Introduction to Deep Learning

- Learning Objectives:
  - Discuss the major trends driving the rise of deep learning.
  - Explain how deep learning is applied to supervised learning
  - List the major categories of models (CNNs, RNNs, etc.), and when they should be applied
  - Assess appropriate use cases for deep learning

Introduction to Deep Learning

1 Welcome
2 What is a Neural Network?
3 Supervised Learning with Neural Networks
4 Why is Deep Learning taking off?

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Introduction to Deep Learning

Welcome

Introduction to Deep Learning

- AI is the new Electricity
- Electricity had once transformed
  - countless industries: transportation, manufacturing, healthcare,
  - communications, and more
- AI will now bring about an equally big transformation.

Introduction to Deep Learning

What is a Neural Network?

What is a Neural Network?

- A neural network is a type of machine learning algorithm that is inspired by the structure and function of the human brain.
- It consists of interconnected nodes, called neurons, that are organized into layers:
  1. The input layer receives input data
  2. The output layer produces the output of the model.
  3. The intermediate layers, known as hidden layers, perform computations on the input data and progressively extract higher-level features.

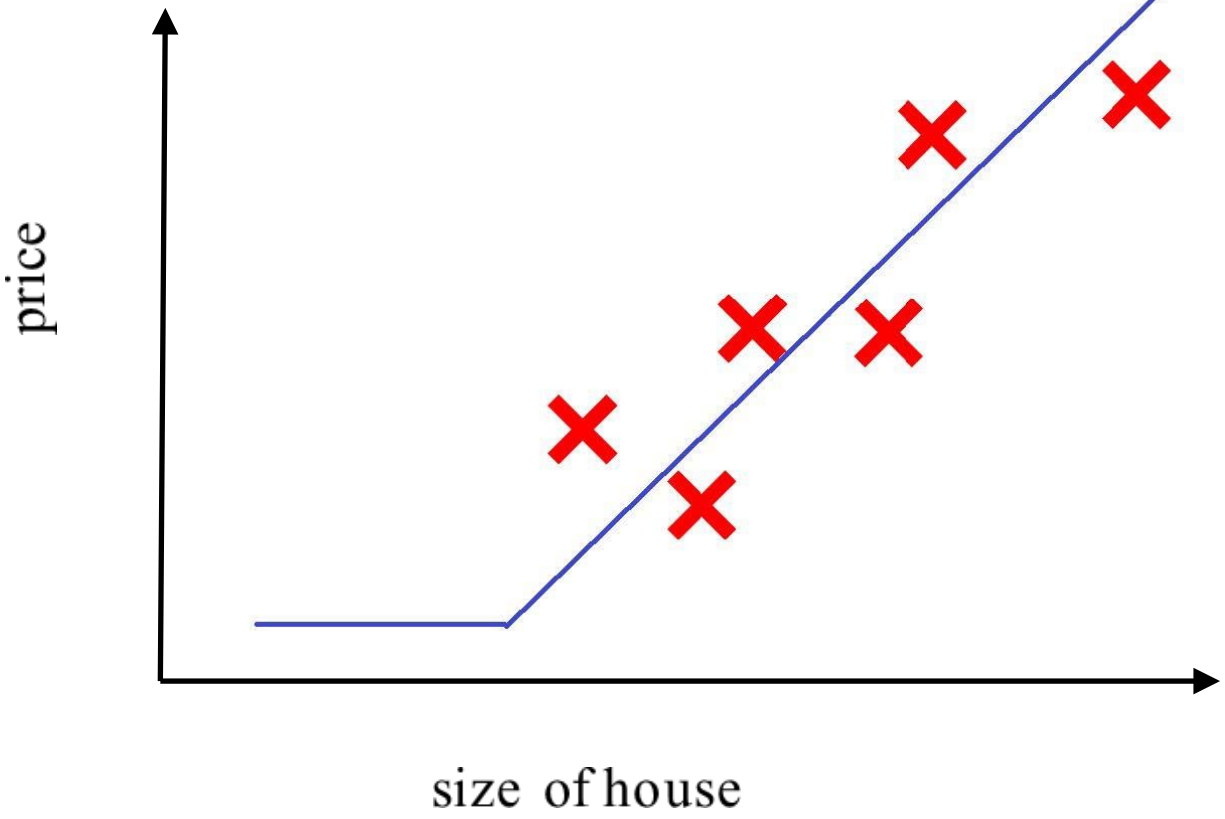
What is a Neural Network?

- By adjusting the connections and weights between the neurons, the neural network can be trained to recognize patterns and make predictions on new data.
- Neural networks are commonly used in image recognition, speech recognition, natural language processing, and other complex tasks where traditional algorithms may struggle.

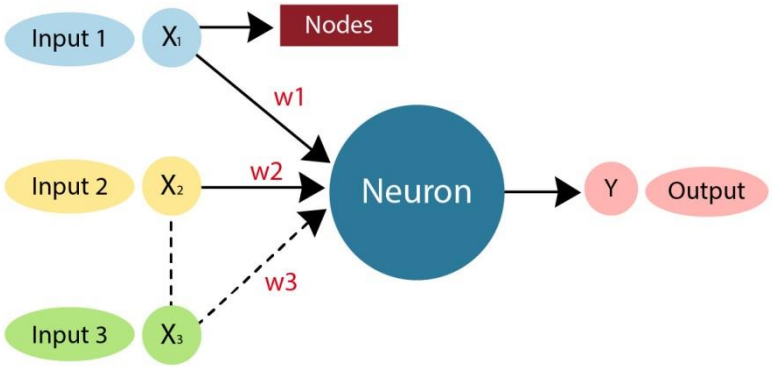
What is a Neural Network?

- Neural networks are made up of neurons, which take input, compute a function, and produce output.
- To explain how neural networks work, consider the example of predicting the price of a house based on its size and other features.

Housing Price Prediction



Relu



Price

size X

X

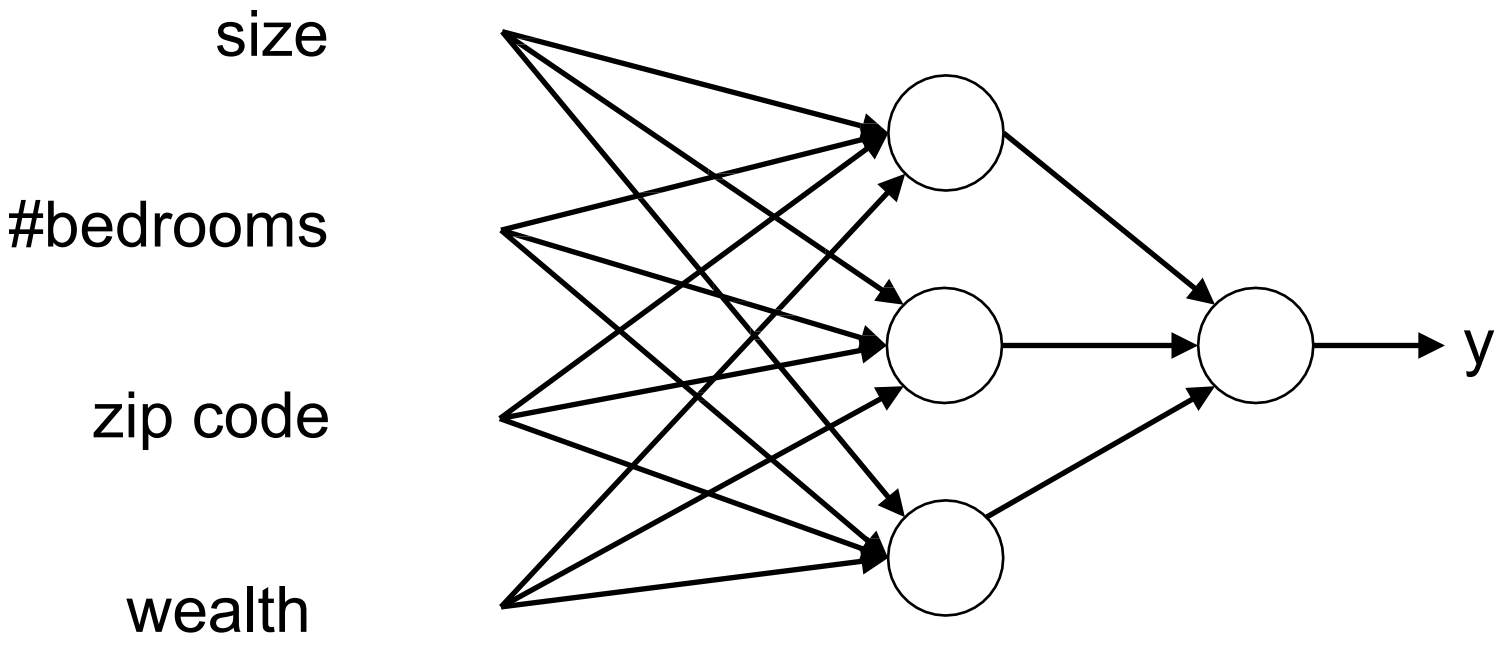
What is a Neural Network?

- A single neuron can implement a simple function, such as a ReLU (Rectified Linear Unit) function, which is an activation function commonly used in neural networks.
- It is a simple, yet powerful function that allows neural networks to learn complex nonlinear mappings between inputs and outputs
- In contrast, a larger neural network can be formed by stacking many neurons together.

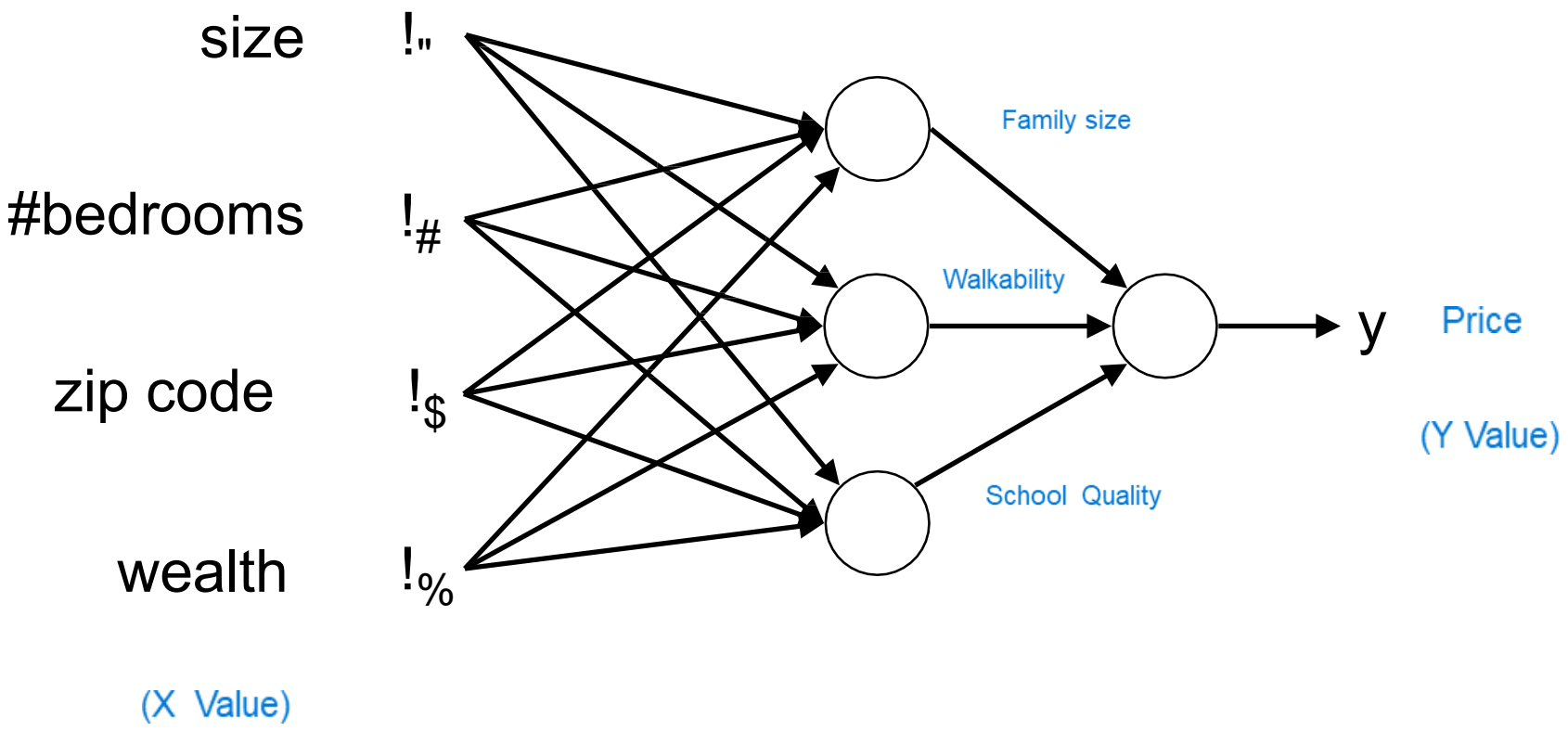
What is a Neural Network?

- The neural network takes input features and predicts an output, such as the price of a house.
- The neural network is trained using input-output pairs and that the hidden units in the neural network compute features based on the input data.

Housing Price Prediction



Housing Price Prediction



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Introduction to Deep Learning

Supervised Learning with Neural Networks

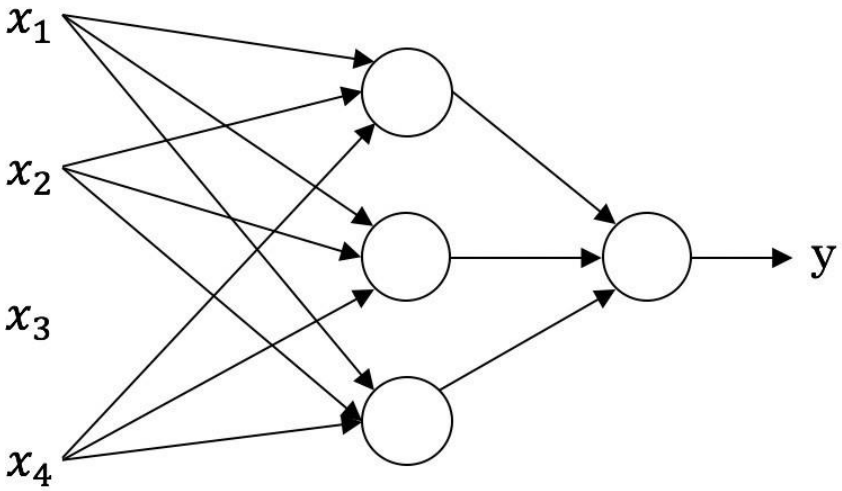
Supervised Learning

- In supervised learning, the model learns a function mapping to some output from an input x.
- Some examples of successful applications of neural networks include online advertising, computer vision, speech recognition, machine translation, and autonomous driving.
- Different types of neural networks are used for different applications, with Convolutional Neural Networks (CNNs) commonly used for image data and Recurrent Neural Networks (RNNs) being used for one-dimensional sequence data.

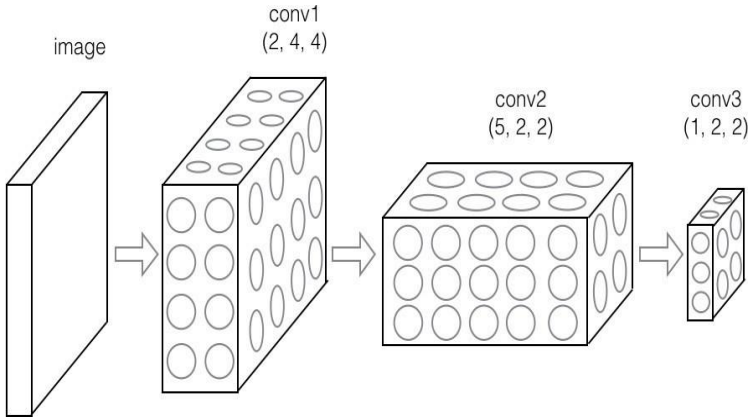
Supervised Learning

Input(x)	Output (y)	Application	
Home features	Price	Real Estate	Standard NN
Ad, user info	Click on ad? (0/1)	Online Advertising	Standard NN
Image	Object (1,…,1000)	Photo tagging	CNN
Audio	Text transcript	Speech recognition	RNN
English	Chinese	Machine translation	RNN
Image, Radar info	Position of other cars	Autonomous driving	Custom Hybrid

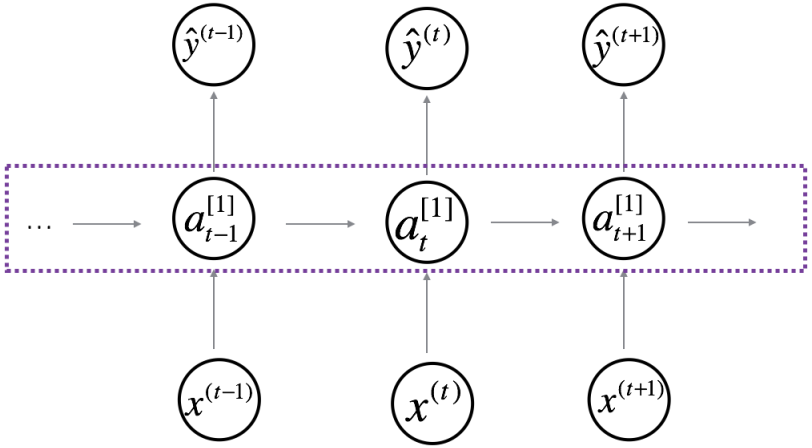
Neural Network examples



Standard NN



Convolutional NN



Recurrent NN

Supervised Learning

- Structured data refers to data that is organized in a pre-defined manner, typically in tables with rows and columns, where each data point has a well-defined meaning.
  - Examples of structured data include data found in relational databases, spreadsheets, and transaction logs.
  - Structured data is often processed using traditional data processing tools, such as SQL.
- Unstructured data refers to data that does not have a pre-defined structure or format.
  - Examples of unstructured data include text documents, images, audio and video files, social media posts, and email messages.
  - Unstructured data is often processed using machine learning algorithms that can extract patterns and meaning from the data.

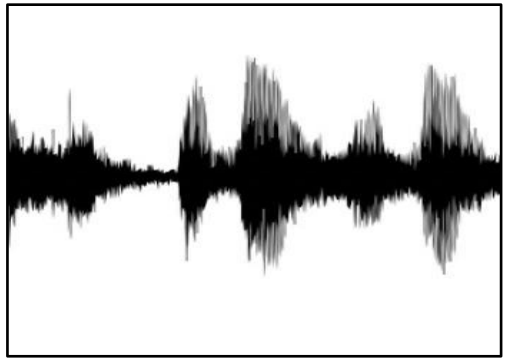
Supervised Learning

Structured Data

Size	#bedrooms	⋯	Price (1000$s)
2104	3		400
1600	3		330
2400	3		369
...	...		...
3000	4		540

User Age	Ad Id	⋯	Click
41	93242		1
80	93287		0
18	87312		1
...	...		...
27	71244		1

Unstructured Data



Audio

Image

Four scores and
seven years ago…

Text

Supervised Learning

- The main differences between structured and unstructured data are in their organization, format, and the tools used to process them.
- Structured data is organized and has a pre-defined format, while unstructured data is often disorganized and lacks a pre-defined format.
- Structured data is often processed using traditional data processing tools, while unstructured data is processed using machine learning algorithms.

Introduction to Neural Networks

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Why is Deep Learning taking off?

Why is Deep Learning taking off?

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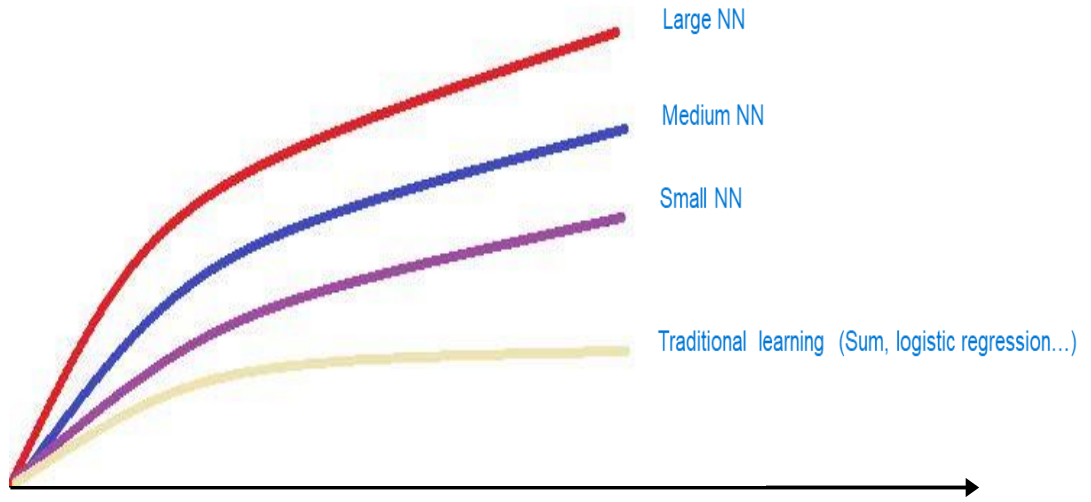
- Deep learning's success is attributed to the increasing availability of data and the development of neural networks that can take advantage of that data.
- As the amount of data increased, traditional learning algorithms, such as support vector machines or logistic regression, were unable to keep up.
- Neural networks, on the other hand, were able to take advantage of the vast amount of data to achieve better performance.

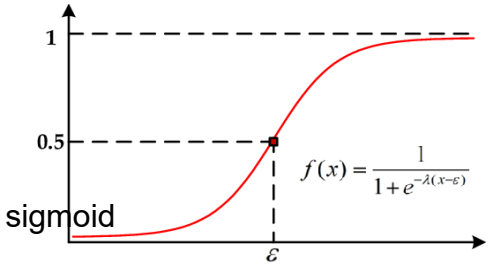
Scale drives deep learning progress

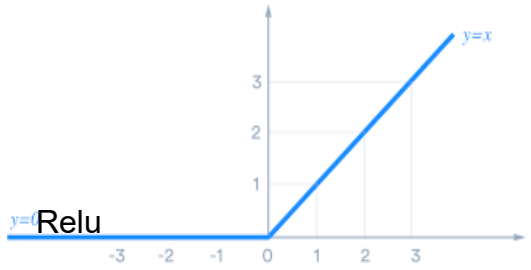
- The plots a graph shows how the performance of traditional learning algorithms plateaus as the amount of data increases, while neural networks continue to improve with more data.
- In the early days of deep learning, scale and data were the main drivers, but there has been a lot of algorithmic innovation in recent years.
- Algorithmic innovations have been aimed at making neural networks run much faster, which has contributed to their success.



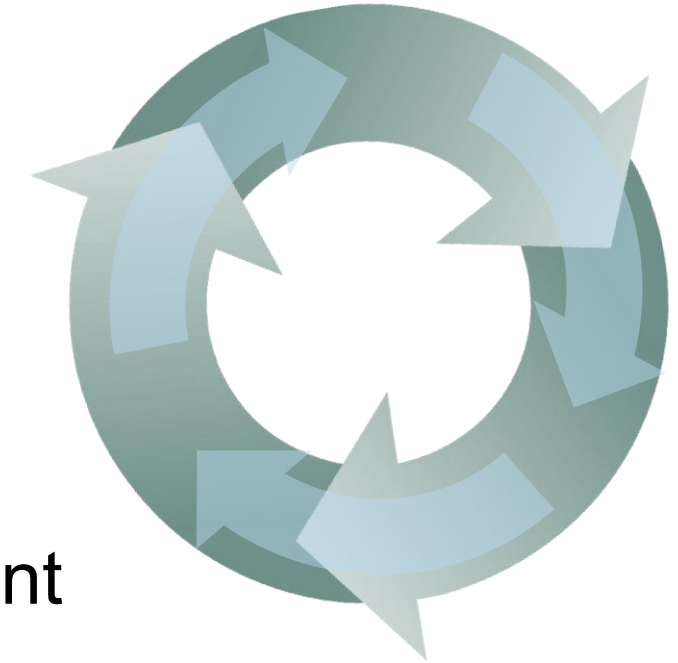
Scale drives deep learning progress

- Data
- Computation
- Algorithms





Idea



Experiment

Code

1 Day
1 week
1 month
...

Summarization

- The major trends driving the rise of deep learning.
- How deep learning is applied to supervised learning.
- The major categories of models (CNNs, RNNs, etc.), and when they should be applied.
- Assess appropriate use cases for deep learning.

Question

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1. What does the "AI is the new electricity" analogy (from lecture) mean?
2. Why has Deep Learning recently taken off (list at least two reasons)?
3. Which statements about iterating ML ideas (from diagram & options) are true, noting dataset size impact?
4. Can experienced DL engineers usually get good models on first try without iteration (True/False & explain, considering notes)?
5. Describe or sketch the ReLU activation function (refer to hint if needed).
6. Are cat images "structured" data because they're computer arrays (True/False & explain)?
7. Is a demographic dataset "unstructured" due to varied sources (True/False & explain)?
8. Why are RNNs used for machine translation like English to French (list applicable reasons)?
9. In the lecture's ML performance vs. data diagram, what are the x and y axes?
10. Based on performance vs. data trends (from diagram & options), which statements are true?