R for text analysis: Supervised Machine Learning

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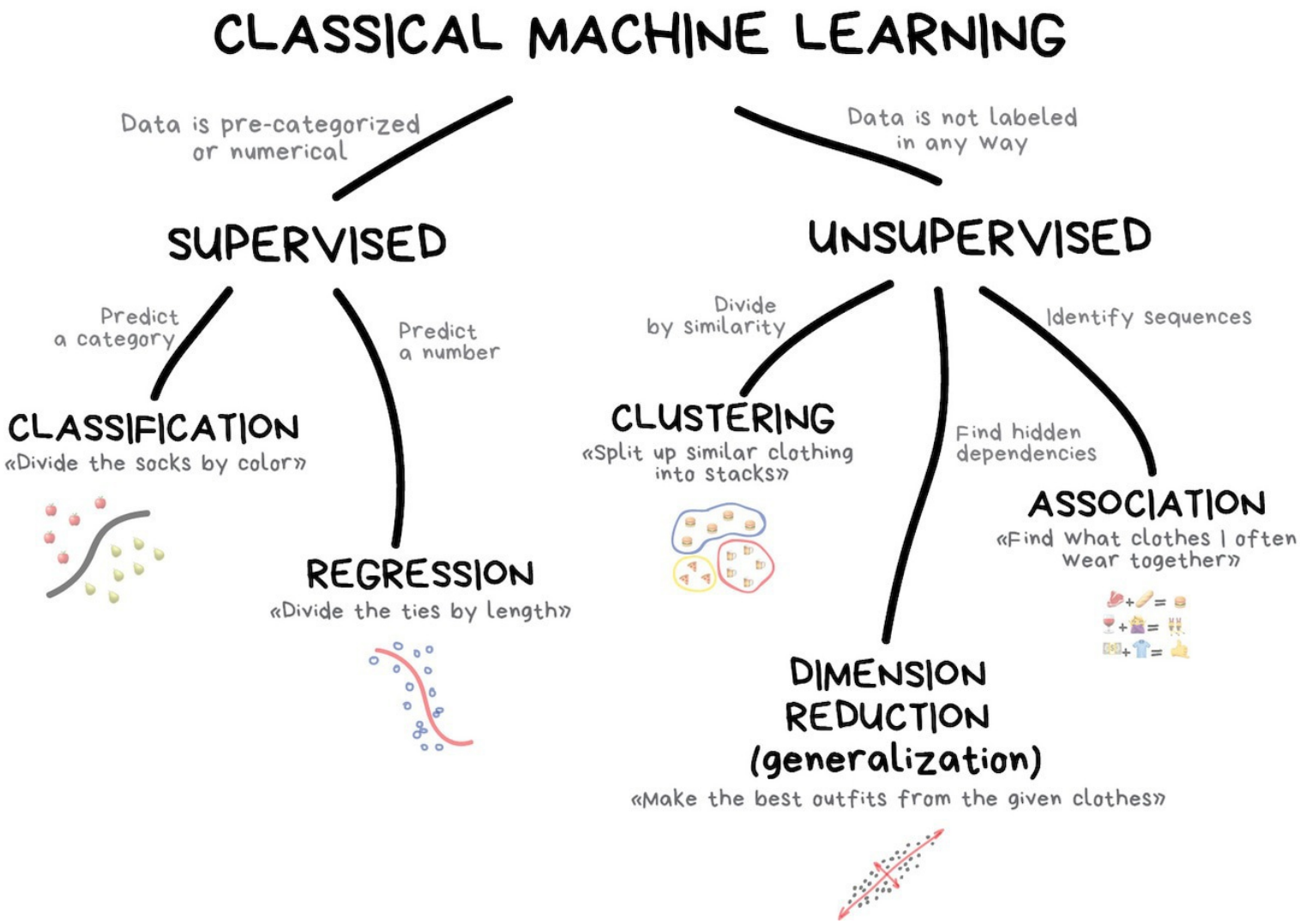
Overview

- What is Machine Learning?
- Principles and validation
- Algorithms

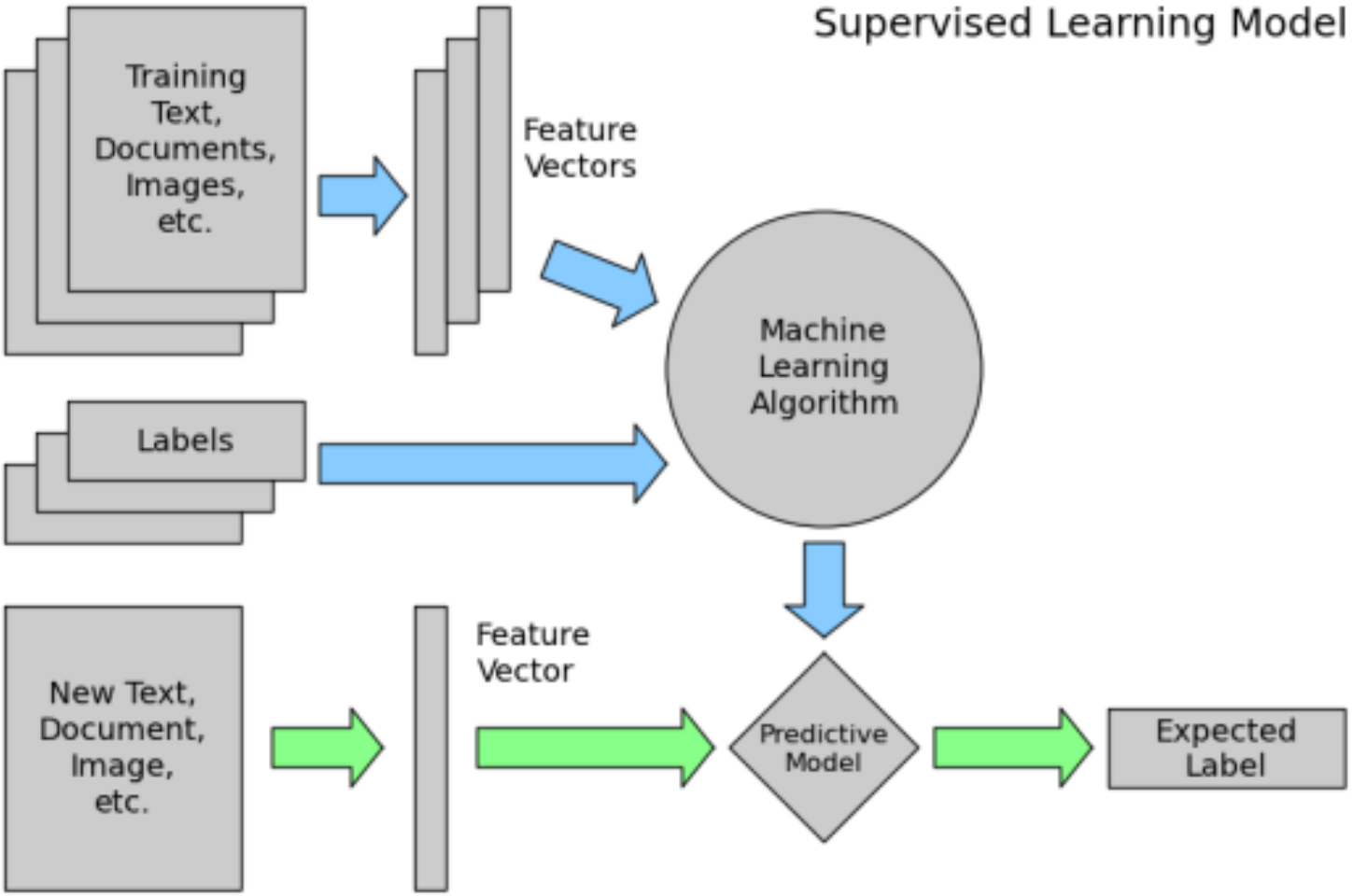
What is Machine Learning

- Form of Statistical Learning
- Given data, find a regularity to predict new data
- Supervised machine learning:
  - Build a model using labeled examples
  - Using many input features (independent variables)
  - To predict the output class (dependent variable)

Supervised Machine Learning



Machine learning process



Machine learning vs "normal" modeling

- Same principle, different goal
- Classical modeling: explain / understand
  - Requires intepretable parameters
- Machine learning: prediction (aka forecasting)
  - Requires high accuracy
- So...
  - ML models use many more features
  - Which are often strong multicollinear
  - But that's ok, since we don't care about the parameters

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- Estimation: 'Regularize' model (bias parameters towards zero)
- Validation: Use train-(develop)-test split

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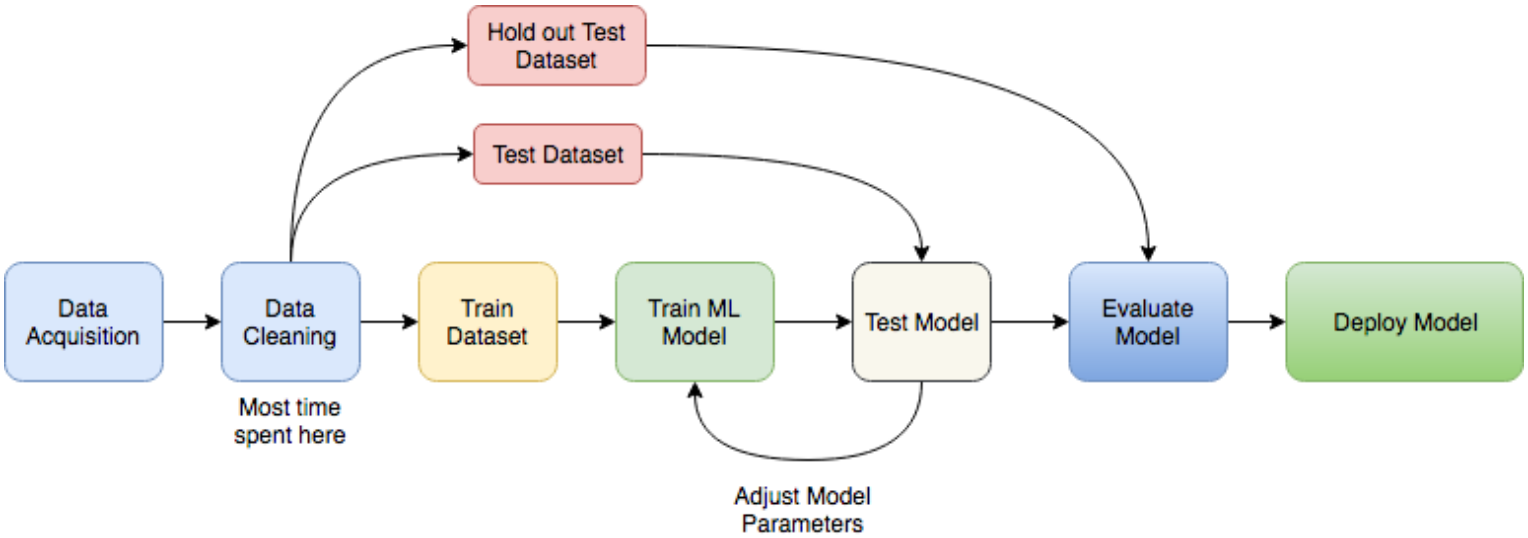
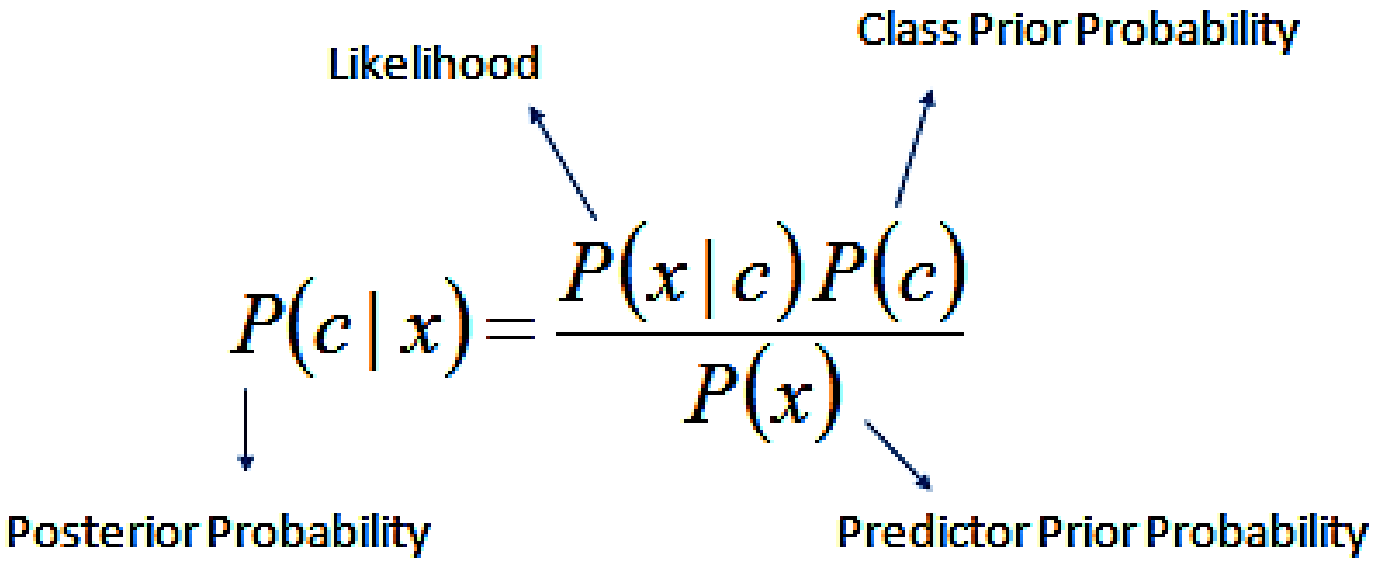


Machine Learning Algorithms

- Estimate model based on data
- Many algorithms exist
- All deal with data scarcity and overfitting problems in some way
- Most need some sort of (hyper)parameter tuning

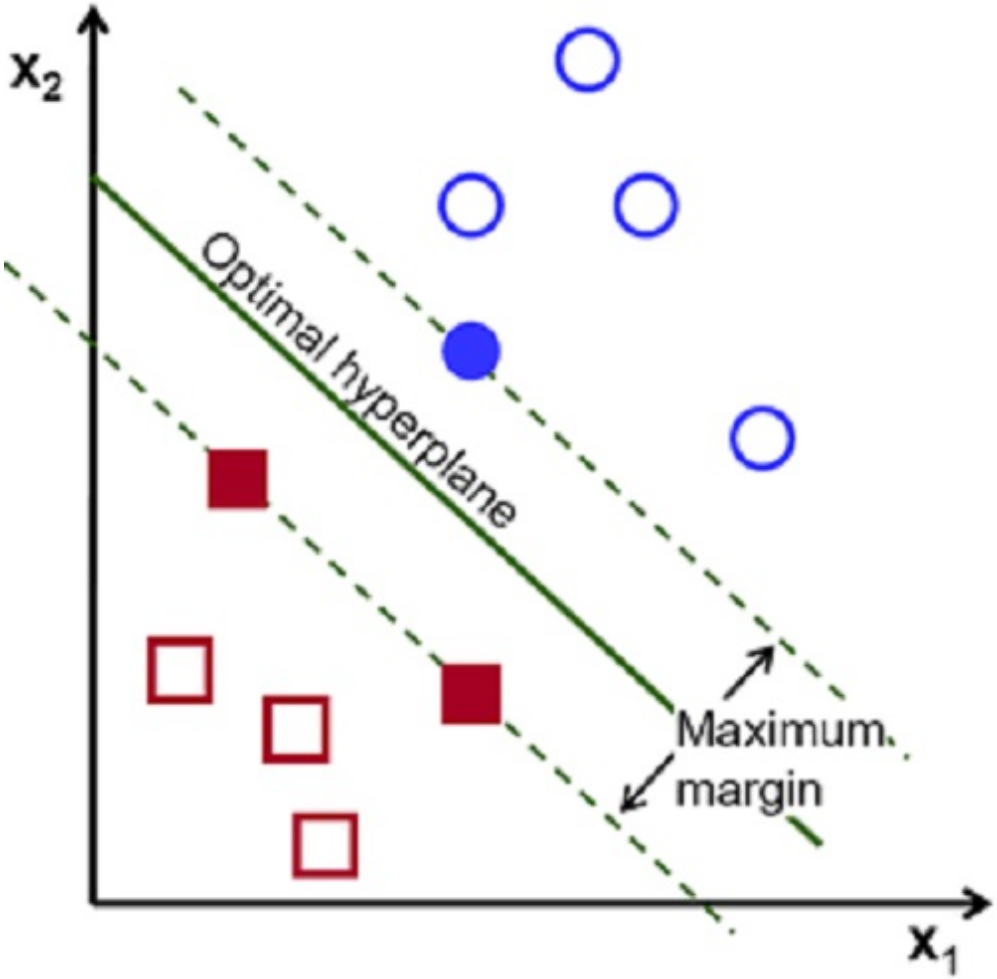
- How to choose?
- Differences often not that big
- Can try all models/parameters on development set, pick the best
- Can even combine multiple models (ensemble methods)

Naive Bayes

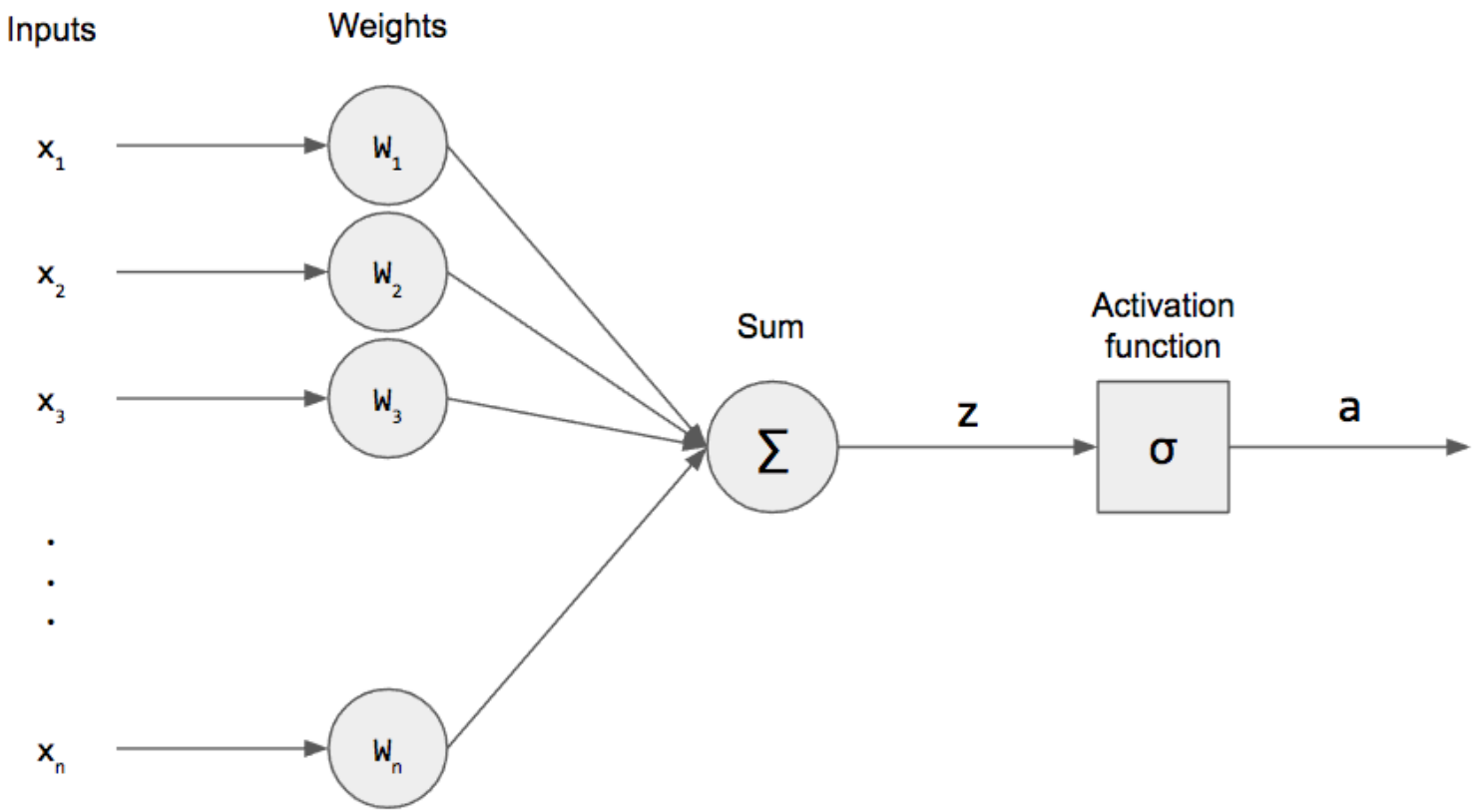


$$P(c \mid \mathbf{X}) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

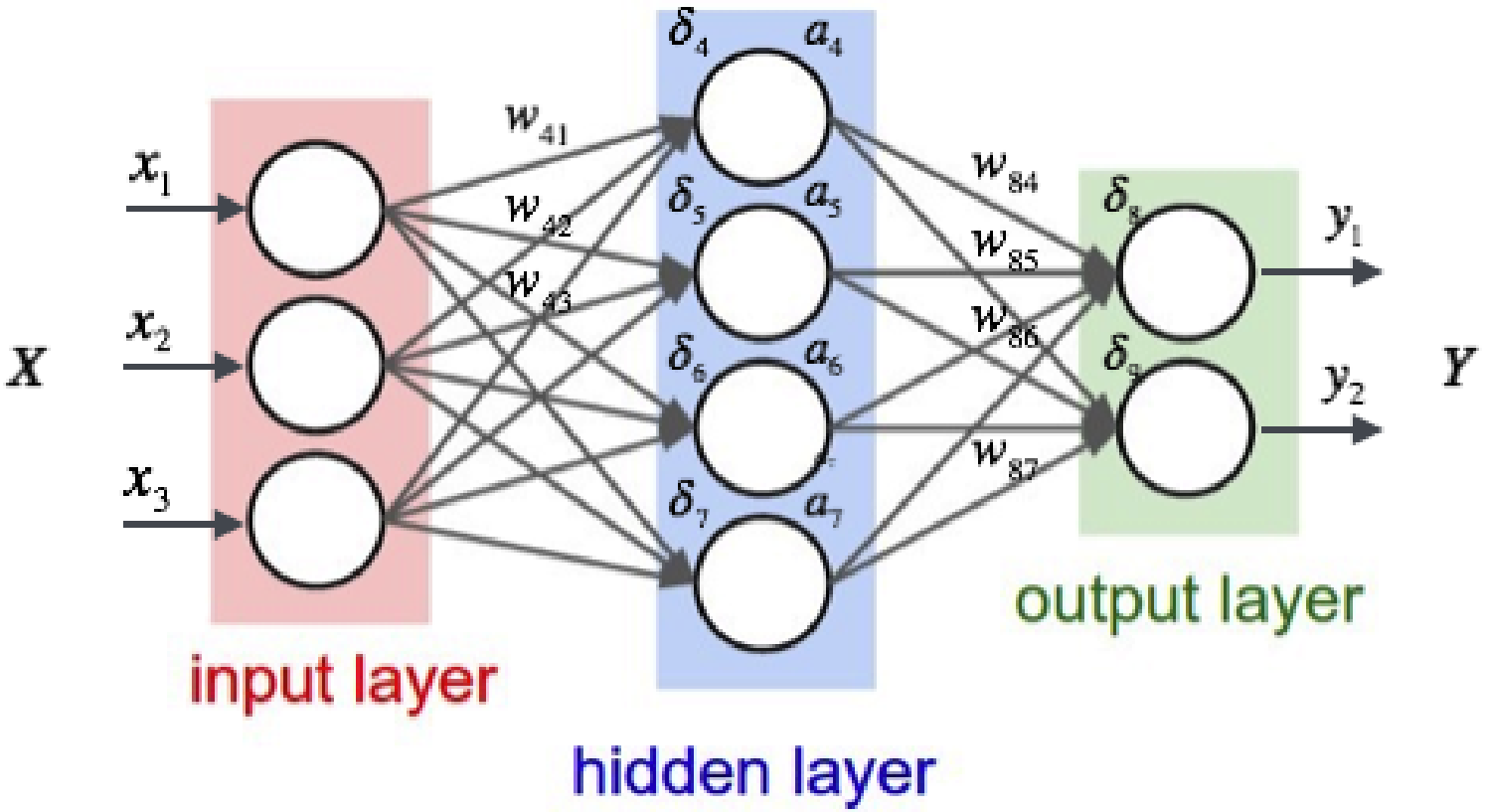
Support Vector Machines



Neural Networks (perceptron)



Neural Networks (multi-layer)



Text Mining: classical approach

- DFM is data
- Run ML model with frequencies as features
- Feature engineering to improve performance
  - e.g. selection, weighting, n-grams, NLP, dictionaries, ...

Text Mining: deep learning

- Deep learning = very large (structured) neural networks
- Include feature extraction / engineering in neural network
  - Word embeddings, convolutions, LSTMs, ...
  - Pre-train with unannotated data (embeddings)
  - Can use context (no bag-of-words assumption)
- Yoav Goldberg, *Neural Network Methods in Natural Language Processing*

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- Quanteda actually does naive bayes, scaling
- Single algorithms:
  - nnet, e1071, ...
- Comprehensive packages:
  - caret, CoreTools

Steps before running machine learning

- (May need to upgrade to R 3.5)
- Data cleaning, feature selection
- Split in train, test, (validation)

Running the model

(see handout!)