Supervised machine learning

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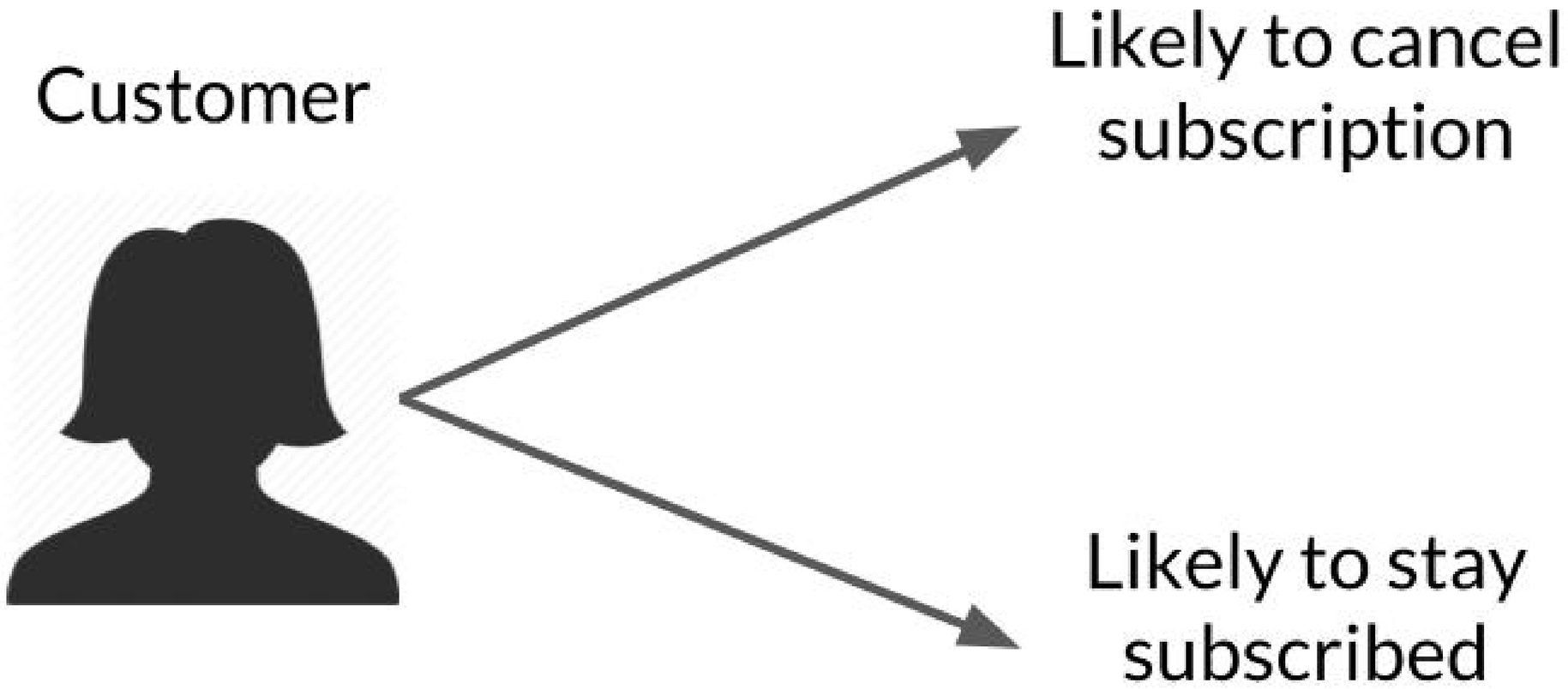
What is supervised machine learning?

- **Machine learning**: Predictions from data
- ***Supervised machine* learning**: Predictions from data with *labels* and *features*
  - Recommendation systems
  - Email subject optimization
  - Churn prediction

Case study: churn prediction



Case study: churn prediction

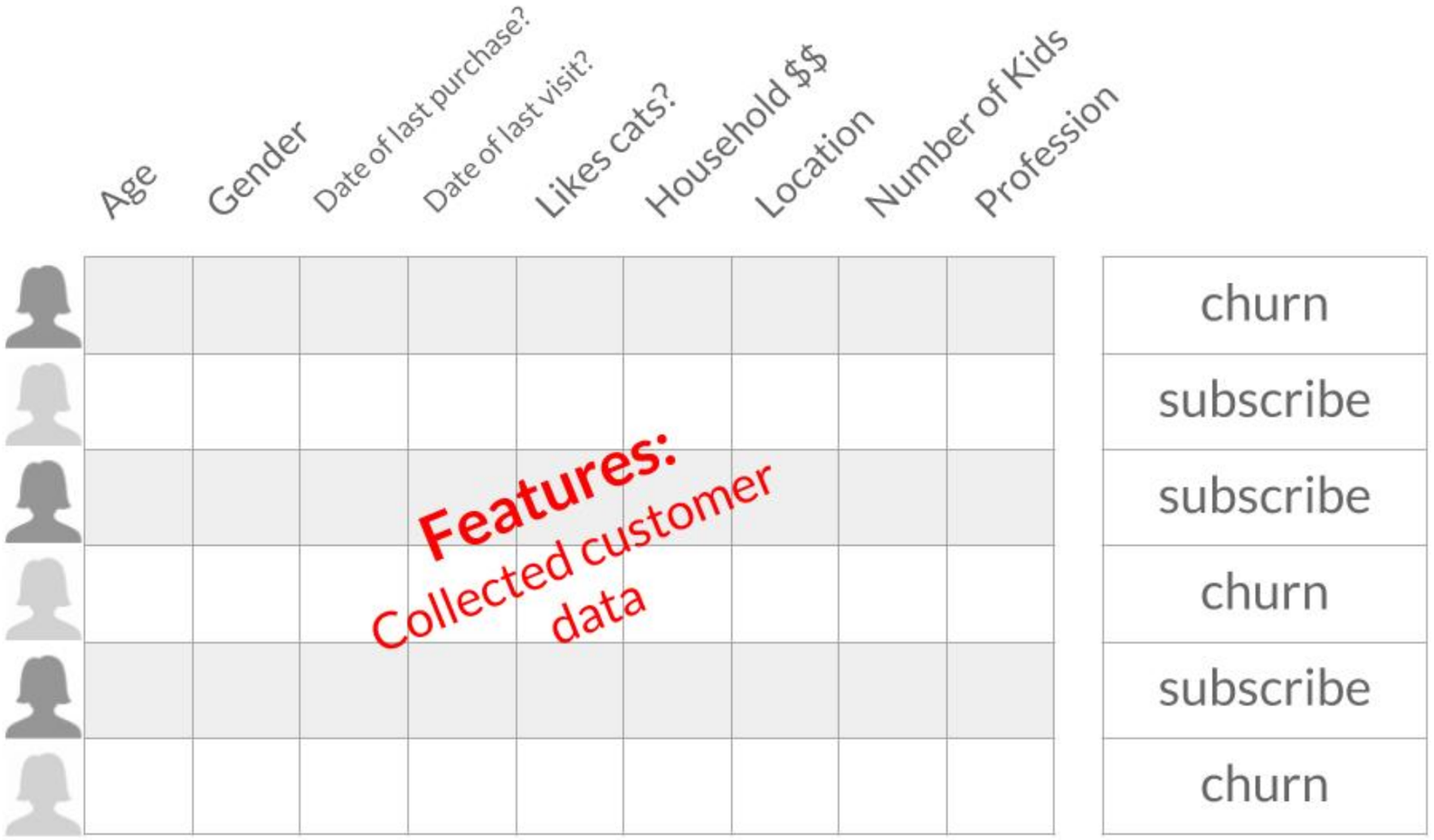
Training Data:
Customers

Case study: churn prediction

Labels
Customer outcomes

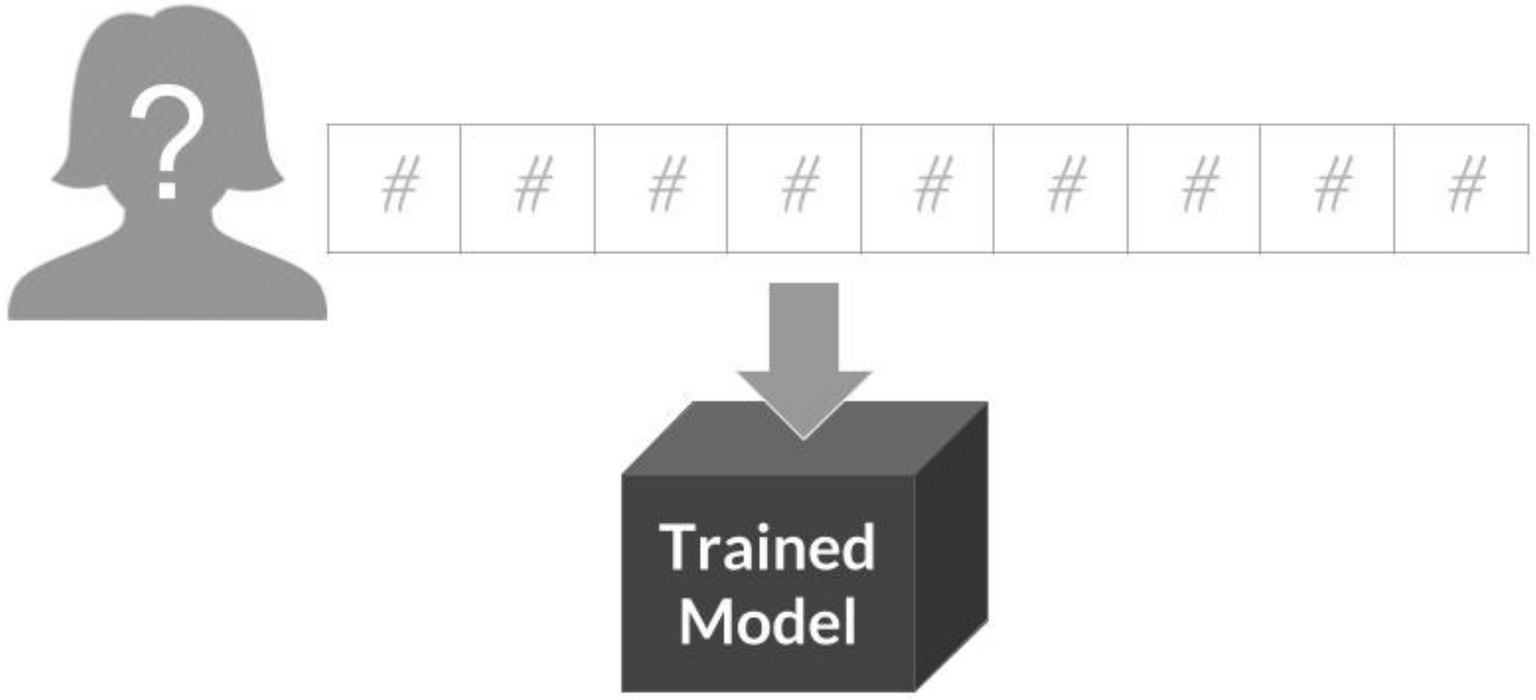
churn
subscribe
subscribe
churn
subscribe
churn

Case study: churn prediction

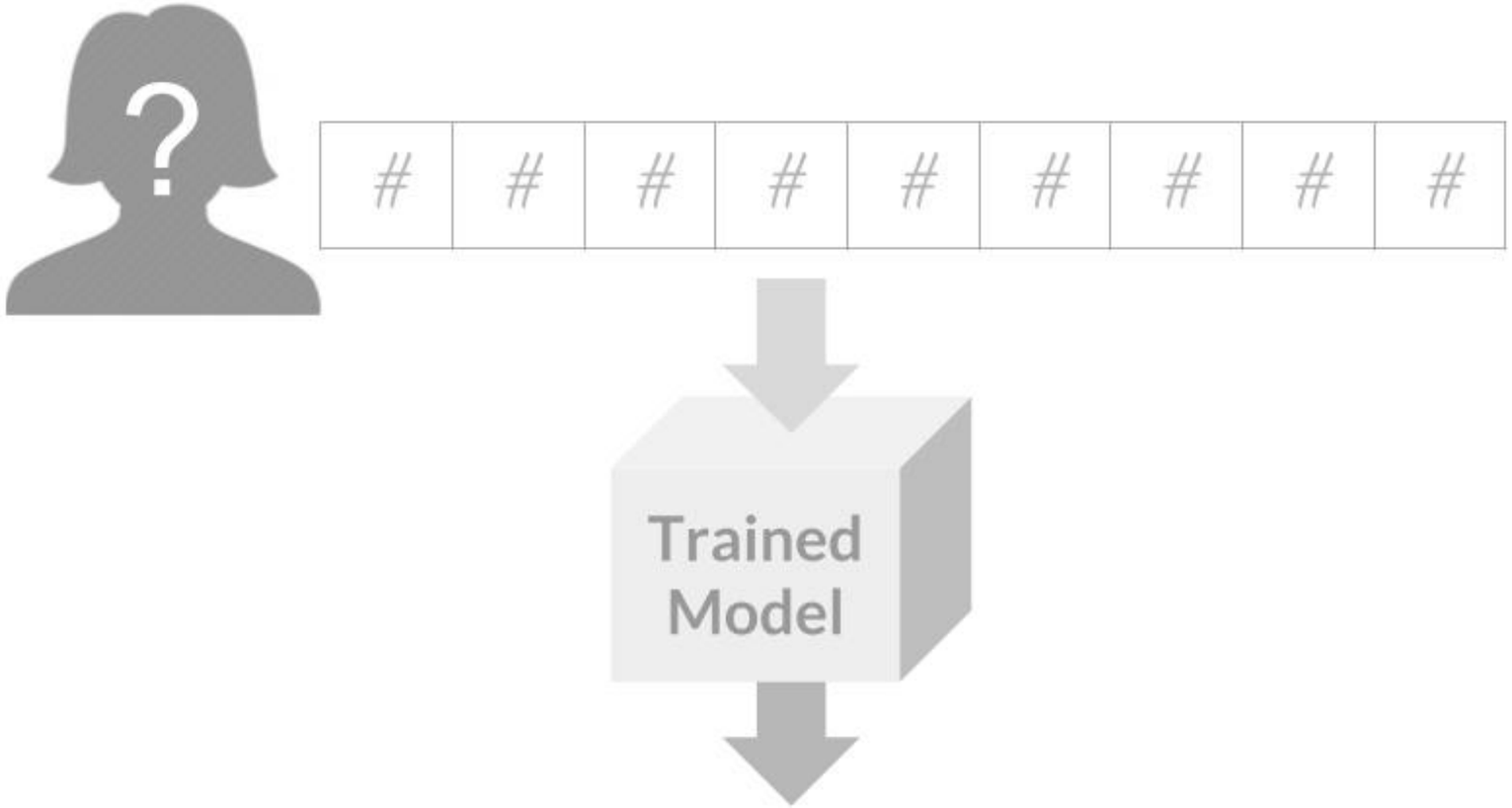


Case study: churn prediction

Case study: churn prediction



Case study: churn prediction



Recap

- Make a prediction based on data
- Data has *features* and *labels*
  - Label: what we want to predict
  - Features: data that might predict the label
- Trained model can make predictions

Model evaluation

Split historical data into training and testing sets

Model evaluation

	Prediction	Reality
Churn	0%	3%
Remain	100%	97%

Let's practice!

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Clustering

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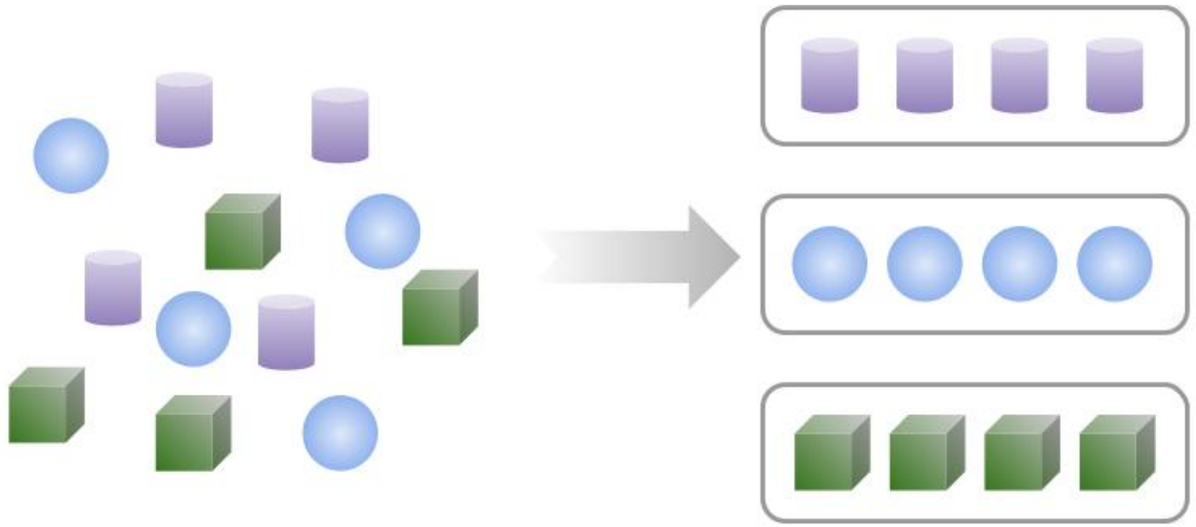
What is clustering?

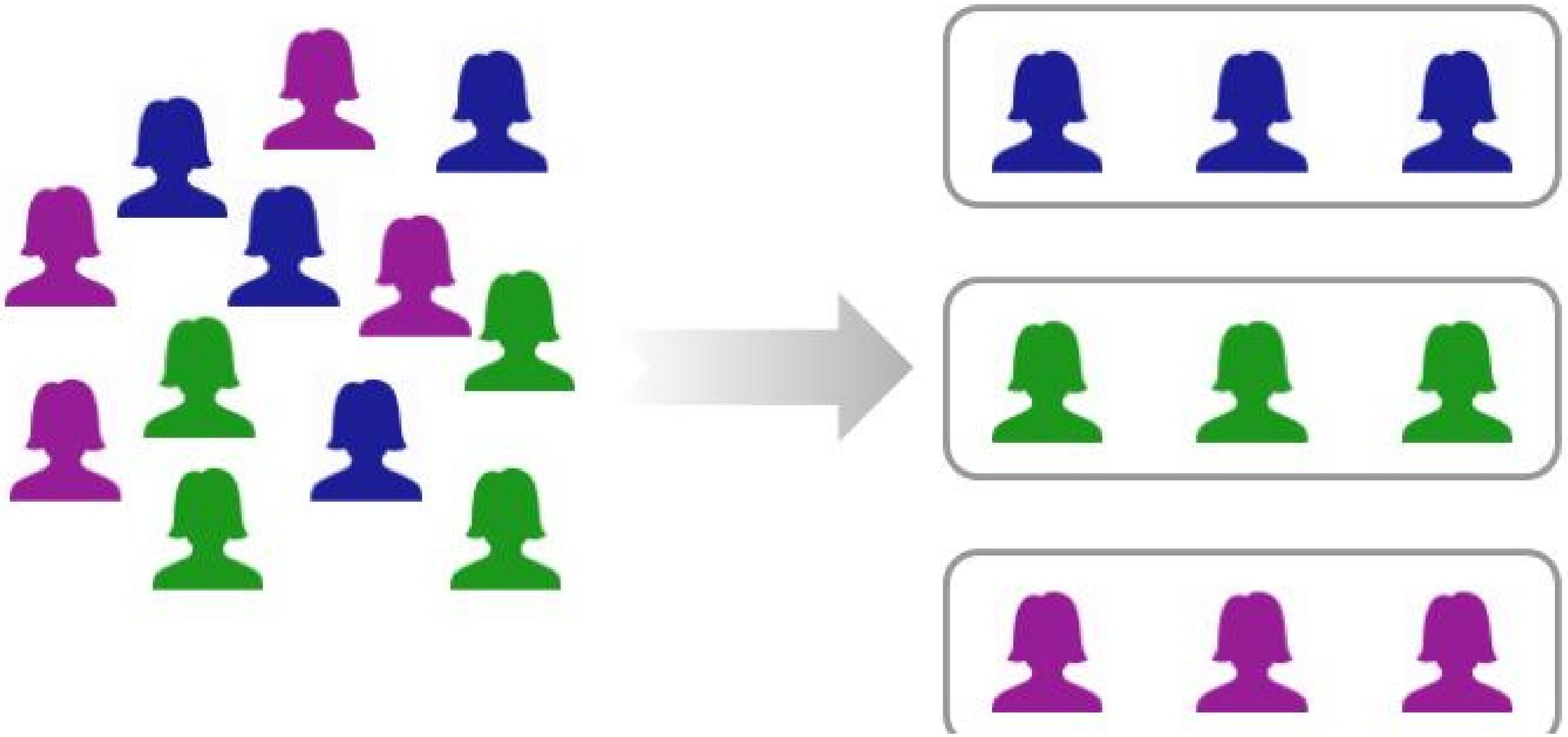


- Divide data into categories
- Use cases
  - Customer segmentation
  - Image segmentation
  - Anomaly detection

Supervised Machine Learning

Unsupervised Machine Learning

Case study: customer segmentation



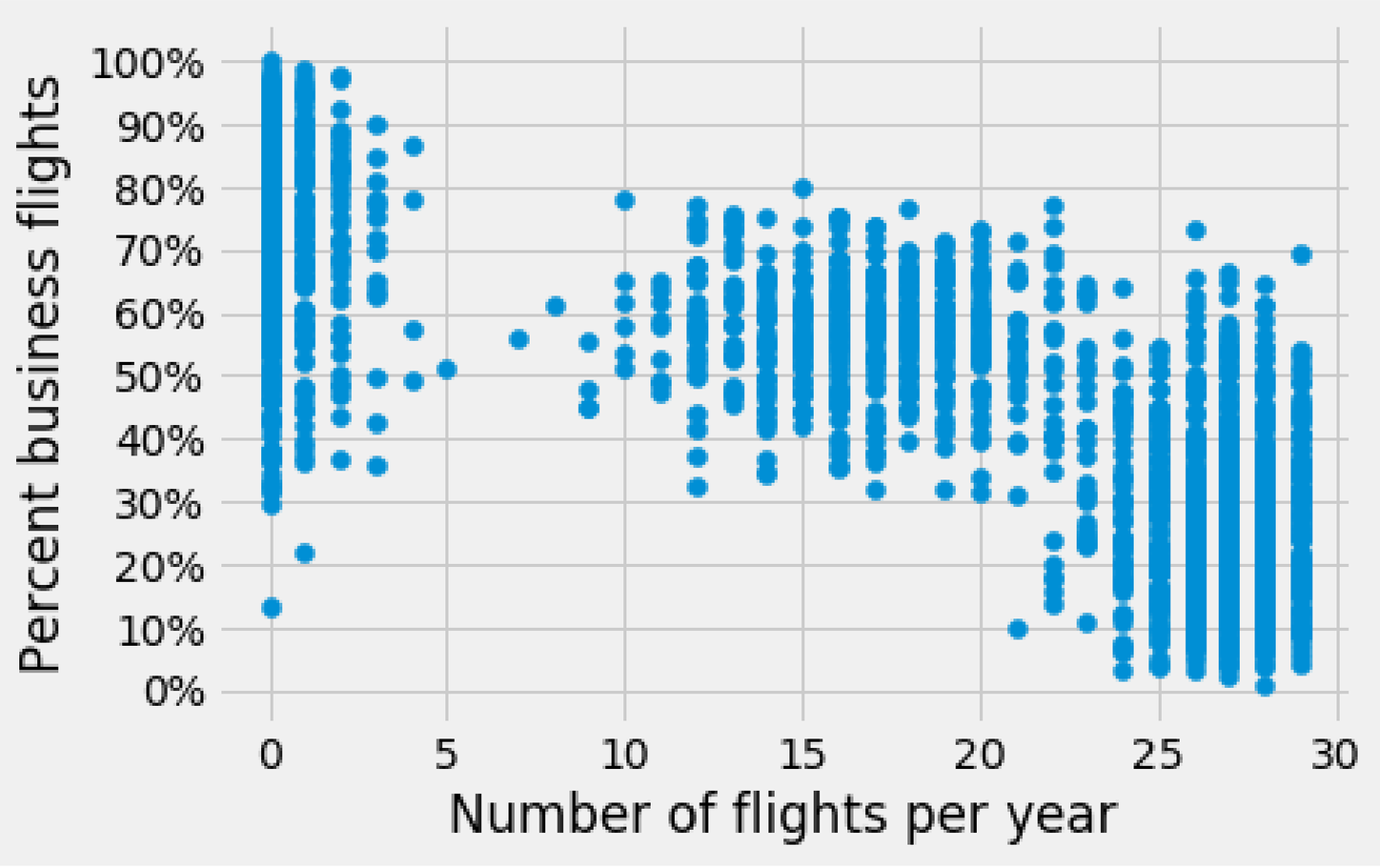
Case study: customer segmentation

Define features

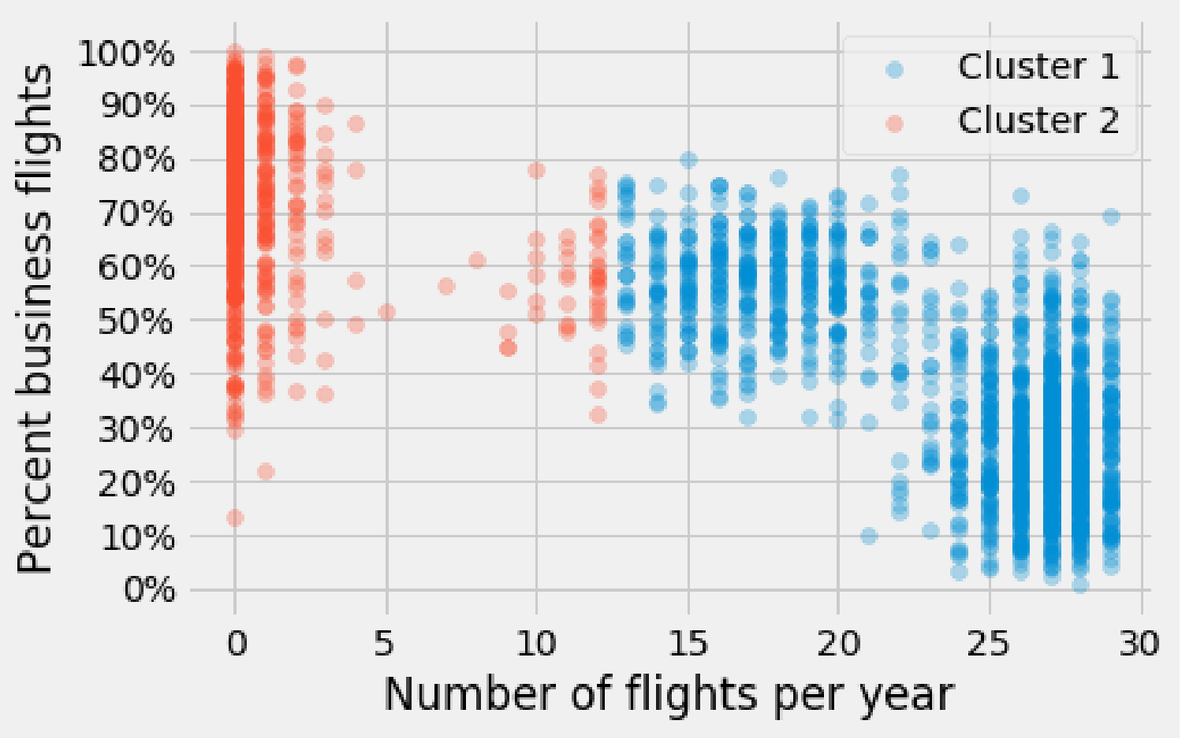
- Number of flights in the past year
- Percent international
- Advanced planning
- Percent business class

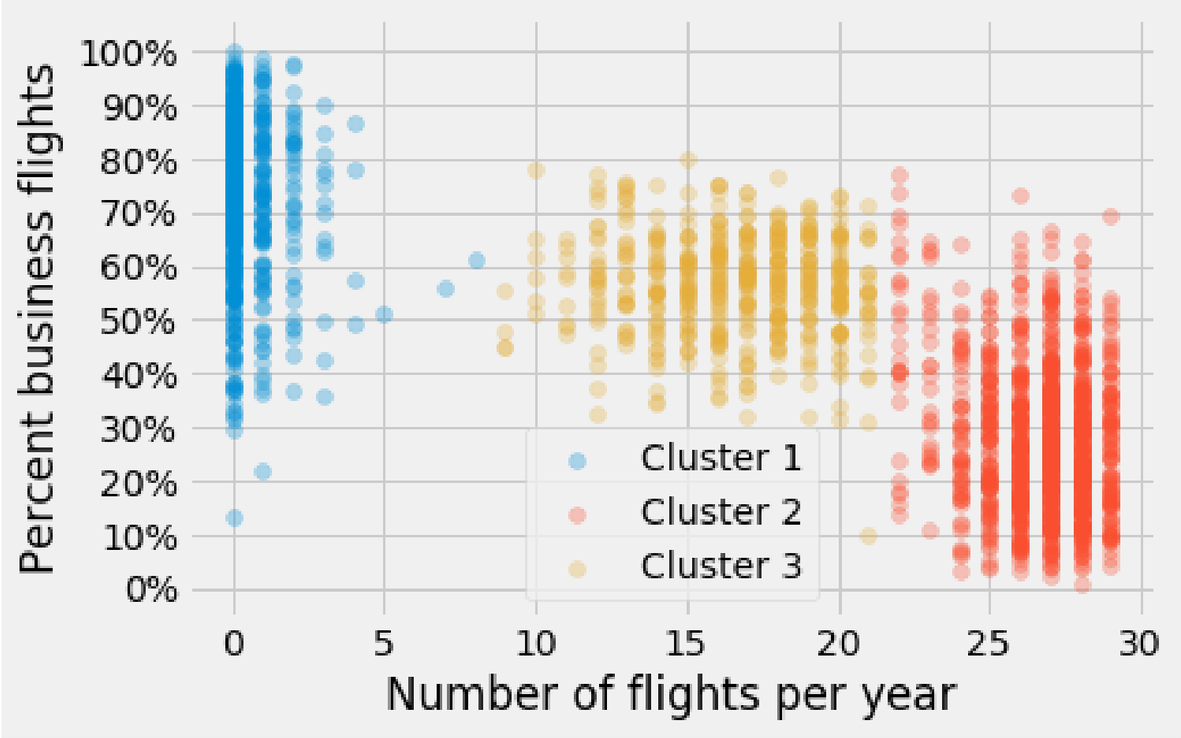
Case study: customer segmentation

- Define number of clusters



Case study: customer segmentation





Clustering review

Definition

- Divide unlabeled dataset into different categories

Steps

- Select features
- Select number of clusters
- Use clusters to solve business problems

Let's practice!

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Special topics in Machine Learning

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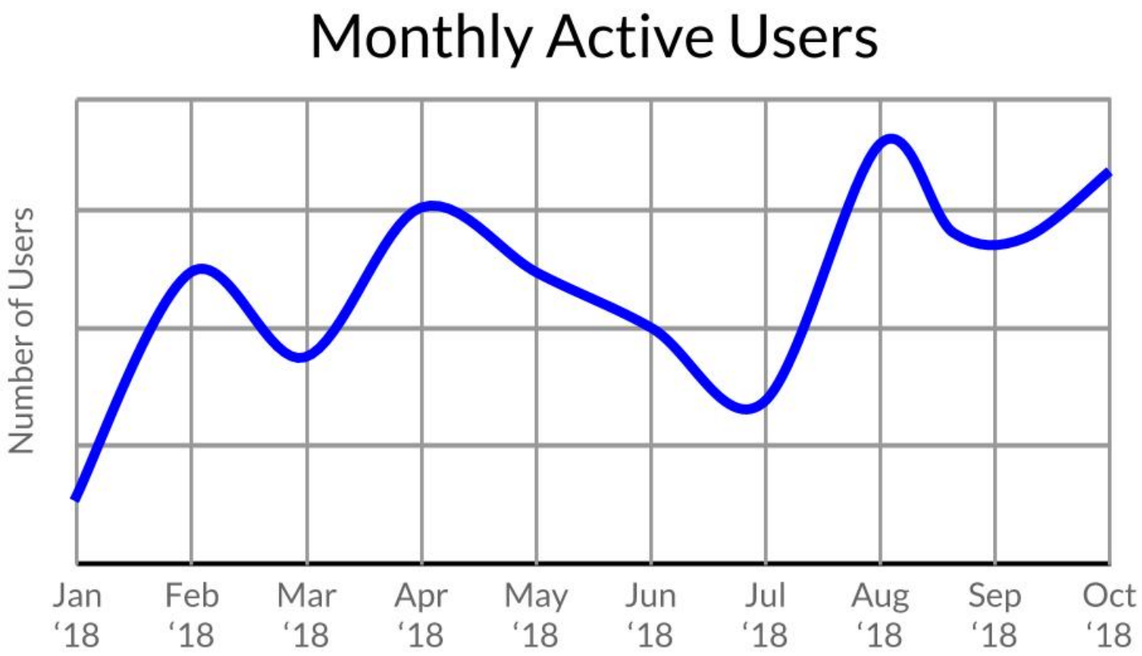
Time series forecasting



- Time is a feature
- Accounts for weekly, monthly, or yearly trends

Seasonality

- **Weekly**: Lower television viewership on Fridays
- **Monthly**: Higher spending at end of pay periods
- **Yearly**: Less ice cream in the winter

Natural Language Processing

- Dataset is text
  - Customer reviews
  - Tweets
  - Medical records
  - Email subjects
- Possible uses
  - Classifying sentiment
  - Clustering medical records

Word counts

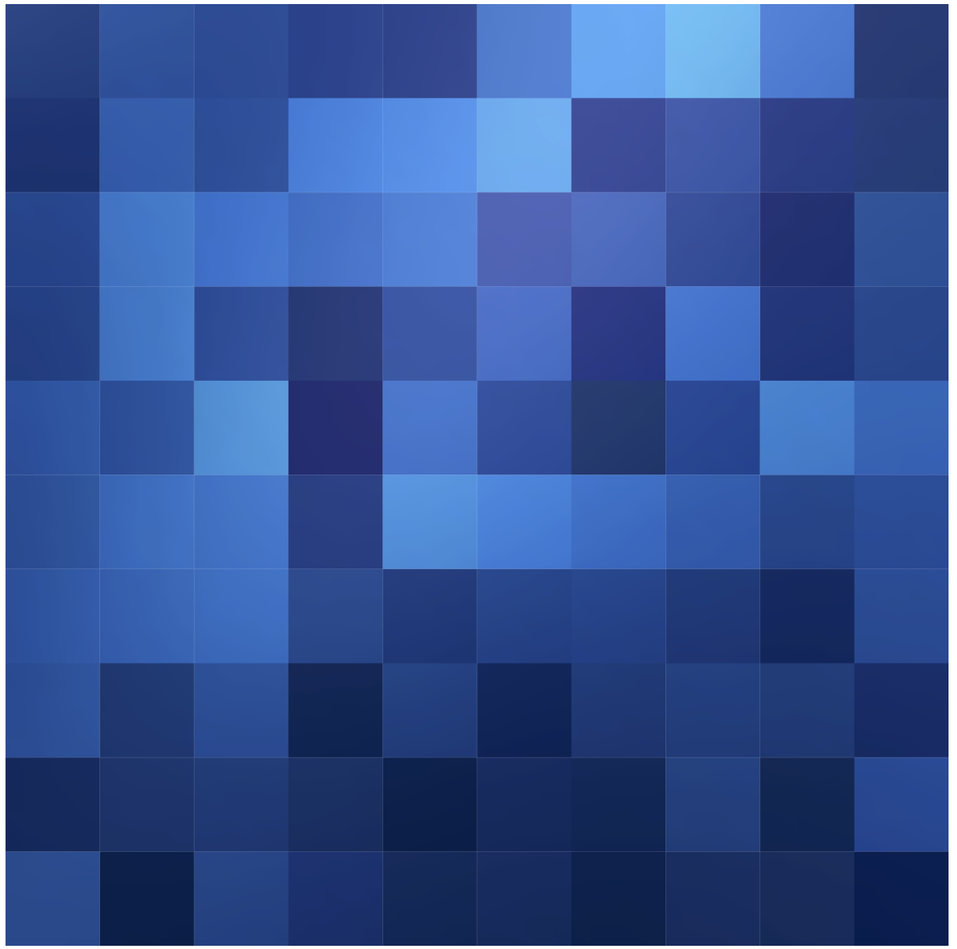
Sentence	Texans	Giants	football	great
The Texans are a great football team.	1	0	1	1
The Giants are a great football team.	0	1	1	1

Problems with word counts: negation

Sentence	Texans	Giants	football	great	not
The Giants are a great football team.	0	1	1	1	0
The Giants are not a great football team.	0	1	1	1	1

Word counts and synonyms

- Word counts don't help us consider synonyms
- Example: "blue"
  - "sky-blue"
  - "aqua"
  - "cerulean"
- Want to group as a single feature



Word embeddings

- Create features that group similar words
- Features have a mathematical meaning:

```
king - man + woman = queen
```

Review

- **Time series forecasting**
  - Time is a feature
  - Seasonality
- **Natural Language Processing (NLP)**
  - Text as input data
  - Word counts
  - Word embeddings

Let's practice!

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Deep Learning and Explainable AI

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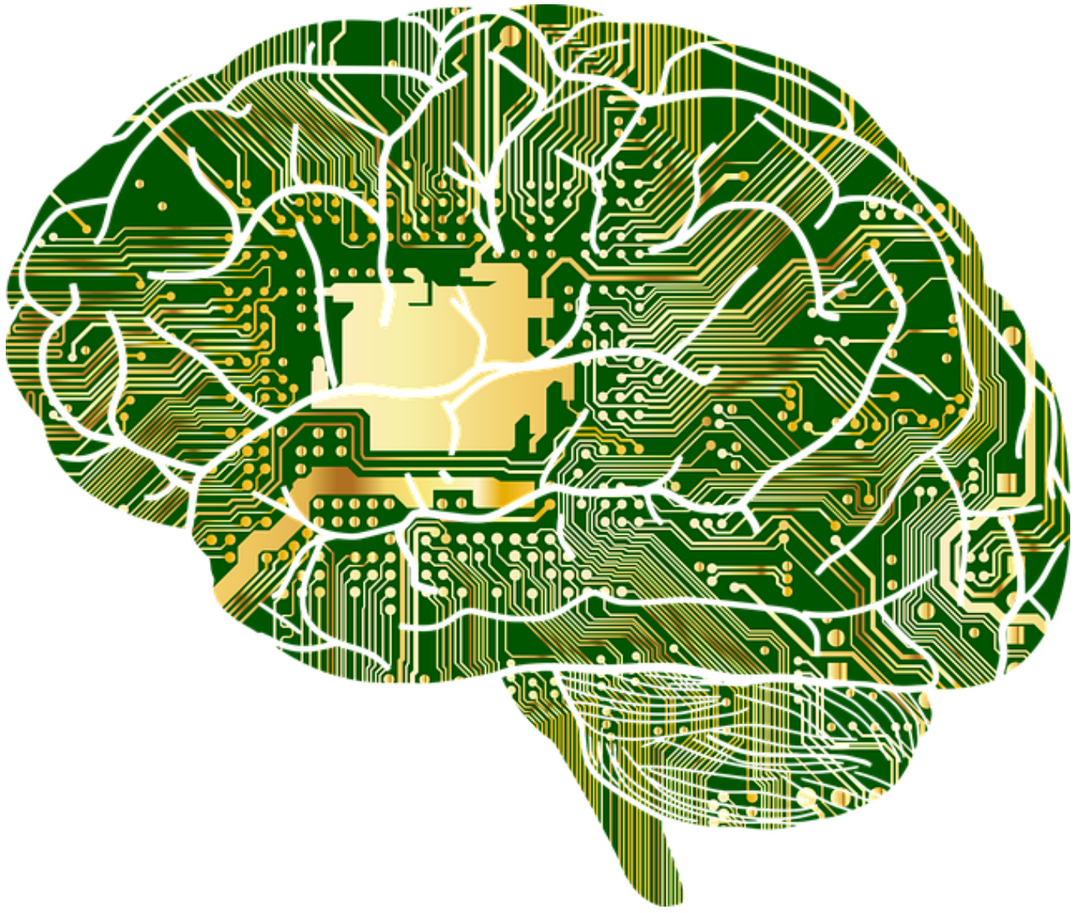
What is Deep Learning?

- AKA: Neural Networks or Neural Nets
- Special area of Machine Learning
- Requires more data
- Best when inputs that are images or text



Explainable AI

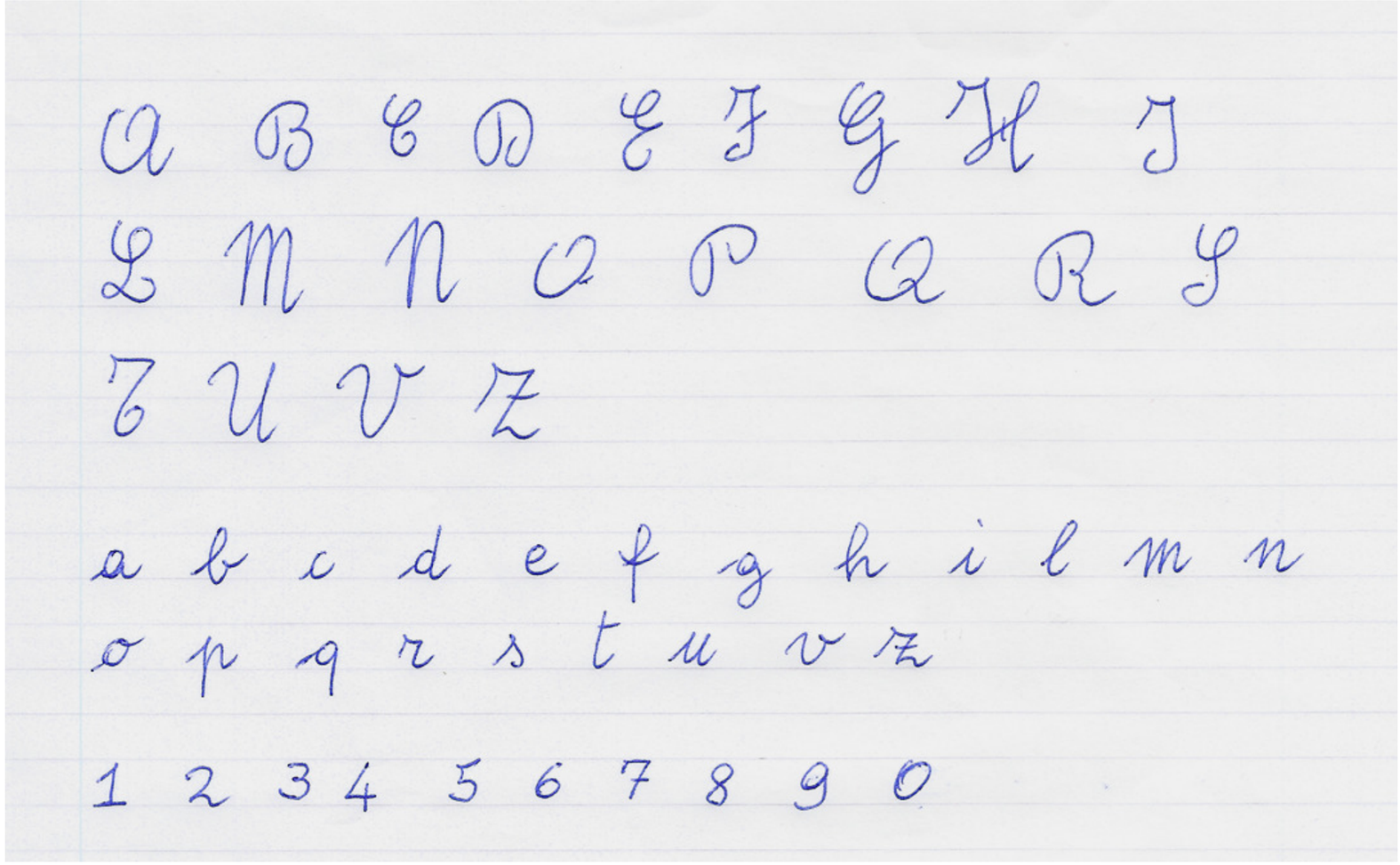
Deep Learning	Explainable AI
Highly accurate predictions	Understandable by humans
Better for "What?"	Better for "Why?"

Case Study: Explainable AI

1. **Prediction:** What a customer is likely to do
2. **Explanation:** Why a customer is likely to do it

Case Study: Inexplicable AI

Prediction only: Which letter is this likely to be?



When to use Deep Learning

1. Is the training data complex?
2. Do we have a very large amount of training data?
3. Does the model need to be predictive or explanatory?

Let's practice!

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