echo or detecting the Alexa keywords as this running example.

- If you want to build an AI system or build a machine learning system to figure out when a user has said the word Alexa, the first step is to collect data.

Workflow of a machine learning project

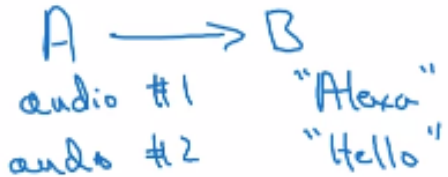
Key steps of a machine learning project

Echo / Alexa

→ 1. Collect data

→ 2. Train model

Iterate many times until good enough



→ 3. Deploy model

Get data back

Maintain / update model

Workflow of a machine learning project

- Let's say you're building a self-driving car. One of the key components of a self-driving car is a machine learning algorithm that takes as input, say a picture, of what's in front of your car and tells you where are the other cars.

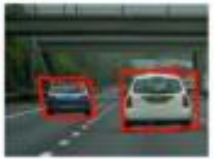
- So, what's the first step of building this machine learning system?
  - Hopefully, you remember from the last slide that the first step was to collect data.

Keysteps of a machine learning project

Self-driving car

1. Collect data

image ⟶ position of other cars


2. Train model

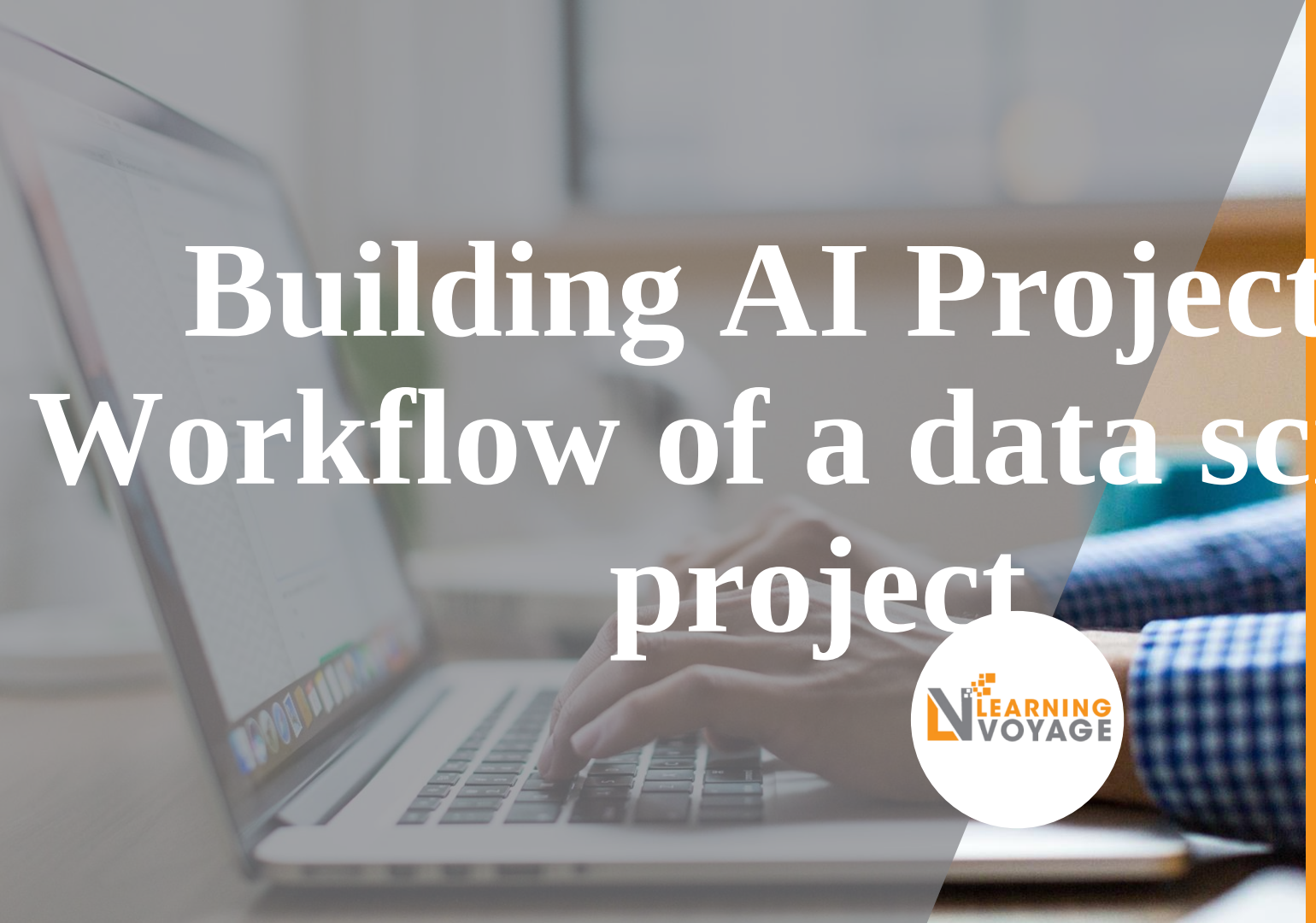
   Iterate many times until good enough

3. Deploy model

   Get data back

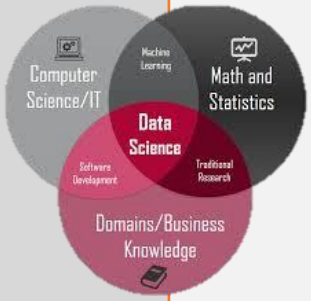
   Maintain / update model


Building AI Projects? Workflow of a data science project



Workflow of a data science project

- Unlike a machine learning project, the output of a data science project is often a set of actionable insights, a set of insights that may cause you to do things differently.
- So, data science projects have a different workflow than machine learning projects.
- Let's take a look at one of the steps of a data science project.



Key Steps of a data science project

Optimizing a sales funnel

User ID	Country	Time	Webpage
2009	Spain	08:34:30 Jan 5	home.html
2897	USA	13:20:22 May 18	redmug.html
4893	Philippines	22:45:16 Jun 11	mug.html

→ 1. Collect data

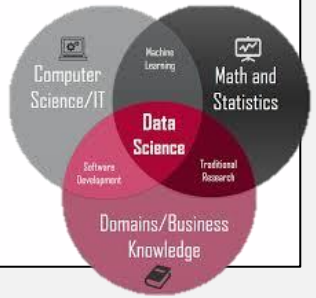
→ 2. Analyze data

Iterate many times to get good insights

→ 3. Suggest hypotheses/actions

Deploy changes

Re-analyze new data periodically



Key Steps of a data science project

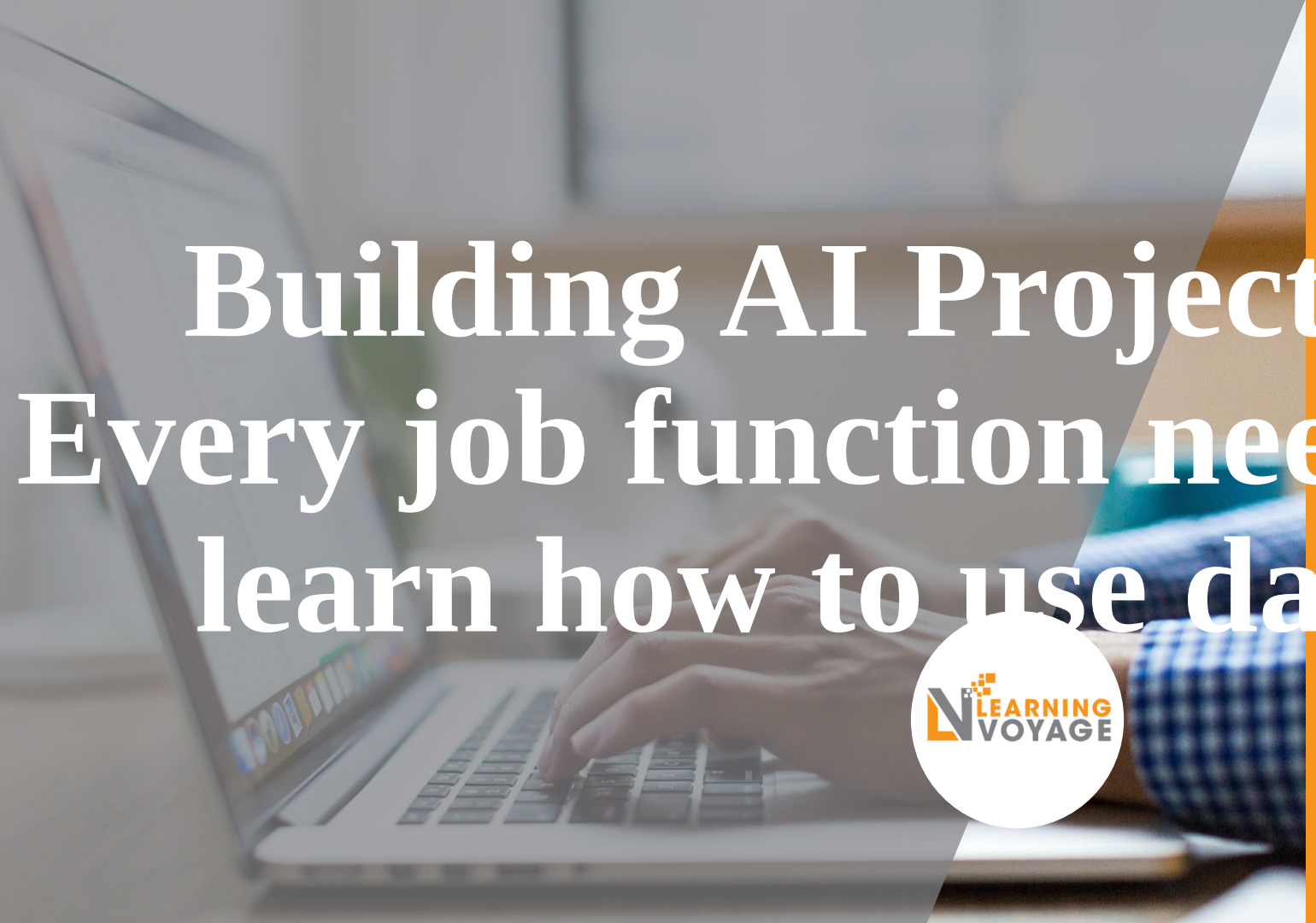
Manufacturing line

Mix clay → Shape mug → Add glaze → Fire kiln → Final inspection

Clay Batch #	Supplier	Mixing time (minutes)
001	ClayCo	35
034	GooClay	22
109	BrownStuff	28

1. Collect data
2. Analyze data
   Iterate many times to get good insights
3. Suggest hypotheses/actions

Mug Batch #	Humidity	Temperature in kiln (F)	Duration in kiln (hours)
301	0.002%	1410"	22
302	0.003%	1520"	24
303	0.002%	1420"	22



Building AI Projects? Every job function needs to learn how to use data

LEARNING VOYAGE

Every job function needs to learn how to use data

- Data is transforming many different job functions, whether you work in recruiting or sales or marketing or manufacturing or agriculture, data is probably transforming your job function. What's happened in the last few decades is the digitization of our society.

- So, rather than handing out papers surveys like these, surveys are more likely to be done in digital format or doctors still write some handwritten notes but doctors handwritten note is increasingly likely to be a digital record a digital record and so to this in just about every single job function.

Every job function needs to learn how to use data

- Machine learning can help you prioritize these leads.
  - So, you might want to prioritize calling up the CEO of a large company rather than the intern at a much smaller company and this type of automated leads sorting is making salespeople more efficient.

- Let say you're manufacturing line manager. You've already seen how data science can help you optimize a manufacturing line.

Every job function needs to learn how to use data

Manufacturing line manager

Data science

Mix clay → Shape mug → Add glaze →

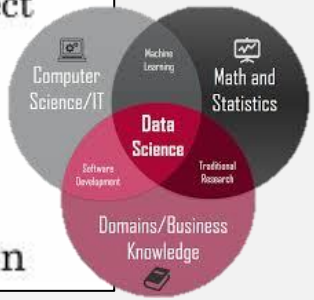
Fire kiln → Final inspection →

Optimize manufacturing line

Machine learning

ok ok defect

Automated visual inspection



Every job function needs to learn how to use data

- How about recruiting?
  - When recruiting someone to join your company, there may be a pretty predictable sequence of steps where your recruiter or someone else would send an email to a candidate and then you'd have a phone call with them, bring them on-site for an interview and then extend an offer and maybe close the offer.

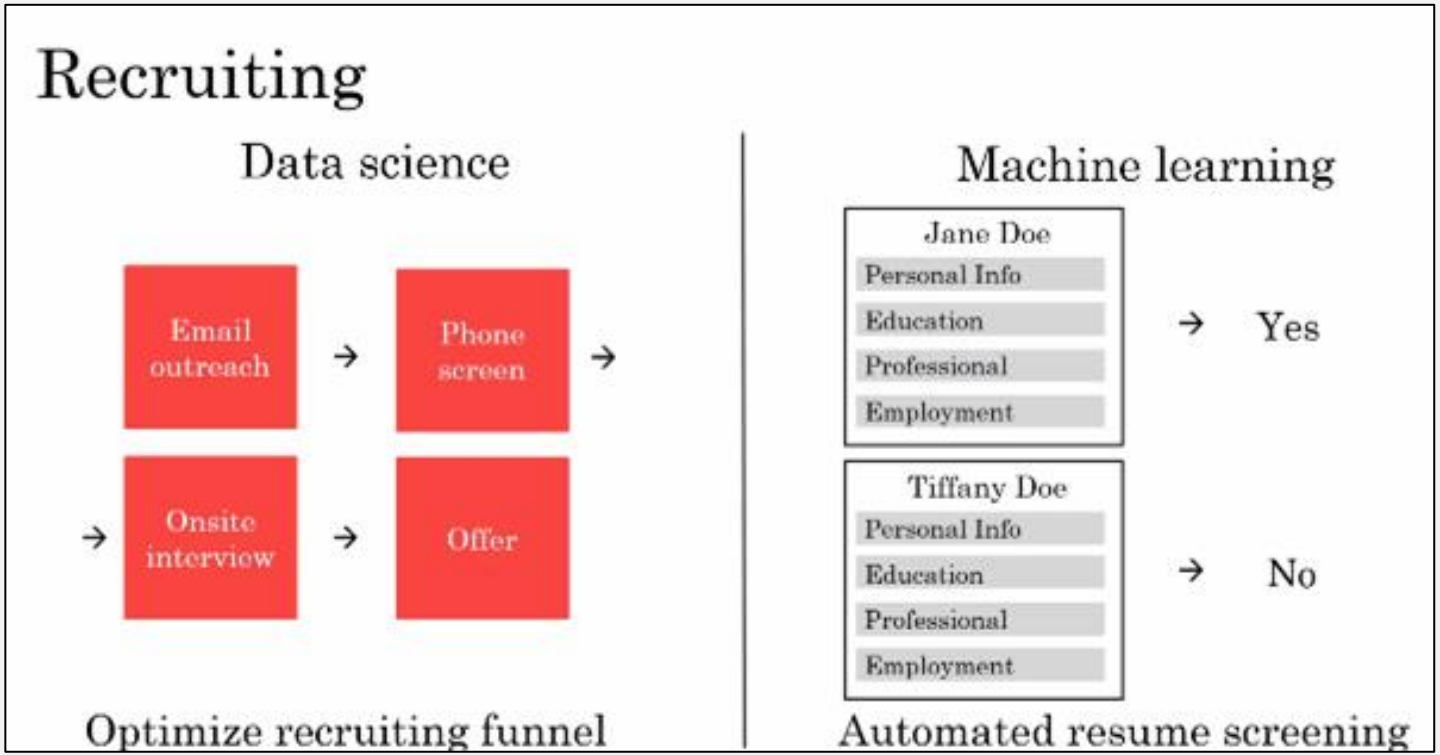
- Similar to how data science can be used to optimize a sales funnel, recruiting can also use data science to optimize a recruiting funnel and in fact many recruiting organizations are doing so today

Every job function needs to learn how to use data

- For example, if you find that hardly anyone is making it from phone screen step to the on-site interviews step then you may conclude that maybe too many people are getting into the phone screen stage or maybe the people doing the phone screen are just being too tough and you should let more people get to the onsite interview stage.

- This type of data science is already having an impact on recruiting. What about machine learning projects? What about machine learning projects? Well, one of the steps of recruiting is to screen a lot of resumes to decide who to reach out to you.

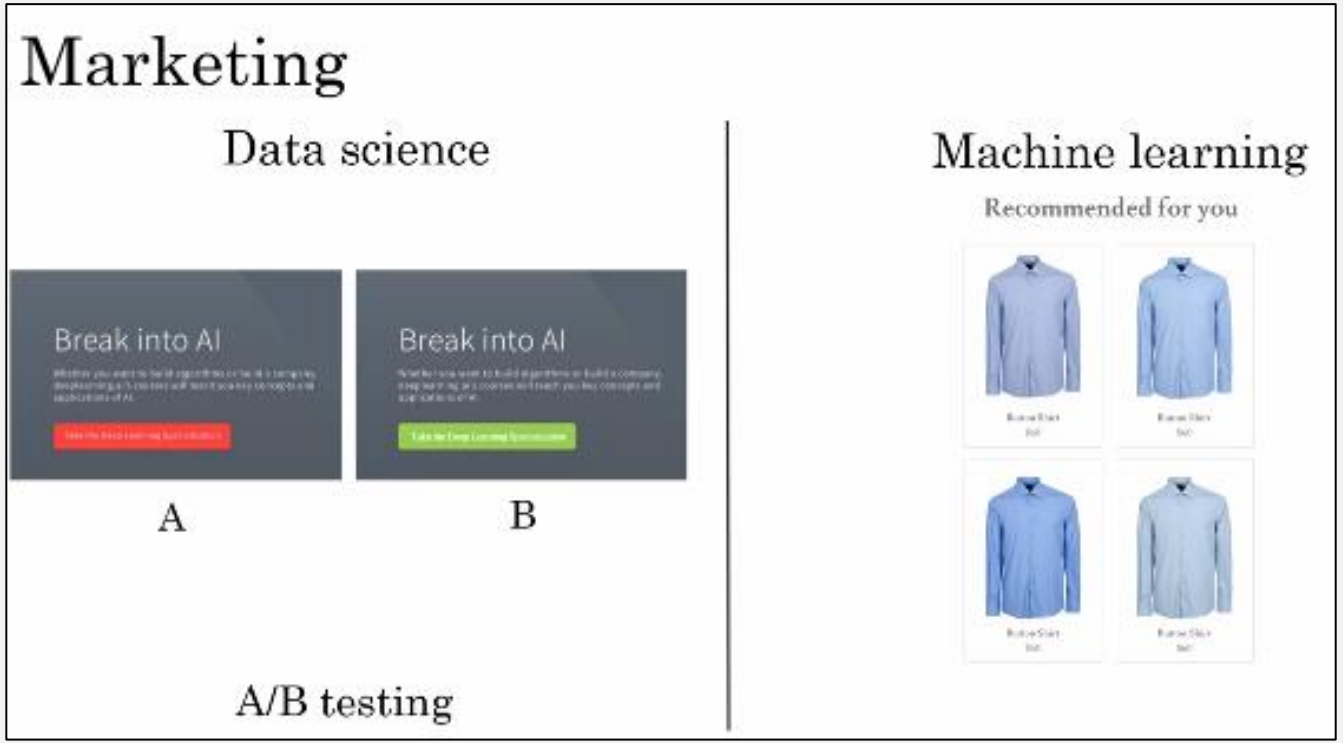
Every job function needs to learn how to use data



Every job function needs to learn how to use data

- What if you work in marketing? One of the common ways to optimize the performance in website is called AB testing, in which you launch two versions of website.
- Here version A has a red button, version B has a green button and you measure which websites causes people to click through more.
- So with this type of data, a data science team can help you gain insights and suggests hypotheses or actions for optimizing your website.

Every job function needs to learn how to use data



Every job function needs to learn how to use data

- One last example from a totally different sector. Let's say you work in agriculture.

- Maybe you're a farmer working on the light industrial farm, how can data science help you?
  - Today farmers are already using data science for crop analytics, where you can take data on the soil conditions, the weather conditions, the presence of different crops in the market and have data science teams make recommendations to what to plant, when to plant so as to improve use while maintaining the condition of the soil on your farm.

Every job function needs to learn how to use data

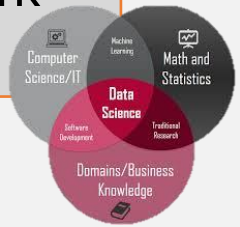
Agriculture

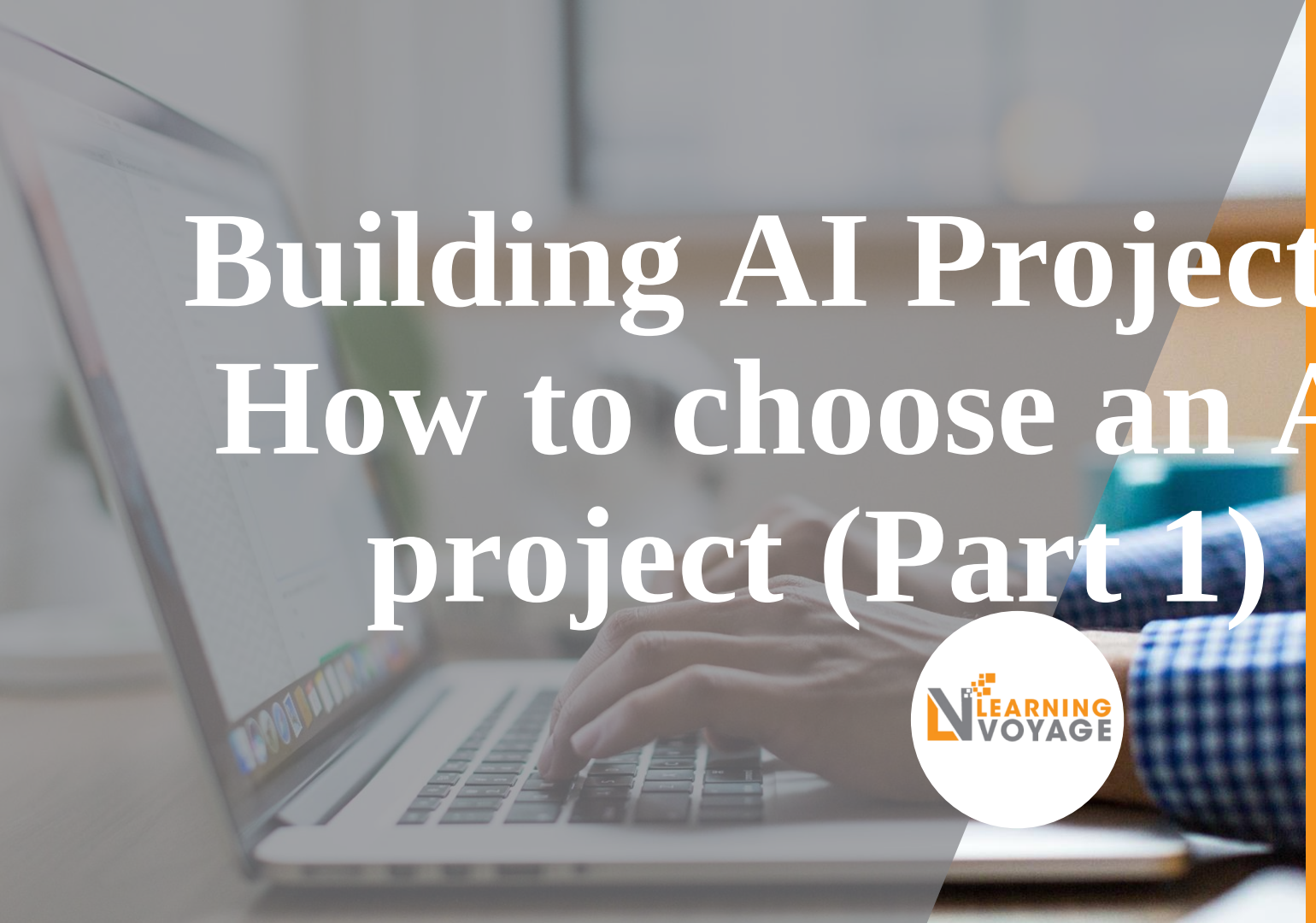
Data science	Machine learning
	
Crop analytics	Precision weed killing

Every job function needs to learn how to use data

- In this, you saw how all of these job functions, everything from sales, recruiting to marketing to manufacturing to farming agriculture, how all of these job functions are being affected by data, by data science and machine learning.

- It seems like there's a lot of different things you could do with AI. But how do you actually select a promising project to work on? Let's talk about that in the next.





Building AI Projects? How to choose an AI project (Part 1)

LEARNING VOYAGE

How to choose an AI project (Part 1)

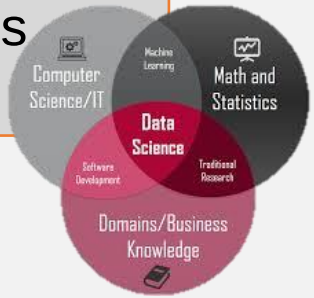
- If you want to try your hand at an AI project, how do you select a worthwhile project to work on? Don't expect an idea to naturally come overnight.

- Sometimes it happens, but sometimes it also takes a few days or maybe a few weeks to come up with a worthy idea to pursue. Next, you will see a framework for brainstorming potentially exciting AI projects to pursue.

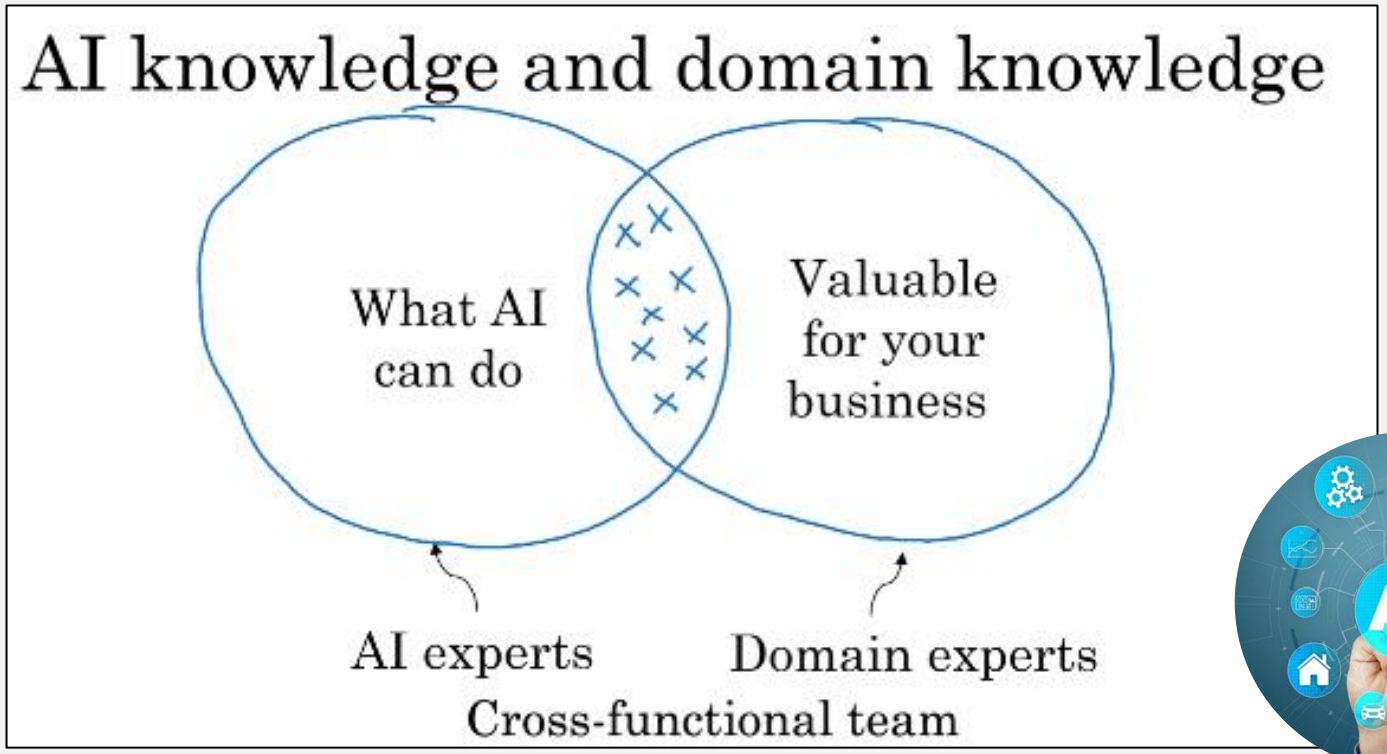
How to choose an AI project (Part 1)

Let's say you want to build an AI project for your business. You've already seen that AI can't do everything, and so there's going to be a certain set of things that is what AI can do.

- So let's let the circle represent the set of things that AI can do. Now, there's also going to be a certain set of things that is valuable for your business.



How to choose an AI project (Part 1)



How to choose an AI project (Part 1)

- When brainstorming projects, there's a framework that I've used with a lot of companies that I found to be useful.
- So let me share with you three principles or three ideas for how you can have a team brainstorm projects
- First, even though there's been a lot of press coverage about AI automating jobs away, and this is an important societal issue that needs to addressed, when thinking about concrete AI projects, I find it much more useful to think about automating tasks rather than automating jobs

How to choose an AI project (Part 1)

Brainstorming framework

- Think about automating tasks rather than automating jobs. E.g., call center routing, radiologists.

How to choose an AI project (Part 1)

- Ranging from people picking up the phone to answering phone calls to replying to emails, to taking specific actions, such as issuing a refund on behalf of a customer request.
- But of all of these tasks that employees in a call center do, there may be one, call routing or email routing, that maybe particularly amenable to machine learning automation.
- And it's by looking at all these tasks that the group of employees do and selecting one that may allow you to select the most fruitful project for automation in the near term.

How to choose an AI project (Part 1)

- Let's look at another example, the job of a radiologist. There's been a lot of press about how AI my automate radiologists' jobs, but radiologists actually do a lot of things.
- They read x-rays, that's really important, but they also engage in their own continuing education.
- They consult with other doctors, they may mentor younger doctors, some of them also consult directly with patients.

How to choose an AI project (Part 1)

- And so it's by looking at all of these tasks that a radiologist does that you may Identify one of them, let's say AI assistance or AI automation for reading x-rays, that allows you to select the most fruitful projects to work on.

- So what I would recommend is, if you look at your business, think about the tasks that people do, to see if you can identify just one of them, or just a couple of them, that may be automatable using machine learning.

How to choose an AI project (Part 1)

Brainstorming framework

- Think about automating tasks rather than automating jobs. E.g., call center routing, radiologists.
- What are the main drivers of business value?
- What are the main pain points in your business?

How to choose an AI project (Part 1)

- I have one last piece of advice for brainstorming AI projects, which is that you can make progress even without big data, even without tons of data.

- Now don't get me wrong, having more data almost never hurts, other than maybe needing to pay a bit more for disk space or network bandwidth to transmit and store the data, having more data almost always is only helpful.

How to choose an AI project (Part 1)

You can make progress even without big data

- Having more data almost never hurts.
- Data makes some businesses (like web search) defensible.
- But with small datasets, you can still make progress.

10
100
1000

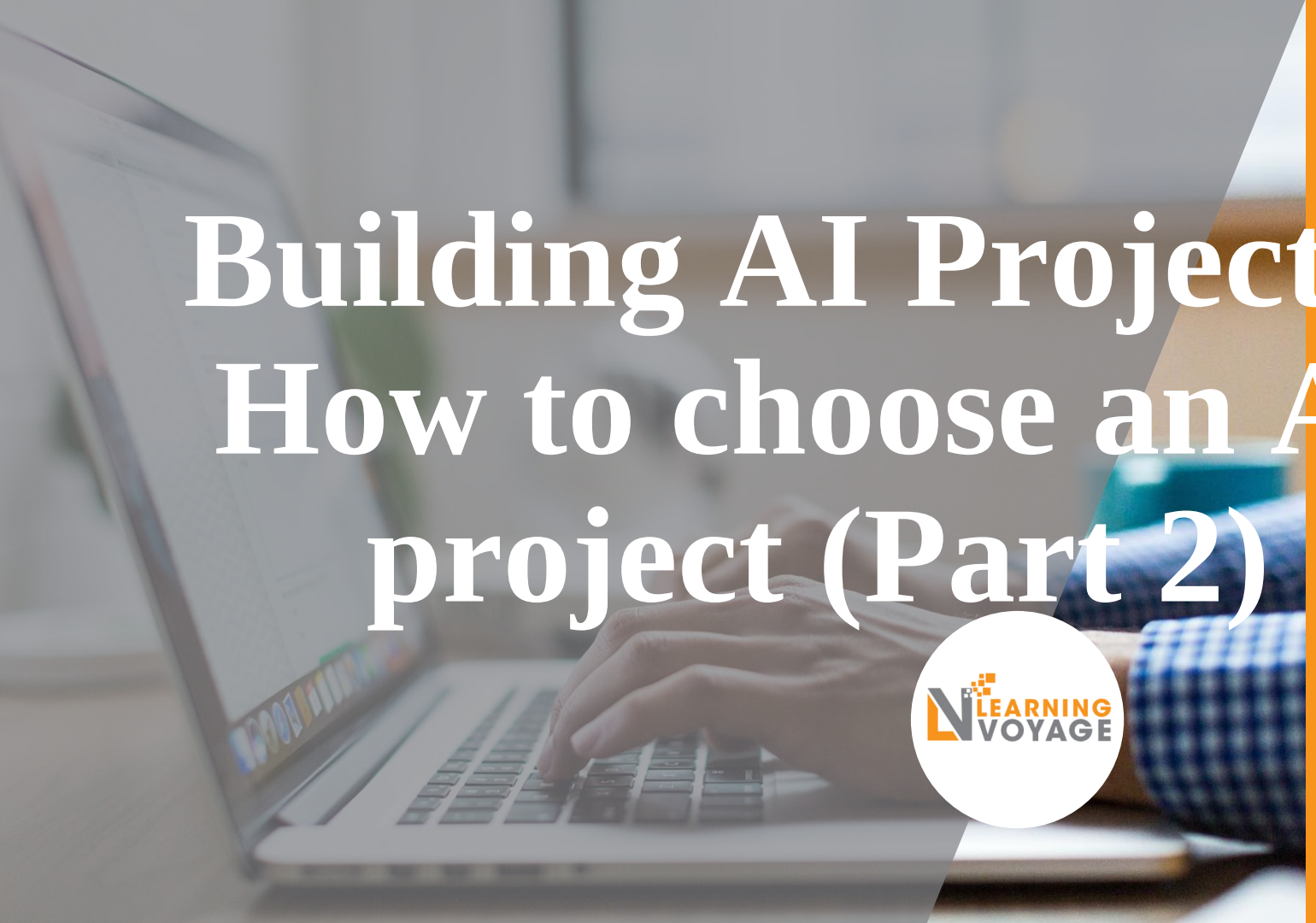
How to choose an AI project (Part 1)

- But I hope you have not manufactured 1 million defective coffee mugs, because that feels like a very expensive thing to have to throw away.
- So sometimes with as few as 100, or maybe 1,000, or sometimes maybe as few as 10, you may be able to get started on the machine learning project.
- The amount of data you need is very problem dependent, and speaking with an AI engineer or AI expert would help you get better sense.

How to choose an AI project (Part 1)

- In this, you saw a brainstorming framework, and a set of criteria for trying to come up with projects that hopefully can be doable with AI, and are also valuable for your business.

- Now, having brainstormed a list of projects, how do you select one or select a small handful to actually commit to and work on? Let's talk about that in the next slides.



Building AI Projects? How to choose an AI project (Part 2)

LEARNING VOYAGE

How to choose an AI project (Part 2)

- Maybe you have a lot of ideas for possible AI projects to work on. But before committing to one, how do you make sure that this really is a worthwhile project?
- If it's a quick project that might take you just a few days maybe just jump in right away and see if it works or not, but some AI projects may take many months to execute.
- In this, I want to step you through the process that I use to double-check if a project is worth that many months of effort.

How to choose an AI project (Part 2)

- Before committing to a big AI project, I will usually conduct due diligence on it. Due diligence has a specific meaning in the legal world.
- But informally, it just means that you want to spend some time to make sure what you hope is true really is true.
- You've already seen how the best AI projects are ones that are feasible. So, it's something that AI can do, as well as valuable.

How to choose an AI project (Part 2)

How to choose an AI project (Part 2)

- Technical diligence is the process of making sure that the AI system you hope to build really is doable, really is feasible.
- So, you might talk to AI experts about whether or not the AI system can actually meet the desired level of performance.

How to choose an AI project (Part 2)

Due diligence on project

Technical diligence

- Can AI system meet desired performance
- How much data is needed
- Engineering timeline

Business diligence

- Lower costs
- Increase revenue

} current business

- Launch new product or business

} new business

How to choose an AI project (Part 2)

- Although not explicitly listed on this slide, one thing I hope you also consider doing as a third type of diligence which is ethical diligence.

- I think there are a lot of things that AI can do that will even make a lot of money, but that may not make society better off. So, in addition to technical diligence and business diligence, I hope you also conduct ethical diligence and make sure that whatever you're doing is actually making humanity and making society better off.

How to choose an AI project (Part 2)

- As you're planning out your AI project, you also have to decide do you want to build or buy? This is an age old question in the IT world and we're facing this question in AI as well.

- For example, hardly any companies build their own computers these days. They buy someone else's computers and hardly any companies build their own Wi-Fi routers, just buy a commercial Wi-Fi router. How about machine learning and data science?

How to choose an AI project (Part 2)

Build vs. buy

- ML projects can be in-house or outsourced
- DS projects are more commonly in-house
- Some things will be industry standard – avoid building those.

How to choose an AI project (Part 2)

- So, when there's a massive force of an industry standard solution that is been built, you might be better off just embracing an industry standard or embracing someone else's platform rather than trying to do everything in-house.

- We all live in a world of limited resources, limited time, limited data, limited engineering resources, and so, I hope you can focus those resources on the projects with our most unique and will make the biggest difference to your company.

How to choose an AI project (Part 2)

- Through the process of technical diligence as well as business diligence, I hope you can start to identify projects that are potentially valuable or that seem promising for your business.

- If the project is a big company, maybe it'll take many months to do. It's not unusual for me to spend even a few weeks conducting this type of diligence before committing to a project.