

Exploring AI & Machine Learning for the Enterprise



What is AI? Introduction



Introduction



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



Introduction



NARROW AI



GENERAL AI

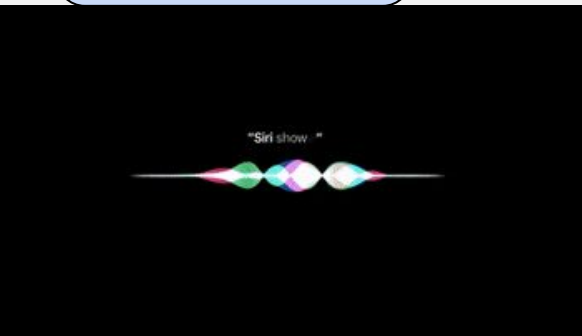


Introduction

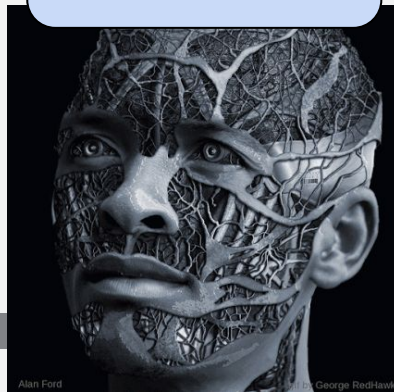


AI

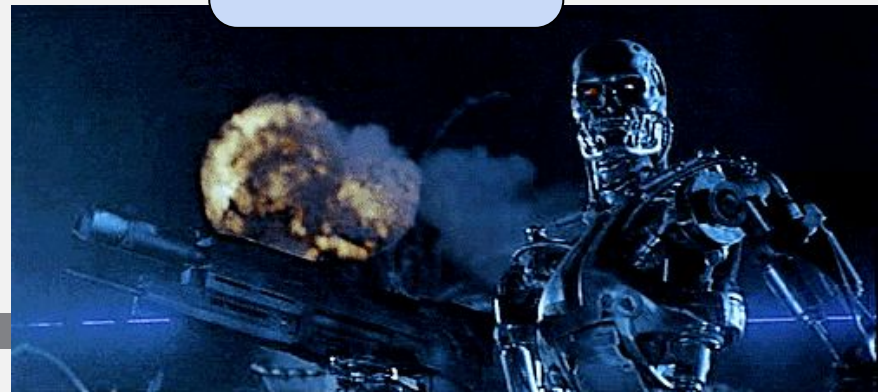
ANI



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**

Introduction



- Finally, AI is having a huge impact on society. You'll learn about how AI systems can be biased and how to diminish or eliminate such biases.
- You also learn how AI is affecting developing economies and how AI is affecting jobs and be better able to navigate this rise of AI for yourself and for your organization.



What is AI? Machine Learning

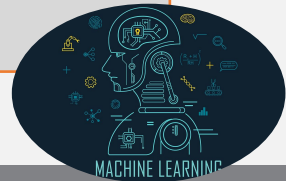


Introduction



Machine Learning

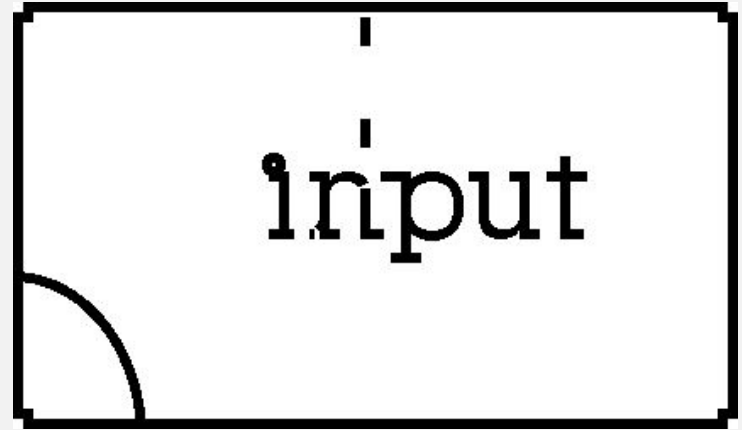
- The rise of AI has been largely driven by one tool in AI:
 - **machine learning.**
- In this you'll learn what machine learning is, so that by the end, you will start thinking how machine learning might be applied to your role at Johnson and Johnson.



Supervised Learning

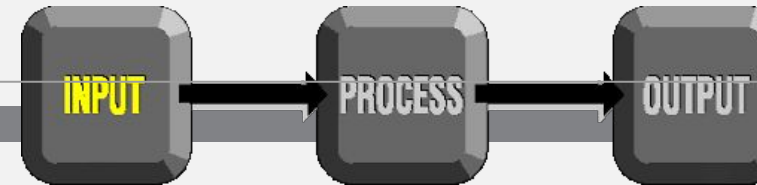
A → B

Input → Output

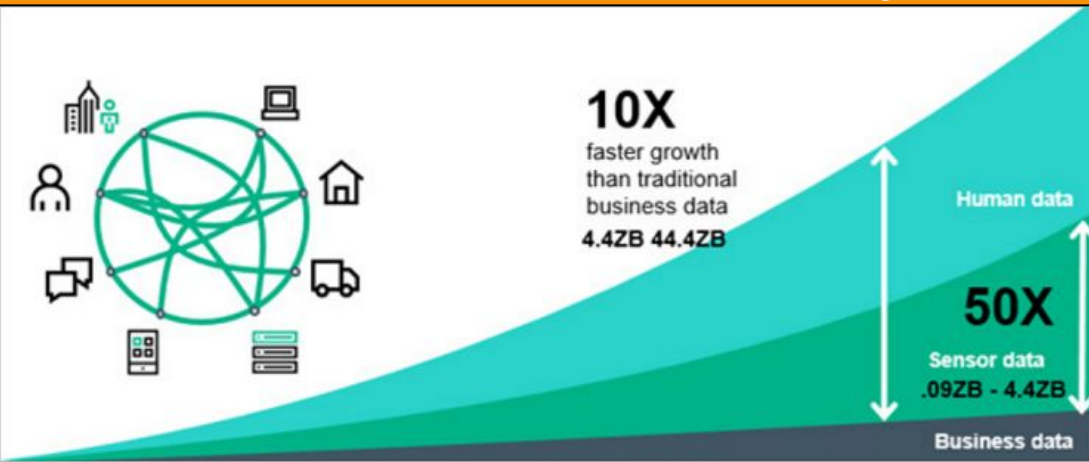


Machine Learning

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



Machine Learning

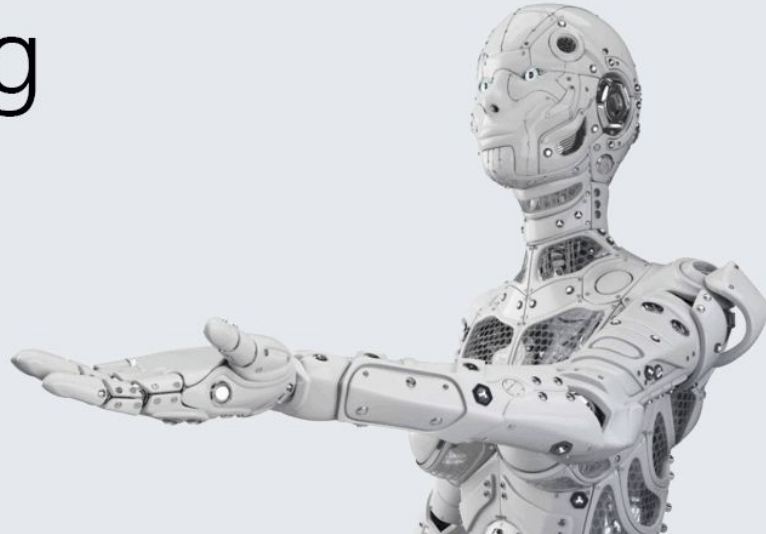


Machine Learning

- 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?










What is data?



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

- Download from websites / partnerships

A

B

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



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

ML. $A \rightarrow B$

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

Machine learning

“Field of study that gives computers the ability to learn without being explicitly programmed.”

software

-Arthur Samuel (1959)

Data science

Science of extracting knowledge and insights from data.

slide deck

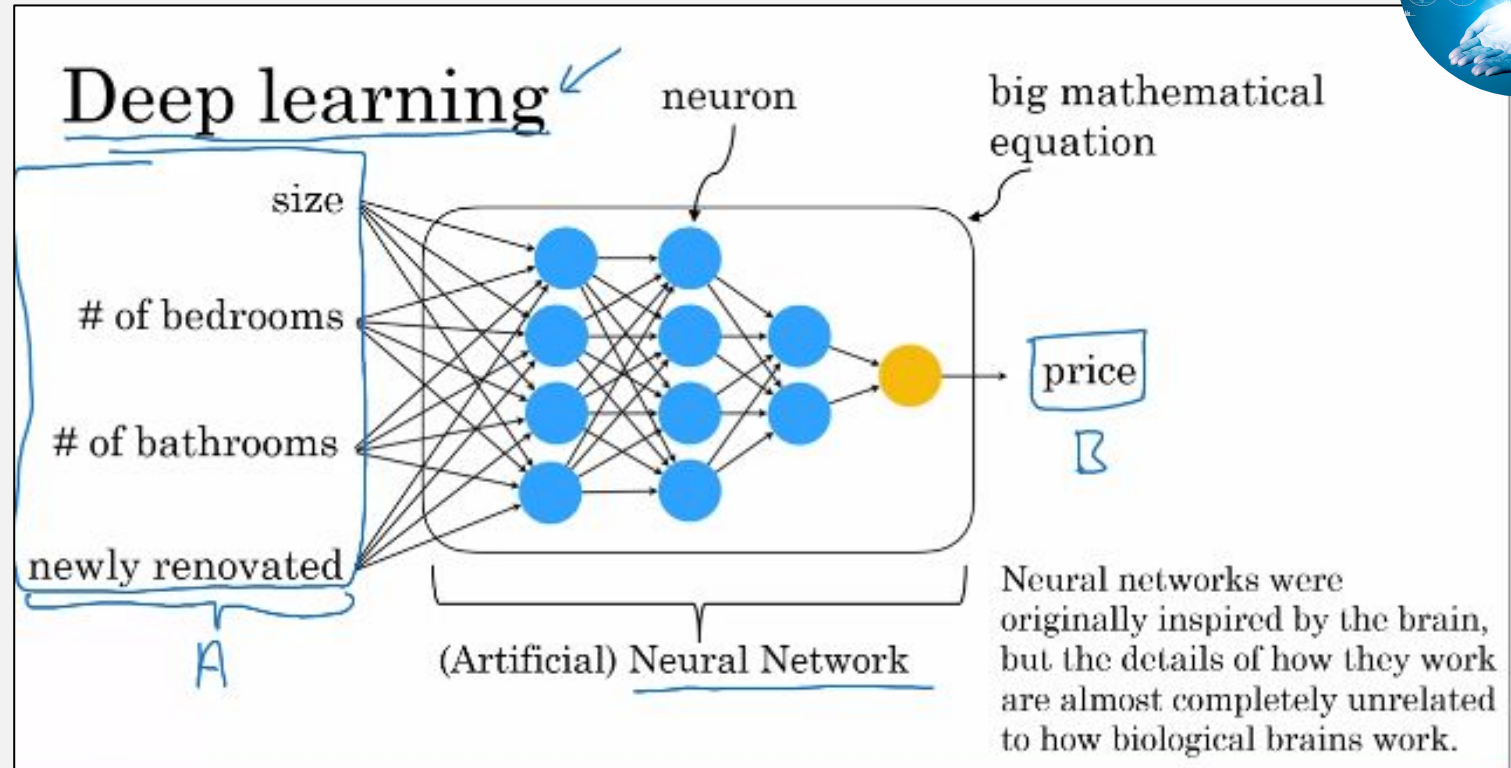
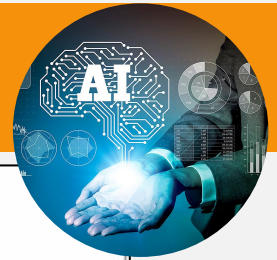
The terminology of AI

A vertical advertisement for Johnson's baby wash. The top half shows a smiling woman lying down with a baby on her chest. The bottom half features a bottle of Johnson's 'head-to-toe' baby wash. The text on the bottle and the advertisement includes:

TESTED BY
PEDIATRICIANS
DERMATOLOGISTS
OPHTHALMOLOGISTS
BECAUSE GENTLE IS ALWAYS IN.

Johnson's
head-to-toe
baby wash & shampoo
with aloe vera
99.9% germ kill
#1 CHOICE OF HOSPITALS
SCAN TO SHOP

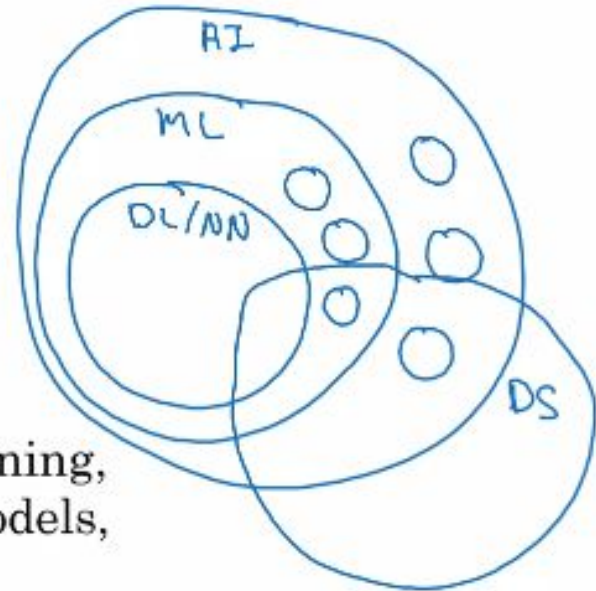
Deep Learning



The terminology of AI

AI has many tools

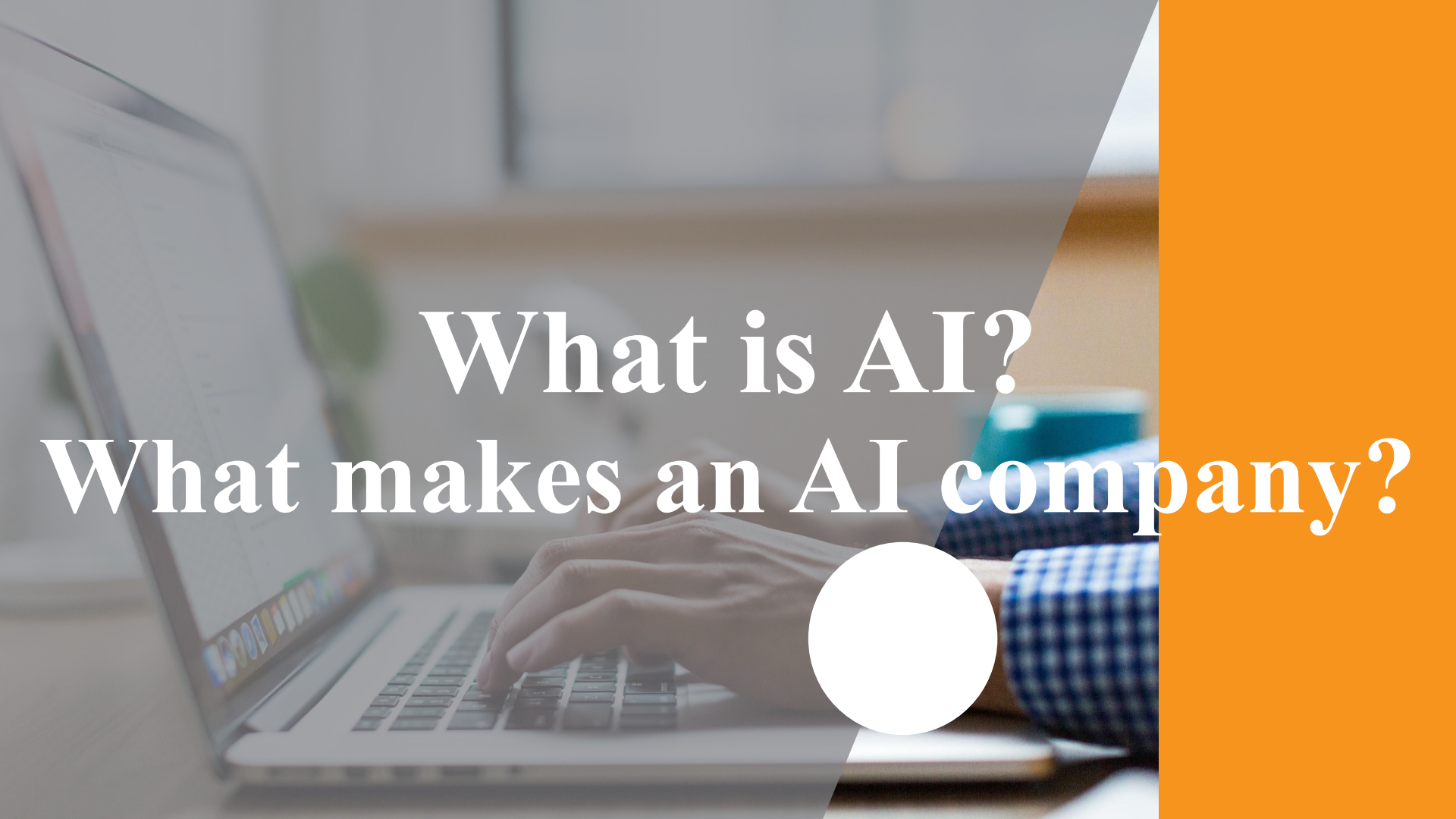
- Machine learning and data science
- Deep learning / neural network
- Other buzzwords: Unsupervised learning, reinforcement learning, graphical models, planning, knowledge graph, ...



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?

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

Shopping mall + website
≠ Internet company

AI era

Any company + deep learning
≠ AI company

What makes an AI company?

A lesson from the rise of the Internet

Internet Era

Shopping mall + website
≠ Internet company

- A/B testing
- Short iteration time
- Decision making pushed down to engineers and other specialized roles

AI era

Any company + deep learning
≠ AI company

- 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 makes an AI company?

- AI has created tremendous value in the software industry and will continue to do so.
- If you can help your company become good at AI, I hope you can play a leading role in creating a lot of this value.
- It is slides you saw what is it that makes a company a good AI company and also briefly the AI transformation playbook which I'll go into much greater detail on in a later lesson as a road-map for helping companies become great at AI.

What makes an AI company?

- In the next slides, I want to show you and give you some examples of what AI can and cannot do, to help you better select projects AI that there may be effective for your company.

What is AI?

What machine learning can and cannot do



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.

What machine learning can and cannot do

- What I've seen unfortunately is that some CEOs can have an inflated expectation of AI and can ask engineers to do things that today's AI just cannot do.
- One of the challenges is that the media, as well as the academic literature, tends to only report on positive results or success stories using AI, and we see a string of success stories and no failure stories, people sometimes think AI can do everything. Unfortunately, that's just not true.

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

- So for example, in order to determine the position of other cars, that's something that you can do with less than a second.
- In order to tell if a phone is scratched, you can look at it and you can tell in less than a second.
- In order to understand or at least transcribe what was said, it doesn't take that many seconds of thought.
- While this is an imperfect rule of thumb, it maybe gives you a way to quickly think of some examples of tasks that AI systems can do.

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)

User email



Output (B)

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

$\underline{A} \rightarrow \underline{B}$

What machine learning can and cannot do

- AI is the new electricity and it's transforming every industry, but it's also not magic and it can't do everything under the sun.
- I hope that this started to help you hone your intuitions about what it can and cannot do, and increase the odds of your selecting feasible and valuable projects for maybe your teams to try working on.
- In order to help you continue developing your intuition, I would like to show you more examples of what AI can and cannot do.



What is AI?

More examples of what machine learning can and cannot do



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.

More examples of what machine learning can and cannot do

- Let's say you're building a self-driving car, here's something that AI can do pretty well, which is to take a picture of what's in front of your car and maybe just using a camera, maybe using other senses as well such as radar or lidar.
- Then to figure out, what is the position, or where are the other cars.
- So, this would be an AI where the input A, is a picture of what's in front of your car, or maybe both a picture as well as radar and other sensor reading

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

Diagnose pneumonia from
~10,000 labeled images

A → B

Cannot do

Diagnose pneumonia from
10 images of a medical textbook
chapter explaining pneumonia

A → B

More examples of what machine learning can and cannot do

- Machine learning tends to work well when you're trying to learn a simple concept, such as something that you could do with less than a second of mental thought, and when there's lots of data available.
- Machine learning tends to work poorly when you're trying to learn a complex concept from small amounts of data

Strengths and Weaknesses Of ML

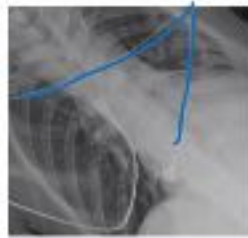
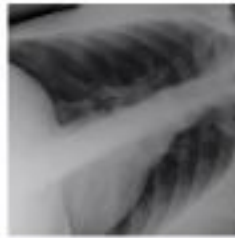
ML tends to work well when:

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)



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

- The terms deep learning and neural network are used almost interchangeably in AI.
- And even though they're great for machine learning, there's also been a bit of hype and bit of mystique about them.
- This will demystify deep learning, so that you have a sense of what deep learning and neural networks really are.

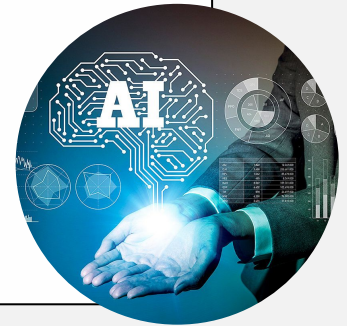
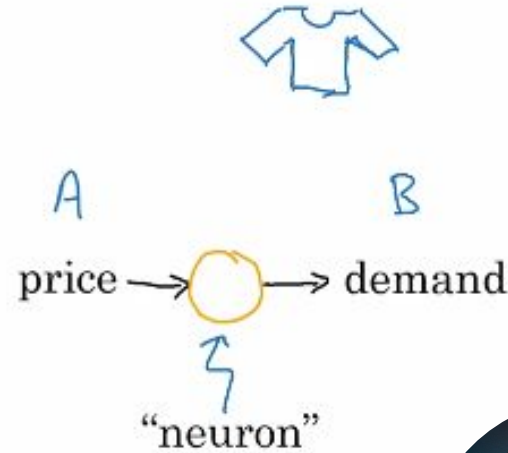


Non-technical explanation of deep learning (Part 1, optional)

- Let's use an example from demand prediction. Let's say you run a website that sells t-shirts.
- And you want to know, based on how you price the t-shirts, how many units you expect to sell, how many t-shirts you expect to sell.
- You might then create a dataset like this, where the higher the price of the t-shirt, the lower the demand.
- So you might fit a straight line to this data, showing that as the price goes up, the demand goes down.

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

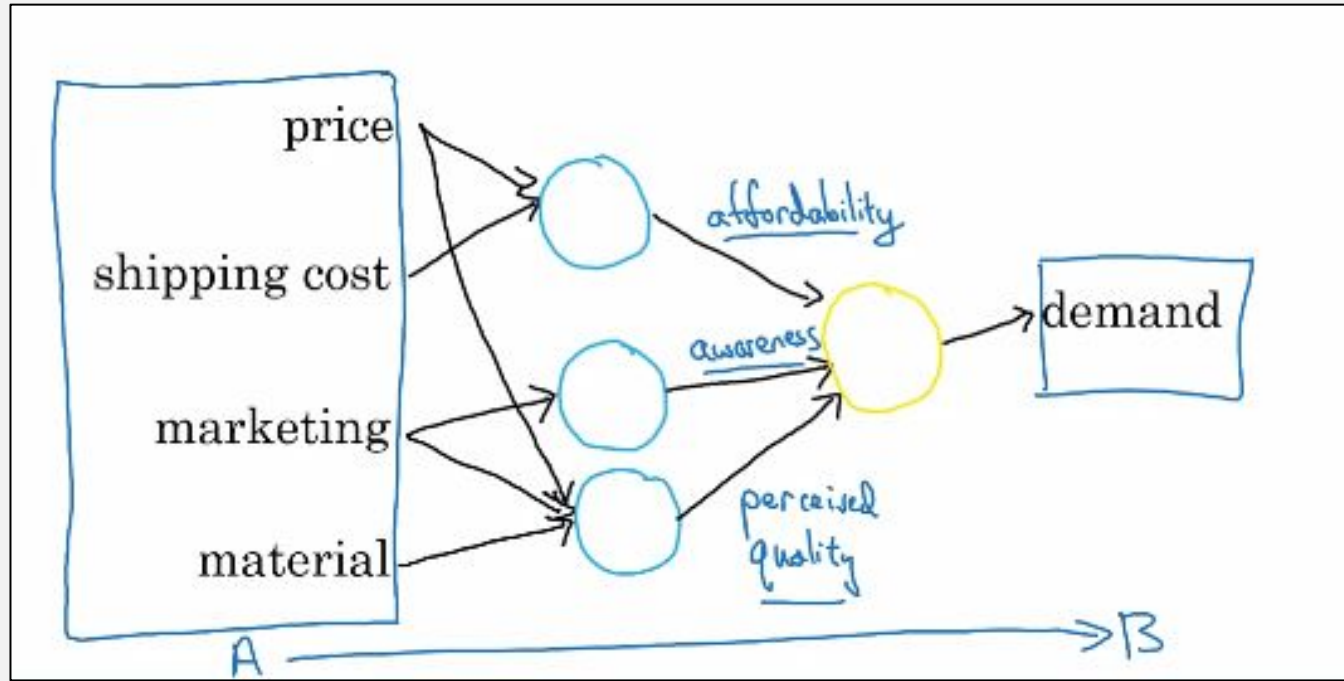
Demand prediction



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.

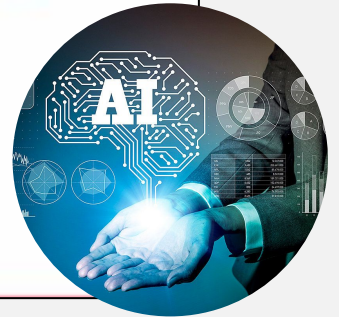
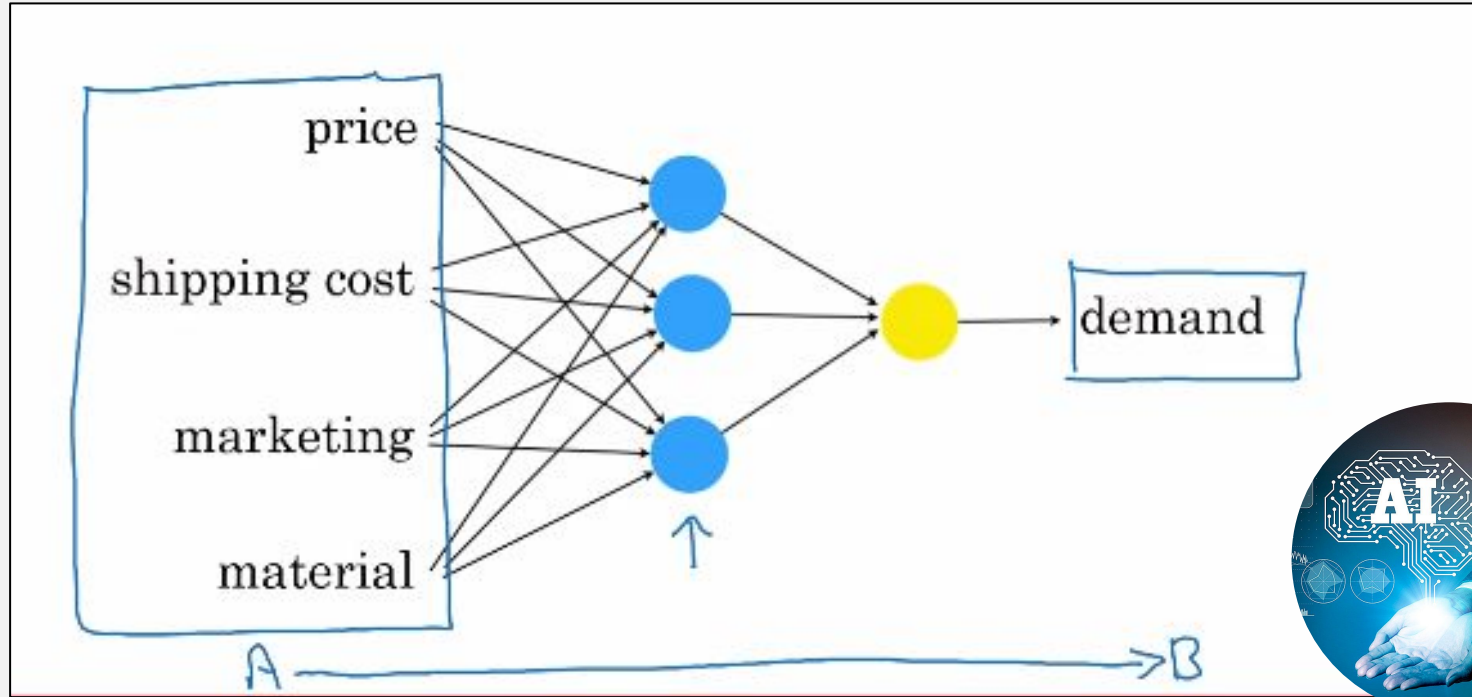
Demand Prediction



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.

What is AI?

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



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

- In the last, you saw how a neural network can be applied to demand prediction, but how can the new network look at the picture and figure out what's in the picture?
- Or listen to an audio clip and understand what is said in an audio clip?
- Let's take a look at a more complex example of applying a neural network to face recognition.

Face Recognition



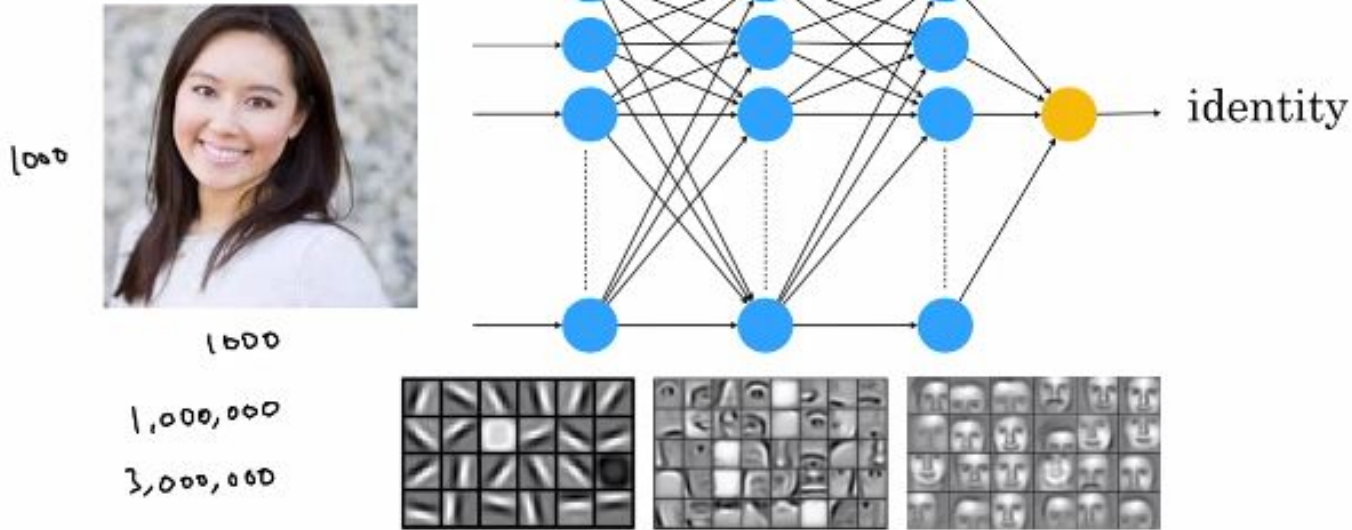
30	32	22	12	10	10	12	33	35	30
12	11	12	234	170	176	13	15	12	12
234	222	220	230	200	222	230	234	56	78
190	220	186	112	110	110	112	180	30	32
49	250	250	250	4	2	254	200	44	6
55	250	250	250	3	1	250	245	25	3
189	195	199	150	110	110	182	190	199	55
200	202	218	222	203	200	200	208	215	222
219	215	220	220	222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

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

- You saw how a neural network can take as input four numbers corresponding to the price, shipping costs, amounts of marketing, and cloth material of a T-shirt and output demand.
- In this example, the neural network just has to input a lot more numbers corresponding to all of the pixel brightness values of this picture.
- If the resolution of this picture is 1000 pixels by 1000 pixels, then that's a million pixels.

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

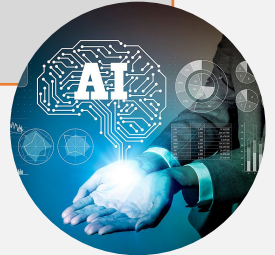
Face recognition



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



Congratulations on finishing this. You now know how machine learning and data science work.



Building AI Projects? Introduction



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

- Now you will learn what the workflow of an AI project. Different projects have different steps.
- First, you figure out the guest list, and you find a venue, then you order the birthday cake, and send invites, and so on. So, too does an AI project have a sequence of predictable steps.



Introduction



Starting an AI project

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

Introduction



- Finally, you also learn how to organize the data as well as the team, which again could be just you are a few friends or much bigger corporate team.
- We learn how to organize the data and team for executing on an AI project.
- By the end of this, you know what it feels like and how to build your own AI project, and maybe you'll be able to start exploring with some of your friends promising ideas to try

Building AI Projects?

Workflow of a machine learning project



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.

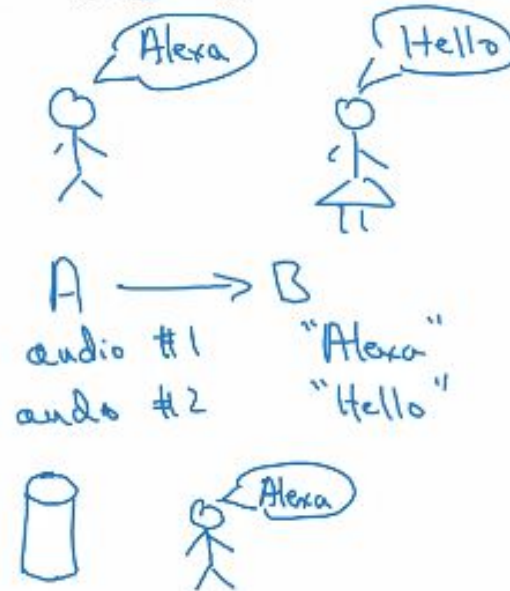


Workflow of a machine learning project

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

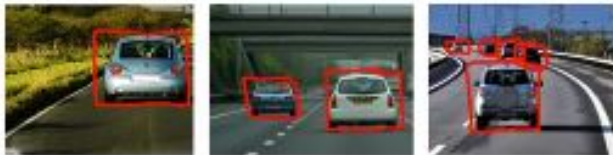


image → position of other cars

2. Train model

Iterate many times until
good enough



3. Deploy model

Get data back
Maintain / update model



Workflow of a machine learning project

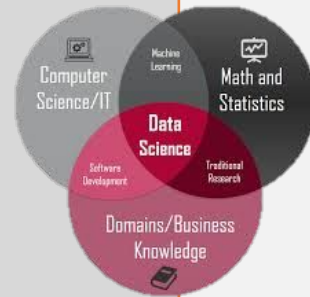
- In this , you learned what are the key steps of a machine learning project, which are to collect data, to train the model, and then to deploy the model.
- Next, let's take a look at what are the key steps or what is a workflow of a data science project. Let's go on to the next slides

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.



Workflow of a data science project

- Say you run a e-commerce or a online shopping website that sells coffee mugs and so for a user to buy a coffee mug from you, there's a sequence of steps they'll usually follow.
- First, they'll visit your website and take a look at the different coffee mugs on offer, then eventually, they have to get to a product page, and then they'll have to put it into their shopping cart, and go to the shopping cart page, and then they'll finally have to check out.

Key Steps of a data science project

Optimizing a sales funnel

→ 1. Collect data

→ 2. Analyze data

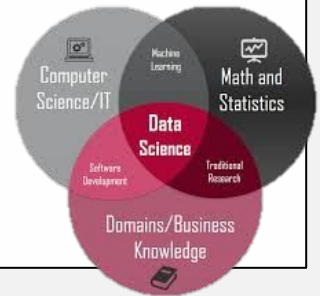
Iterate many times to get good insights

→ 3. Suggest hypotheses/actions

Deploy changes

Re-analyze new data periodically

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



Workflow of a data science project

- Let's say you run a factory that's manufacturing thousands of coffee mugs a month for sale and you want to optimize the manufacturing lines. So, these are the key steps in manufacturing coffee mugs.
- Step one is to mix the clay, so make sure the appropriate amount of water is added. Step two is take this clay and to shape the mugs.
- Then you have to add the glaze, so add the coloring, a protective cover. Then you have to heat this mug and we call that firing the kiln.

Key Steps of a data science project

Manufacturing line

Mix clay



Shape mug



Add glaze



Fire kiln



Final inspection



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

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

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

Workflow of a data science project

- To summarize, the key steps of a data science project are to collect the data, to analyze the data, and then to suggest hypotheses and actions.
- In this and the last slide you saw some examples of machine learning projects and data science projects.
- It turns out that machine learning and data science are affecting almost every single job function.

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



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

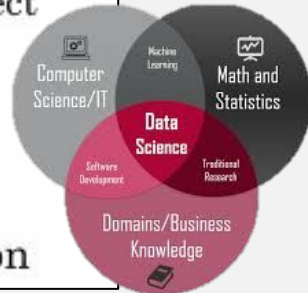
Data science



Machine learning



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

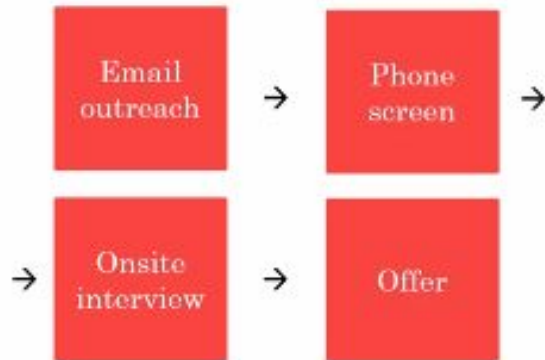
Every job function needs to learn how to use data

- 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

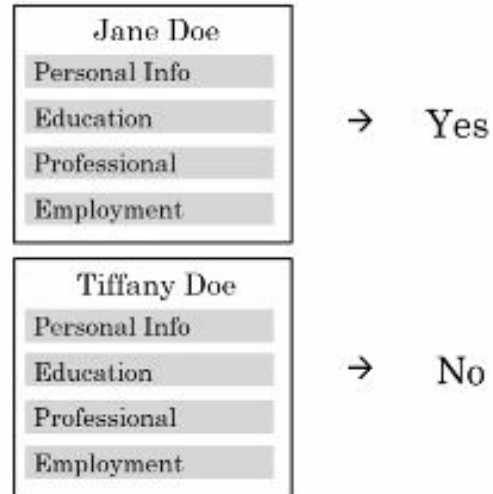
Recruiting

Data science



Optimize recruiting funnel

Machine learning



Automated resume screening

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

Marketing

Data science

Break into AI

Whether you want to build algorithms or build a company, this program is designed to help you learn the concepts and applications of AI.

Take the Break into AI course

Break into AI

Whether you want to build algorithms or build a company, this program is designed to help you learn the concepts and applications of AI.

Take the Break into AI course

A

B

A/B testing

Machine learning

Recommended for you



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



Crop analytics

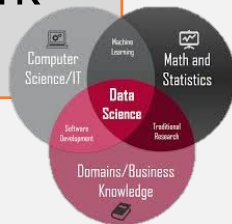
Machine learning



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)



How to choose an AI project (Part 1)

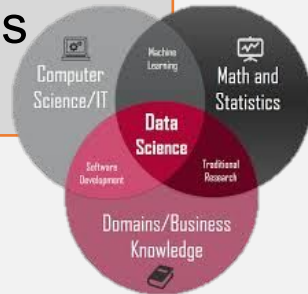
- If you want to try your hand at an AI project, how do you select a worthwhile project to work on? Don't expect an idea to naturally come overnight.
- Sometimes it happens, but sometimes it also takes a few days or maybe a few weeks to come up with a worthy idea to pursue. Next, you will see a framework for brainstorming potentially exciting AI projects to pursue.

How to choose an AI project (Part 1)



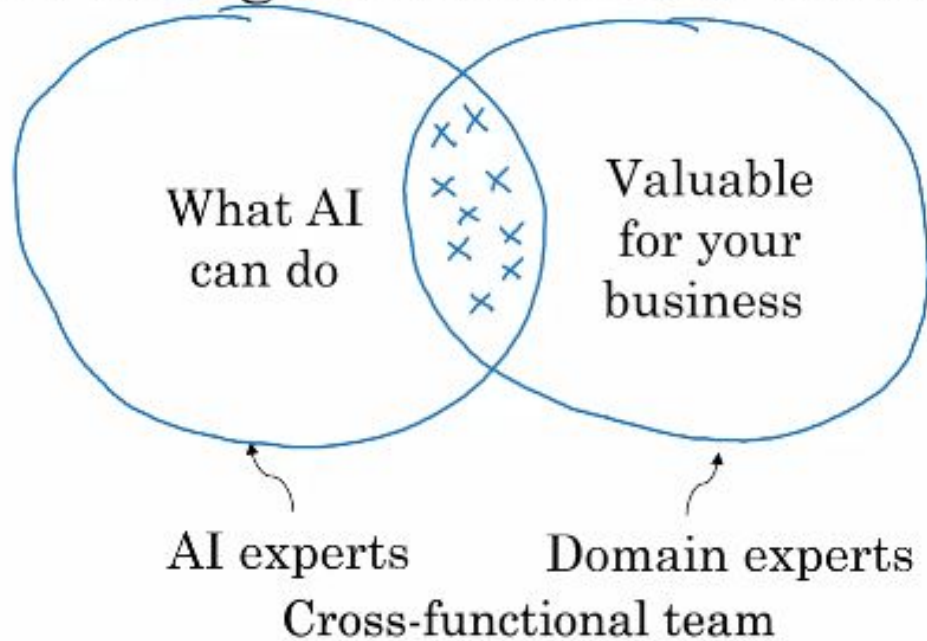
Let's say you want to build an AI project for your business. You've already seen that AI can't do everything, and so there's going to be a certain set of things that is what AI can do.

- 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)

AI knowledge and domain knowledge



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 be 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 may 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)



How to choose an AI project (Part 2)

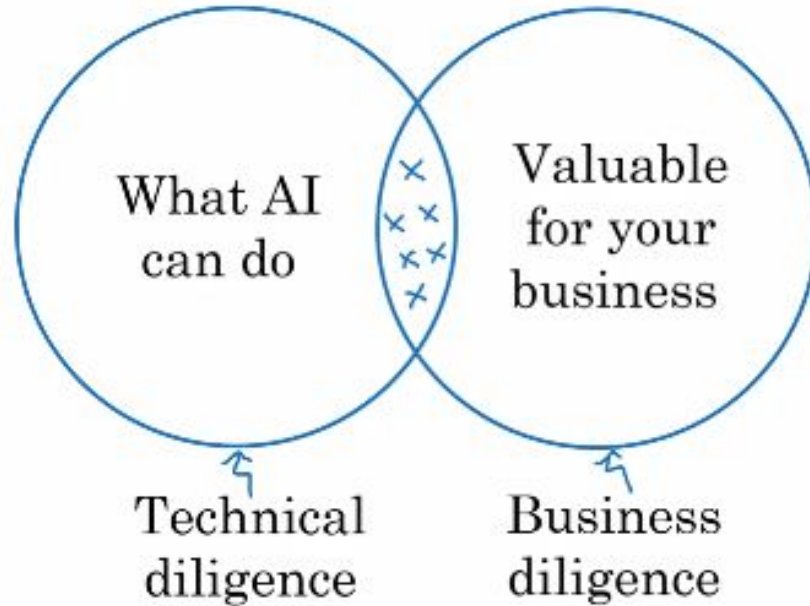
- Maybe you have a lot of ideas for possible AI projects to work on. But before committing to one, how do you make sure that this really is a worthwhile project?
- If it's a quick project that might take you just a few days maybe just jump in right away and see if it works or not, but some AI projects 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)

Due diligence on project



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
 - Launch new product or business
- } current 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.

Building AI Projects? Working with an AI team



Working with an AI team

- Say you found an exciting project that you want to try to execute on, how do you work with an AI team on this project?
- In this, you learn how AI teams think about data and therefore how you can interact with AI teams to help them succeed on a project.
- Now, there is one caveat which is, whether you have a cool idea but you don't have access to an AI team, you don't have any access to any AI engineers.

Working with an AI team

- First, it really helps your AI team if you can specify an acceptance criteria for the project. I've done a lot of work in automated vision inspection.
- So, I'm going to use that as a running example in these few slides. Let's say your goal is to detect defects in coffee mugs with at least 95% accuracy.

Working with an AI team

Specify your acceptance criteria



ok



ok



defect

Goal: detect defects
with 95% accuracy

test
set

N 1000

Provide AI team a dataset on
which to measure their
performance



Working with an AI team

- Let's dive more deeply into the concept of a test set. This is how AI teams think about data. AI teams group data into two main datasets.
- The first called the training set and the second called the test set which we've already talked a bit about.
- The training set is just a set of pictures together with labels showing whether each of these pictures is of a coffee mug that is okay or defective.

Working with an AI team

How AI teams think about data

Training set



ok



defect



ok

Learn
A → B

Test set



ok

ok



ok

ok



defect

ok

66.7%

Working with an AI team

- Before wrapping up this lesson one pitfall I want to urge you to avoid is expecting a 100% accuracy from your AI software.
- Here's what I mean, let's say this is your test set which you've already seen on the last slide.
- But, let me add a few more examples to this test set. Here are some of the reasons it may not be possible for a piece of AI software to be a 100% accurate.

Working with an AI team

- First, machine learning technology today despite being very powerful still has limitations and they just can't do everything. So, you may be working on a problem that it's just very difficult even for today's machine learning technology.
- Second, insufficient data. If you don't have enough data specifically if you don't have enough training data for the AI software to learn from it may be very difficult to get a very high level of accuracy.
- Third, data is messy and sometimes data can be mislabeled

Working with an AI team

Pitfall: Expecting 100% accuracy

Test set



ok



~~defect~~
ok



ok



ok
defect?



defect



ok

- Limitations of ML
- Insufficient data ←
- Misabeled data ←
- Ambiguous labels ←

Working with an AI team

- You now know what it feels like and what it takes to build an AI project.
- I hope you e start brainstorming and exploring some ideas. There is one more optional lesson describing some of the technical tools that AI teams use that you can watch if you wish.

Building AI Projects? Technical tools for AI teams (optional)



Technical tools for AI teams (optional)

- When you work with AI teams, you may hear them refer to the tools that they're using to build these AI systems.
- In this, I want to share with you some details and names of the most commonly used AI tools, so that you'd be able to better understand what these AI engineers are doing.



Technical tools for AI teams (optional)

- We're fortunate that the AI world today is very open, and many teams will openly share ideas with each other.
- There are great machine learning open source frameworks that many teams will use to build their systems. So, if you hear of any of these: TensorFlow, PyTorch, Keras, MXNet, CNTK, Caffe, PaddlePaddle, Scikit-learn, R or Weka, all of these are open source machine learning frameworks that help AI teams be much more efficient in terms of writing software.

Technical tools for AI teams (optional)

- Along with AI technology breakthroughs are also publish freely on the Internet on this website called Arxiv.
- Spelled like this. I hope that other academic communities also freely share their research since I've seen firsthand how much this accelerates progress in the whole field of AI.
- Finally, many teams will also share their code freely on the Internet, most commonly on a website called GitHub.

Technical tools for AI teams (optional)

AI technical tools

Machine learning frameworks:

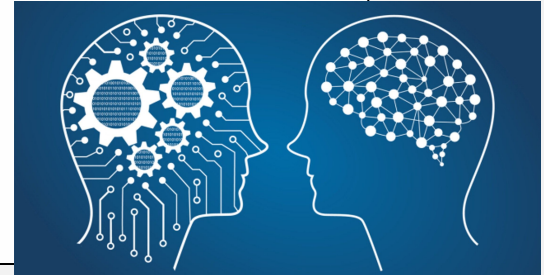
- TensorFlow
- PyTorch
- Keras
- MXNet
- CNTK
- Caffe
- PaddlePaddle
- Scikit-learn
- R
- Weka

Research publications:

- Arxiv

Open source repositories:

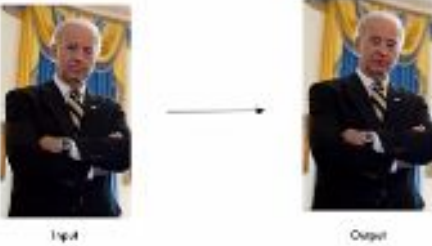
- GitHub



Technical tools for AI teams (optional)


```
image = face_recognition.load_image_file('your_picture.jpg')
face_landmarks_list = face_recognition.find_faces_and_landmarks_in_picture(image)
```

Finding facial features is super useful for lots of important stuff. But you can also use it for really stupid stuff like applying digital make up (think 'Meika').



Input → Output

Identify faces in pictures.
Recognize who appears in each photo.



Input → Output

Picture contains "Joe Biden"

```
known_faces = face_recognition.load_image_file('known_faces')
unknown_image = face_recognition.load_image_file('unknown.jpg')
```



Technical tools for AI teams (optional)

CPU vs. GPU

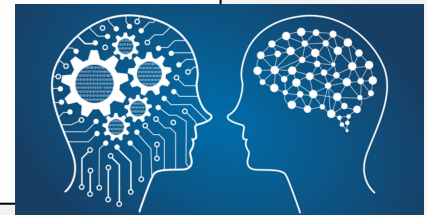
CPU: Computer processor (Central Processing Unit)



GPU: Graphics Processing Unit



Cloud vs. On-premises

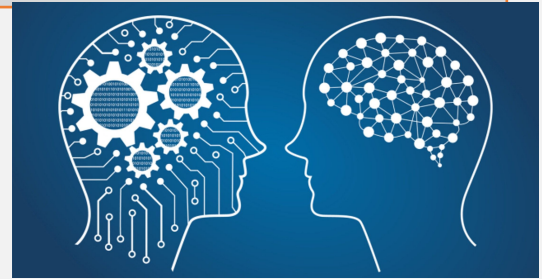


Technical tools for AI teams (optional)

- A lot of the world is moving to Cloud deployments. Whether you search online you find many articles talking about the pros and cons of Cloud versus On-prem deployments.
- There is one last term you might hear about, which is Edge deployments.
- If you are building a self-driving car, there's not enough time to send data from a self-driving car to a Cloud server to decide if you should stop the car or not, and then send that message back to the self-driving car.

Technical tools for AI teams (optional)

- Thanks to finishing this optional Slides on the technical tools that AI engineers use.
- Hopefully, when you hear them refer to some of these tools, you'll start to have a better sense of what they mean.



Building AI In Your Company? Introduction



Introduction

- We'll look at the projects we talked about already, and talk about how projects fit in the context of a company. Whether it's a for-profit, non-profit, or even within a government entity.
- For the sake of concreteness, I'll talk about building AI for companies will equally apply, no matter what type of organization you're in.



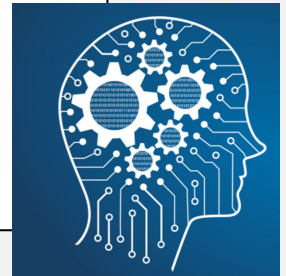
Introduction

- Now, in case some of what you hear this lesson sounds like CEO level talk, don't be intimidated.
- This is actually useful for everyone to know, the ones that hope, your company will help your organization Improve using AI.
- And it does take maybe two or three years for a company to become good at AI.

Introduction

Building AI in your company

- Case studies of complex AI products
- Roles in an AI team
- AI Transformation Playbook
- Taking your first step





Introduction

- We'll wrap these lessons with concrete suggestions on how you can take your first step, right away, toward building AI in your company.
- Beyond these major topics, we'll also have a couple of optional lessons at the end, where you see a survey of major AI application areas and techniques.

Building AI In Your Company?

Case study: Smart speaker



Case study: Smart speaker

- What does it feel like to work on a complex AI product, where isn't just using a single machine learning algorithm to map from A to B, but that learning algorithm is part of a bigger more complex project or product.
- I want to start it this lesson with two case studies of building complex AI products.
- First, building a smart speaker so that you can start to understand whether my feel like to maybe someday work on a complex AI product within your own company.



Case study: Smart speaker

- Let's get started. Smart speakers and voice activated devices like these are taking the world by storm and if you don't already have one in your home, maybe you buy one someday.
- I'd like to go through a case study of how you would write AI software to get a smart speaker to respond to a verbal command such as "Hey device, tell me a joke."

Case study: Smart speaker

- " For this example, rather than using Alexa, or Okay Google, or Hey Siri, or Hello Baidu as the wake word or trigger word, to be more device agnostic, I'm just going to use "Hey device" as the trigger word or wake work.
- To wake up say a smart speaker and let's say you wanted to tell you a joke.
- So how do you build a piece of AI software to understand a command like this and executes on it? These are the steps needed to process the command.

Case study: Smart speaker

Smart speaker



Amazon
Echo / Alexa



Google
Home



Apple
Siri



Baidu
DuerOS

“Hey device, tell me a joke”

Case study: Smart speaker

- There can be four steps. Step one is the trigger word or the wake word detection.
- The speaker uses a machine learning algorithm to input the audio clip and output.
- Did they just hear the wake word or the trigger word "Hey Device," so 0 plus 0 or one and once it hears the trigger word or wake word, once it hears "Hey device," it then has to perform step two, which is speech recognition.
- So what the software has to do is take the audio of what came after "Hey device" and map that to "Tell me a joke."



Case study: Smart speaker

“Hey device, tell me a joke”

Steps to process the command:

1. Trigger word/wakeword detection
2. Speech recognition
3. Intent recognition
4. Execute joke



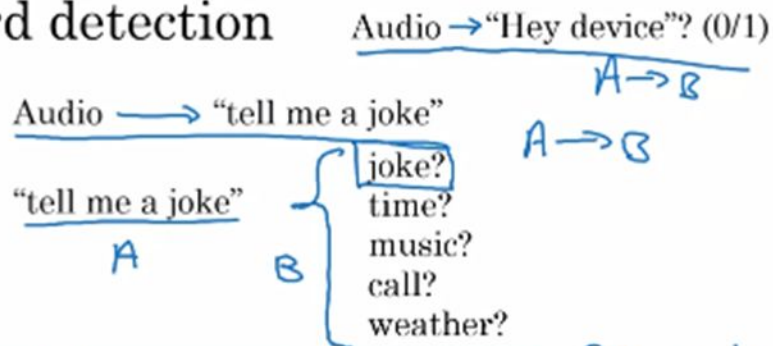


Case study: Smart speaker

“Hey device, tell me a joke”

Steps to process the command:

1. Trigger word/wakeword detection
2. Speech recognition
3. Intent recognition
4. Execute joke



AI pipeline

Case study: Smart speaker

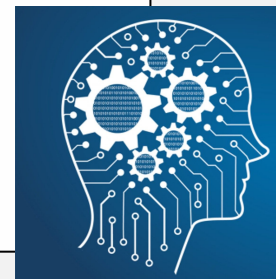
- One of you issue a more complex commands like "Hey device, set timer for 10 minutes."
- These are the steps needed to process a command. First step, same as before is trigger word detection.
- So input an audio and just let me know when someone said the trigger word hey device.

Case study: Smart speaker

“Hey device, set timer for 10 minutes”

Steps to process the command:

1. Trigger word/wakeword detection Audio → “Hey device”? (0/1)
2. Speech recognition Audio → “set timer for 10 minutes”
3. Intent recognition “set timer for 10 minutes” → timer
4. a) Extract duration
 “Set timer for 10 minutes”
 “Let me know when 10 minutes is up”
 b) Start timer with set duration



Case study: Smart speaker

- Today's smart speakers have many functions.
- Other than the two we've talked about of telling jokes and setting a timer, here are some other functions that many smart speakers today can execute and the key steps of executing these commands are trigger word or the wake word detection, speech recognition to transcribe the text in the command, intent recognition to figure out which of these functions or which of these commands you want to execute, and then a specialized program to execute whichever command you uttered

Case study: Smart speaker

Other functions

- Play music
- Volume up/down
- Make call
- Current time
- Units conversion
- Simple question
- ...

Key steps:

1. Trigger/wakeword detection
2. Speech recognition
3. Intent recognition
4. Specialized program to execute command

Case study: Smart speaker

- So it's been an ongoing processes of smart speaker companies to explain to users what they can and cannot do.
- Nonetheless, with what they can do using voice to command these speakers is making life much more convenient for many people.



Case study: Smart speaker

- I hope this gave you a sense of what it takes to build a complex AI product such as a smart speaker.
- In order to help you better understand how these complex products work, let's go on to see a second case study of how to piece together multiple AI components to build a self-driving car.



Building AI In Your Company?

Case study: Self-driving car



Case study: Self-driving car

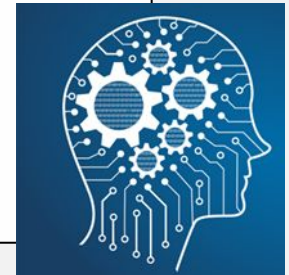
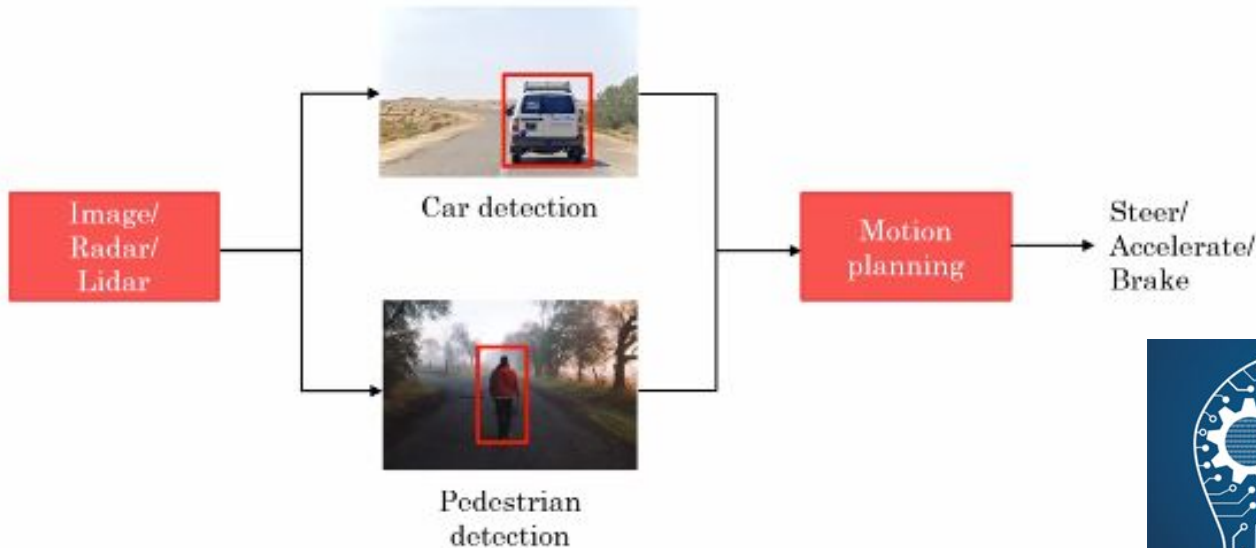
- One of the most exciting products of the AI era is the self-driving car.
- Self-driving cars are also one of the most mysterious things you hear about in AI these days.
- In this what I want do is share with you a somewhat simplified description of a self-driving car so that you understand how you can piece together multiple AI components in order to build these amazing things.

Case study: Self-driving car

- Let's get started. These are the key steps for deciding how to drive your self-driving car.
- The car will take as input various sensors such as pictures of what's in front of the car or to the sides or behind, as well as maybe radar or Lidar meaning laser sensor readings.
- Given these inputs of a picture(next slide) and maybe other things, it then has to detect other cars.

Case study: Self-driving car

Steps for deciding how to drive



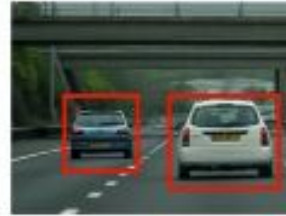
Case study: Self-driving car

- Let's look at the three key steps of car detection, pedestrian detection, and motion planning in more detail.
- Car detection uses supervised learning. So, you've already seen how a learning algorithm can take as input pictures like these and output the detected cars.
- For most self-driving cars rather than using only a front-facing camera, so a camera that looks forward, also often use cameras that look to the left, to the right as well as to the back so it can detect cars not just to the front but all around it.

Case study: Self-driving car

Key steps:

1. Car detection



2. Pedestrian detection



3. Motion planning

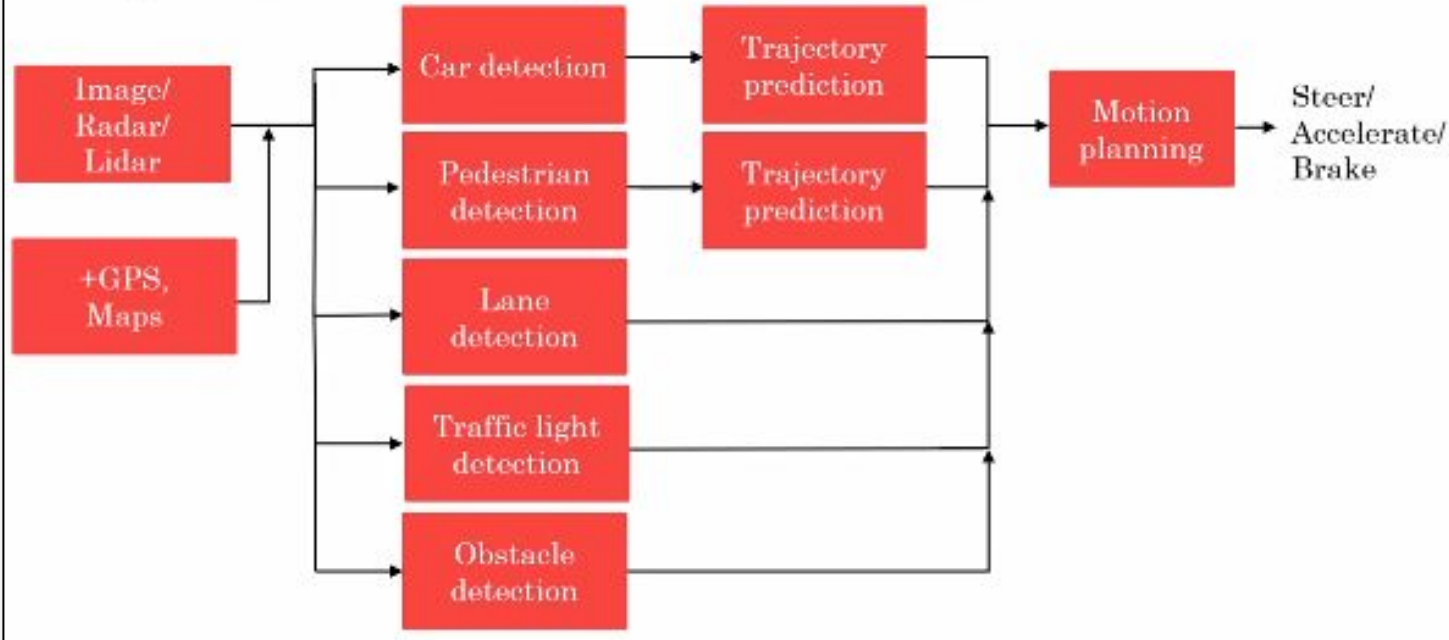


Case study: Self-driving car

- Let's look at a bit more detail of how an actual self-driving car might work.
- This is a picture you've seen so far. Input image, radar, or Lidar, sensor readings into car detection and pedestrian detection, and that is then fed to motion planning to help you select your path and speed.
- Now in a real self-driving car, you would usually use more than just cameras, radar, and Lidar.

Case study: Self-driving car

Steps for deciding how to drive





Case study: Self-driving car

- On a large self-driving car team, it would not be that unexpected to have a team or maybe a few people working on each of the boxes shown here in red, and it's by building all of these components and putting them together that you can build a self-driving car.

Case study: Self-driving car

- As you can tell both from this rather complex example of an AI pipeline, as well as the early example of the four-step AI pipeline for the smart speaker, sometimes it takes a team to build all of these different components of a complex AI product.
- What I'd like to do in the next slides is share with you what are the key roles in large AI teams.
- If you're either a one-person or small AI team now, that's okay, but I want you to have a vision of what building a large AI team, maybe in the distant future, might look like.

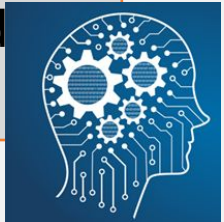
Building AI In Your Company?

Example roles of an AI team



Example roles of an AI team

- You saw from the last that some AI products may require a large AI team, maybe you have a 100 engineers or sometimes many more than a 100 to build.
- What I would like to do in this lesson is share with you the typical roles and responsibilities of a large AI team like this so you can better understand the types of work needed to build these complex AI products.



Example roles of an AI team



- Many AI teams will have Software Engineers in them. So, for example, for the smart speaker we needed to write specialized software to execute on the joke or to set a timer or to answer questions about today's weather.
- So, those are traditional software engineering tasks. Or you're building a self-driving car to make sure that your self-driving car software is reliable and doesn't crash.

Example roles of an AI team



Example roles

- Software Engineer
 - E.g., joke execution, ensure self-driving reliability, ...
 - Machine Learning Engineer
 - $A \rightarrow B$
 - Machine Learning Researcher
 - Extend state-of-the-art in ML
- } Applied ML Scientist

Example roles of an AI team

- Let's look at some more of those. Today, there are a lot of Data Scientists working in industries.
- The role of Data Scientist is not very well defined and the meaning is still evolving today.
- I think one of the primary responsibilities of Data Scientists is to examine data and provide insights, as well as to make presentations to teams or the executives in order to help drive business decision-making.

Example roles of an AI team

Example roles

- Data Scientist

- Examine data and provide insights
- Make presentation to team/executive

- Data Engineer

- Organize data
- Make sure data is saved in an easily accessible, secure and cost effective way

- AI Product Manager

- Help decide what to build; what's feasible and valuable



→ 1 MB (megabyte)
→ 1,000 MB = GB (gigabyte)
→ 1,000,000 MB = TB (terabyte)
→ 1,000,000,000 MB = PB (petabyte)

Example roles of an AI team

- Finally, you'll also hear some people referred to AI Product Managers whose job is to help decide what to build. In other words, they help to figure out what's feasible and valuable.
- Traditional Product Manager's job was already to decide what to build as well as sometimes some other roles, but the AI Product Manager now has to do this in the AI era and they're needing new skill sets to figure out what's feasible and valuable in light of what AI can and cannot do today.

Example roles of an AI team

- So, whether you just have one Software Engineer working with you, or just a single Machine Learning Engineer, or just a single Data Scientists, or maybe nobody, but yourself, if either you or an engineer working with you has taken some online courses on machine learning or deep learning or data science, that's often enough for you by yourself or for you and an engineer to start looking at some smaller volumes of data, start drawing some conclusions or start trading some machine learning models to get going

Example roles of an AI team

Getting started with a small team

- 1 Software Engineer , or
- 1 Machine Learning Engineer/Data Scientist , or
- Nobody but yourself



Example roles of an AI team

- In this, you saw what an AI team might look like, but when you look at a bigger company, an AI team doesn't live in isolation.
- So, how does an AI team fit into a bigger company to help the whole company become good at AI? You might remember that previously, I briefly alluded to an AI transformation playbook, which is a roadmap for you to help a company, to help maybe a great company become great at AI.

Example roles of an AI team

- Now that you've learned what is AI, how to do AI projects and even what AI teams in companies and the competency AI projects and coms may look like, let's return to their AI transmission playbook and go much deeper into the individual steps of the playbook so that you can understand what it takes to help a company over maybe a small number of years become good at AI and hopefully become much more valuable and much more effective along the way.
- Let's go into the AI transmission playbook in the next.



Building AI In Your Company?

AI Transformation Playbook (Part 1)



AI Transformation Playbook (Part 1)

- How can you help your company become good at AI? Based on my experience, starting leading the Google Brain Team as well as Baidu's AI group which were respectively the leading forces for helping Google and Baidu become good and deeper in AI.
- I've spent a lot of time thinking about what it takes to help a great company become a great AI company and I wound up writing an AI transformation playbook to help other countries on this journey.



AI Transformation Playbook (Part 1)

- Here are the five steps of the AI transformation playbook. We'll dive into greater detail in a little bit but briefly, step one is for your company to execute pilot projects to gain momentum. Start to know what it feels like to work on AI projects.
- Step two, is to build an in-house AI team.
- Step three, is to provide broad AI training, not just the engineers but to many levels within a company including executives.



AI Transformation Playbook (Part 1)

- Step four, is to develop your AI strategy and step five, is to develop internal and external communications about your company and AI.
- The way your company will execute the steps may not be totally sequential and so the different steps may overlap. But this numbering gives a maybe rough sense of the order in which I think you could do these steps.
- In this , we will go in greater depth on the first three of these three steps and the next lesson we'll cover steps for and five.

AI Transformation Playbook (Part 1)

AI Transformation Playbook

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



AI Transformation Playbook (Part 1)

1. Execute pilot projects to gain momentum

- More important for the initial project to succeed rather than be the most valuable



AI Transformation Playbook (Part 1)

- For example, when I was leading the Google Brain Team, there was still a lot of skepticism at that time about deep learning.
- So, my first internal customer was Google's speech recognition team and speech recognition is nice to have this is useful but it's actually not the most important or valuable project for the company's bottom lines.
- It's not as valuable as, for example web search or online appetizing.



AI Transformation Playbook (Part 1)

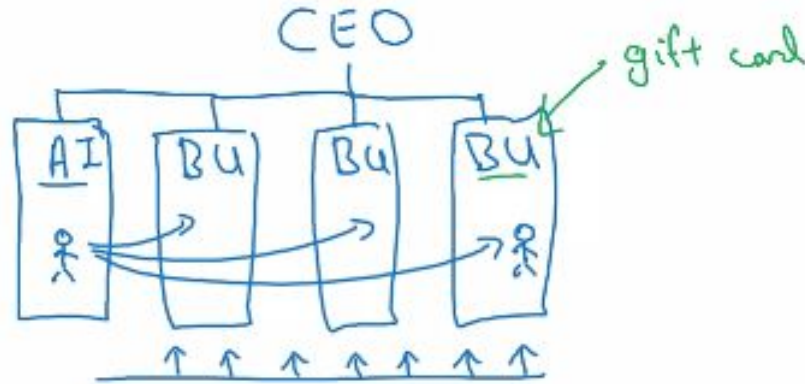
1. Execute pilot projects to gain momentum

- More important for the initial project to succeed rather than be the most valuable
- Show traction within 6-12 months
- Can be in-house or outsourced



AI Transformation Playbook (Part 1)

2. Build an in-house AI team



BU= Business Unit

AI function can be under CTO, CIO, CDO, etc. or a new CAIO

AI Transformation Playbook (Part 1)

3. Provide broad AI training

Role	What they should learn
Executives and senior business leaders	<ul style="list-style-type: none">• What AI can do for your enterprise• AI strategy• Resource allocation
Leaders of divisions working on AI projects	<ul style="list-style-type: none">• Set project direction (technical and business diligence)• Resource allocation• Monitor progress
AI engineer trainees	<ul style="list-style-type: none">• Build and ship AI software• Gather data• Execute on specific AI projects

The smart CLO knows they should *curate* rather than *create* content

AI Transformation Playbook (Part 1)

- So steps one to three of the AI transmission favor. Okay, I hope that your company will be able to start to execute an initial projects, build the team, provide the training and really start to get a lot of momentum going in terms of helping you accompany you become more valuable or more effective using AI.
- Looking at the broader picture, AI also affects company strategy and how you align different stakeholders including investors, employees, customers with this transformation as a company.

Building AI In Your Company?

AI Transformation Playbook (Part 2)

