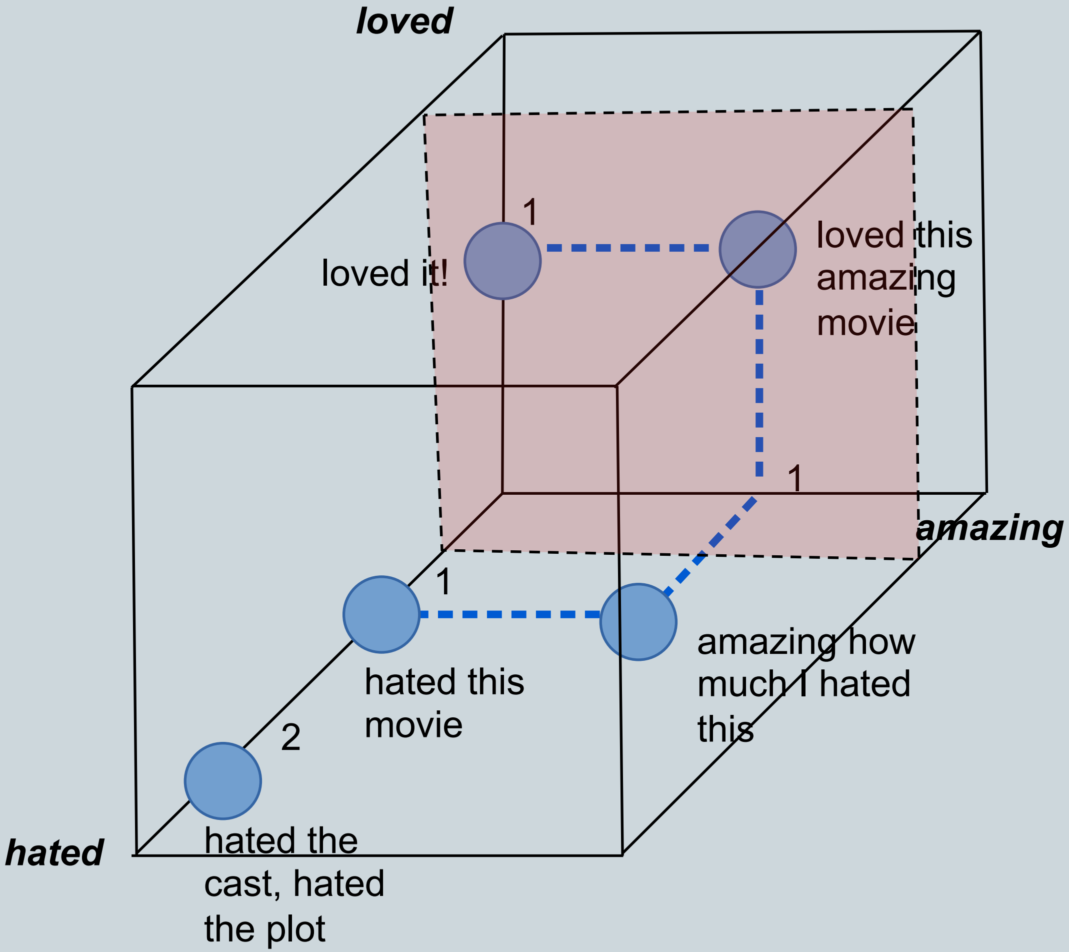
Supervised machine learning for text classification

KING'S College LONDON

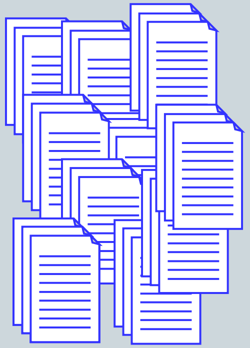
NIHR | Maudsley Biomedical Research Centre

Bag of words

- Recall our bag of words example
- We represented our documents in a vector space
- We separated out different classes of documents
- This is an example of a general technique, called *classification*
- Building a model from examples is called *training* the model, or *supervising* the model

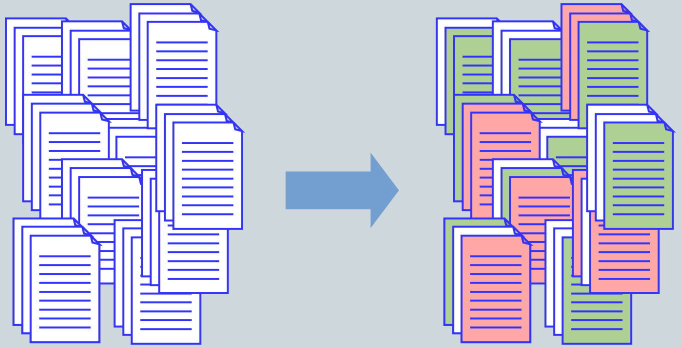


Supervised classification



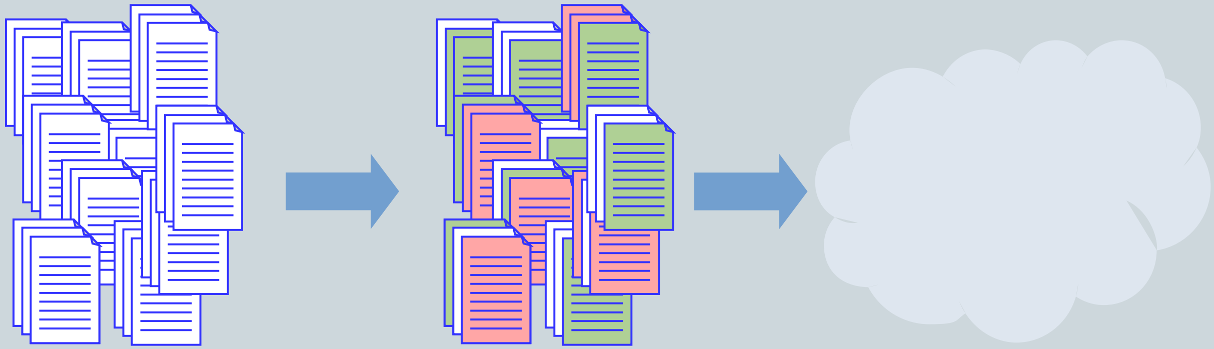
- Take a set of example texts.
- They might be sentences, whole documents, single words, or some other portion of text.
- This is our training corpus.

Supervised classification



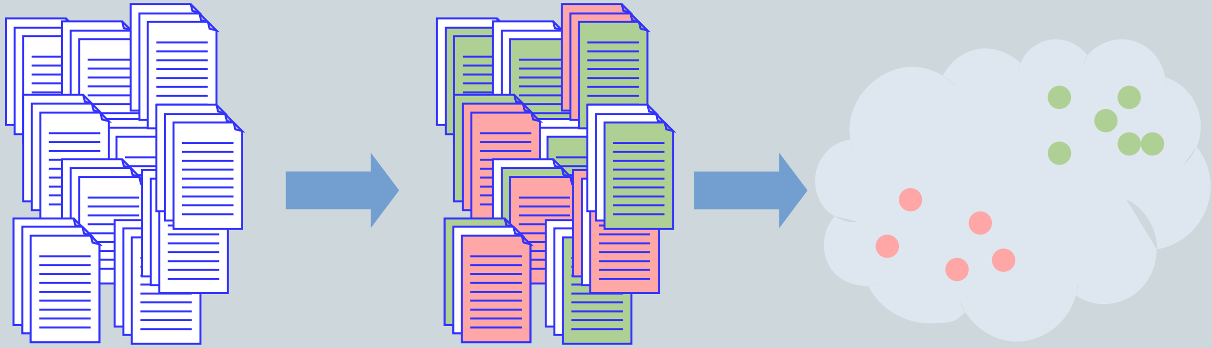
- Label each example, with the classes in our problem.
- Labelling will often be done by human.
- We might be lucky enough to have some existing labelled data, e.g. radiology reports with a code for tumour class attached..

Supervised classification



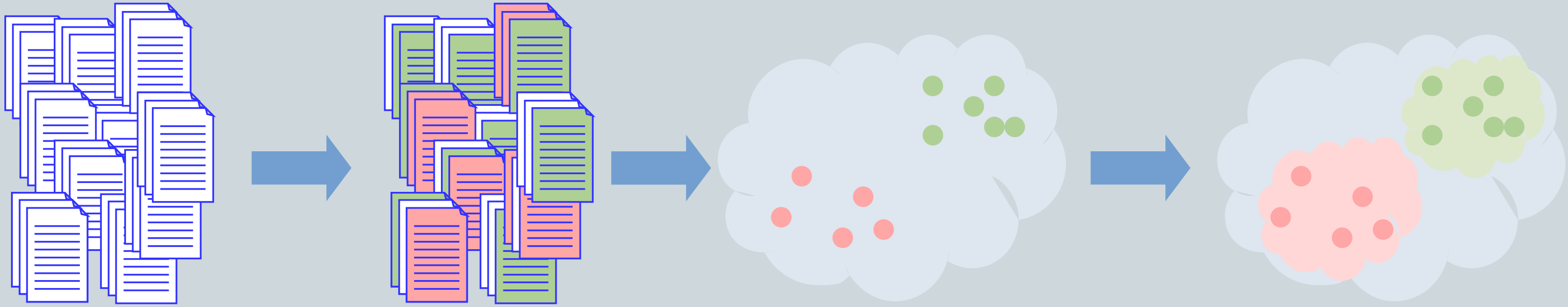
- Select features to represent our texts.
- These might be the presence of words, parts of speech, distances between words, word sequences (ngrams), presence of word groups, sentence lengths, etc.
- We may use numeric representations of words as features, computed in a separate step. In the state of the art, these are referred to as embeddings.

Supervised classification



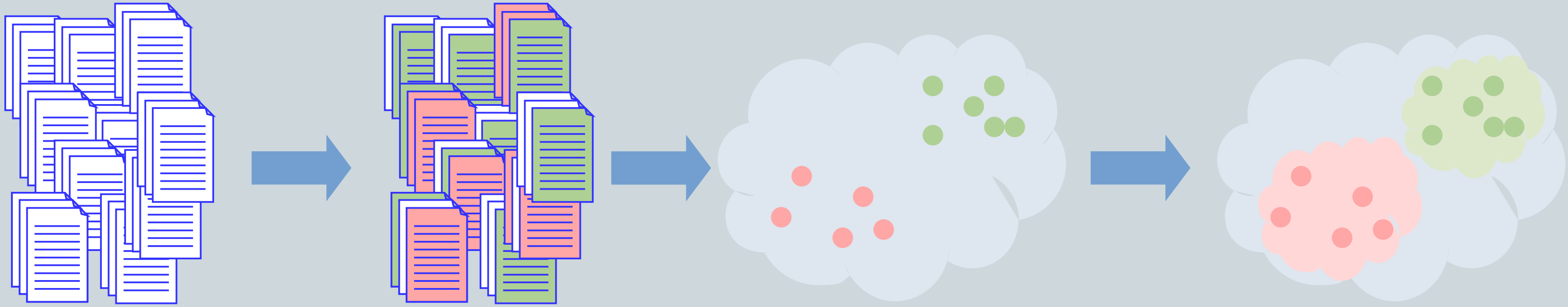
- Represent the texts in this feature space.

Supervised classification



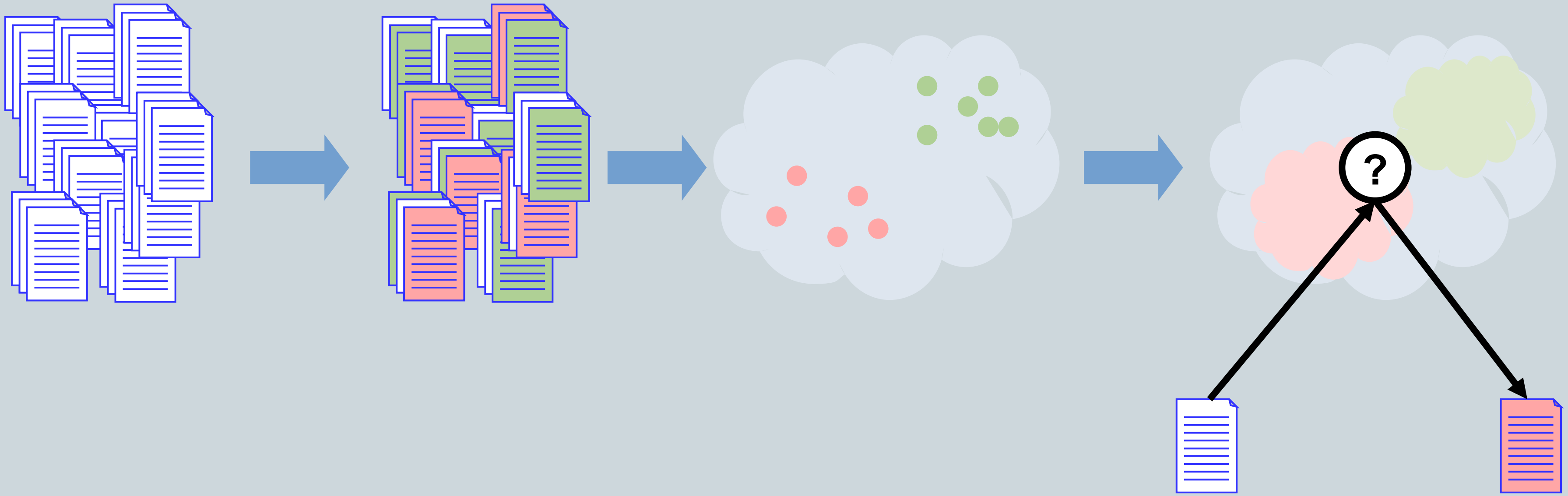
- Compute some separator between classes.
- This will involve measures of distance between points.
- It might also involve methods for projecting multiple dimensions into different spaces in which they are separable (kernels).

Supervised classification



- Commonly used classification algorithms in NLP:
  - K Nearest Neighbours
  - Decision Trees and Random Forest
  - Naive Bayes
  - SVM (very popular)
  - CRF
  - Neural nets, e.g. CNNs, LSTMs, Transformers

Supervised classification

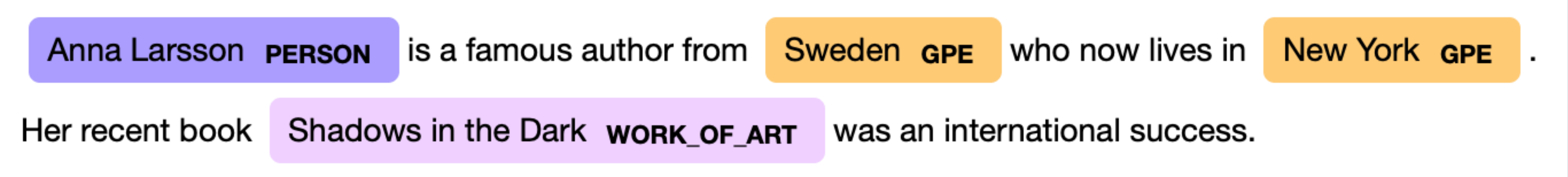


- Classify / label new, previously unseen examples by representing them in the same feature space.

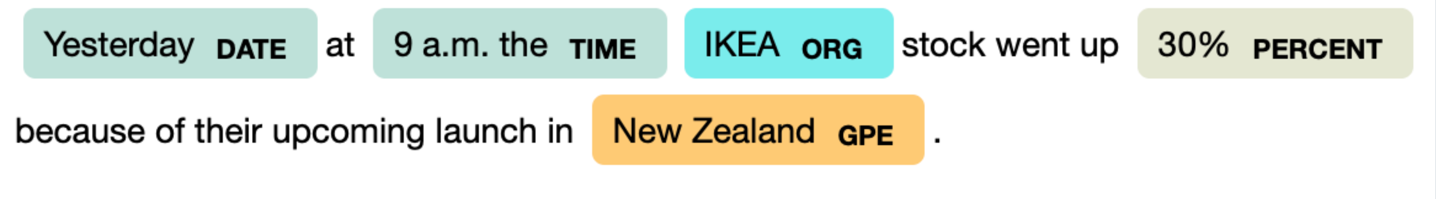
Named entity recognition

Named Entity Recognition as a classification problem

- We have looked at how we might classify document
- But what if we want to extract mentions of things from documents?
- For example, people’s names, or medications, or symptoms?
- This is called Named Entity Recognition (NER)



Anna Larsson PERSON is a famous author from Sweden GPE who now lives in New York GPE .
Her recent book Shadows in the Dark WORK_OF_ART was an international success.



Yesterday DATE at 9 a.m. the TIME IKEA ORG stock went up 30% PERCENT
because of their upcoming launch in New Zealand GPE .

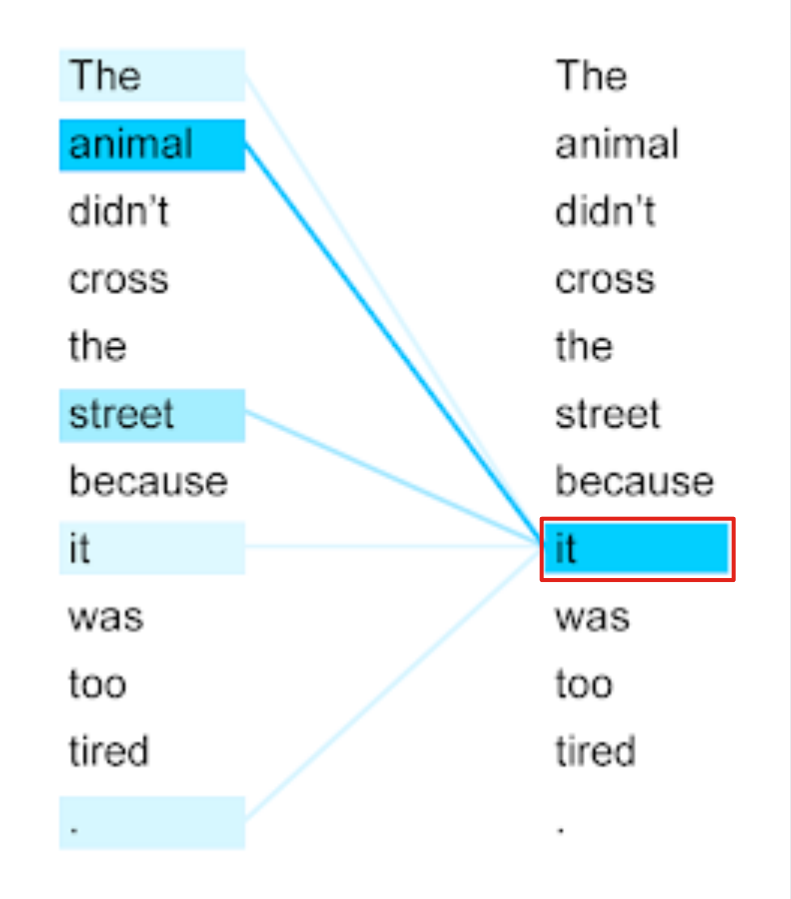
Named Entity Recognition as a classification problem

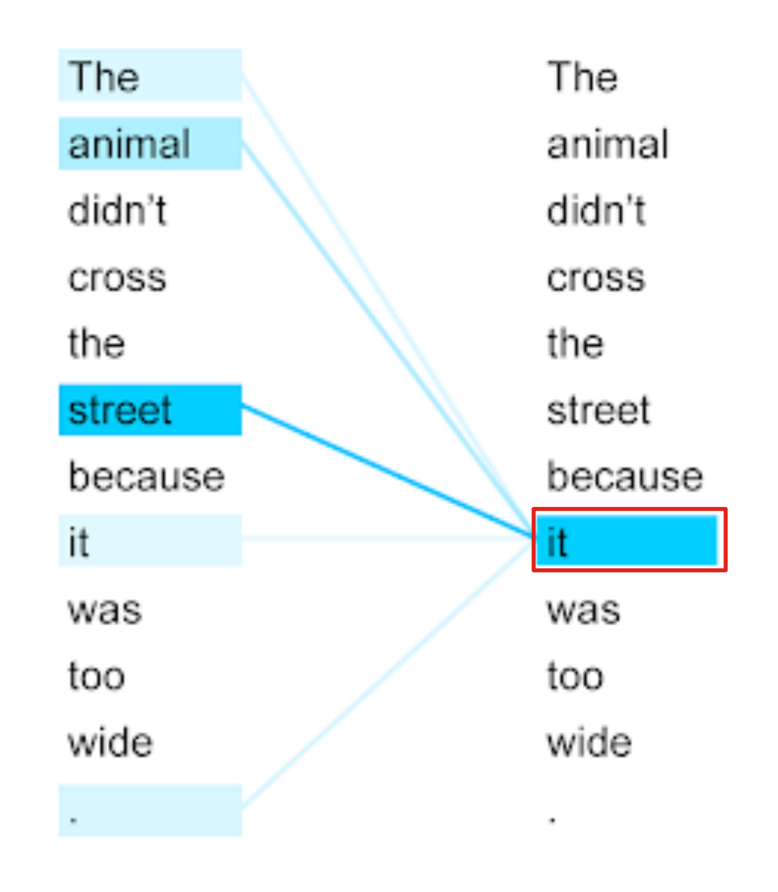
- Instead of finding the class of each document, we find the class of each word
- But some entities are made up of multiple words
- So we have classes that represent both the entity type, and where in that entity the word is found
- (There are other ways to do this)

TEXT	**IOB**	**ENTITY TYPE**	**CLASS**	**DESCRIPTION**
Anna	B	PERSON	PER_B	beginning of an entity
Larsson	I	PERSON	PER_I	inside an entity
is	O	""	O	outside an entity
a	O	""	O	outside an entity
famous	O	""	O	outside an entity
author	O	""	O	outside an entity
from	O	""	O	outside an entity
Sweden	B	GPE	GPE_B	beginning of an entity

Better and bigger representations

Self-attention – example distribution





The encoder self-attention distribution for the word “it” from the 5th to the 6th layer of a Transformer trained on English to French translation (one of eight attention heads).

Credit: https://research.google/blog/transformer-a-novel-neural-network-architecture-for-language-understanding/

Large Language Models

	BERT	GPT	GPT2	GPT3	GPT4
Model layer	Encoder	Decoder	Decoder	Decoder	Decoder
Pre-training task	MLM, NSP	Text generation	+ task conditioning	+ in-context patterns	
Training data	3.3 billion words	7000 books	40 GB	45 TB	1 PB ?
Context window	512	512	1024	2048	8000 – 32000 ?
Parameters	110 M	117 M	1.5 B	175 B	1 T ?
Suitability	Sequence tasks	Generation	Generation	Generation, adaptable	Generation, adaptable
Availability	Open	Open	Open	Limited, API	Limited, API

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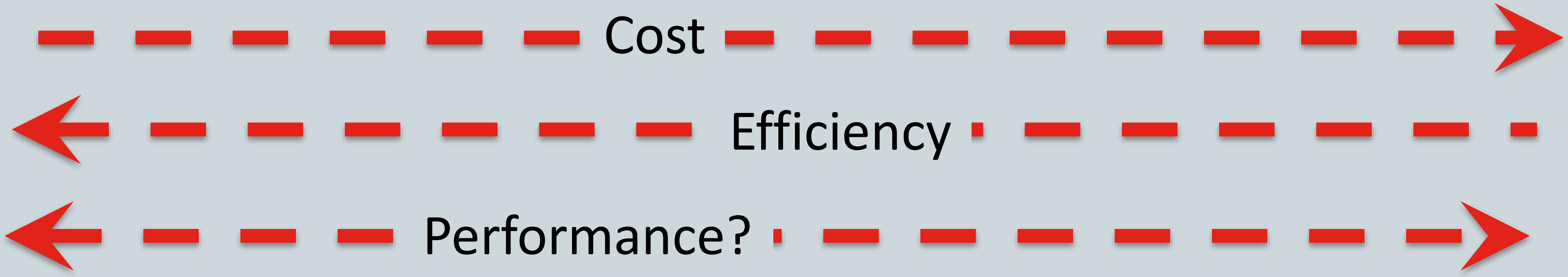


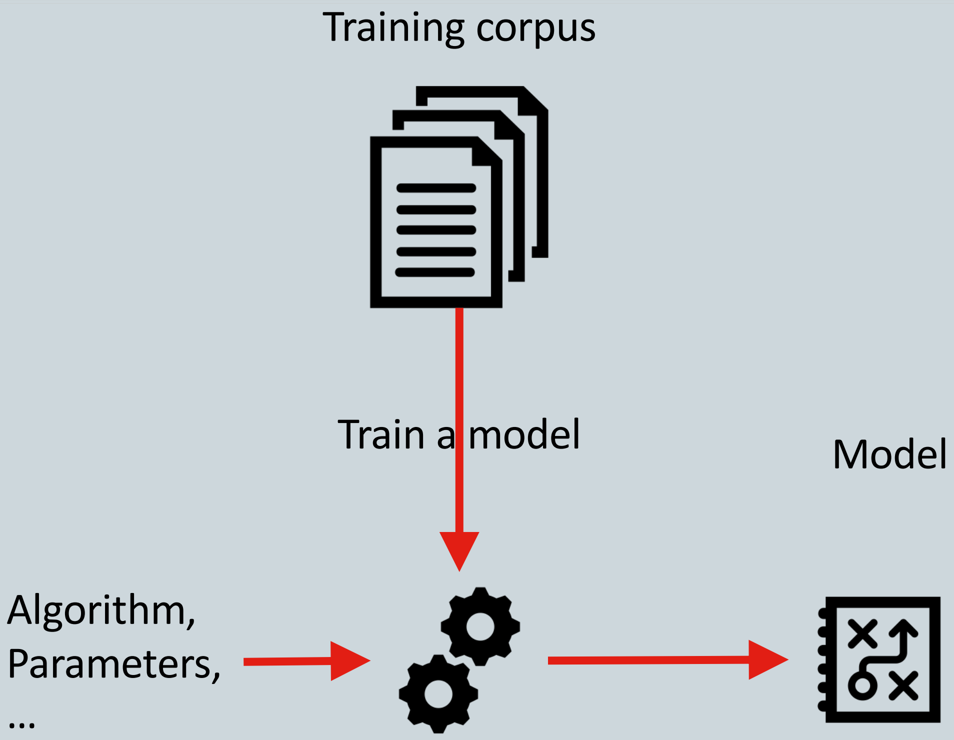
Cost

Efficiency

Performance?

Testing and evaluating

How good is the model?



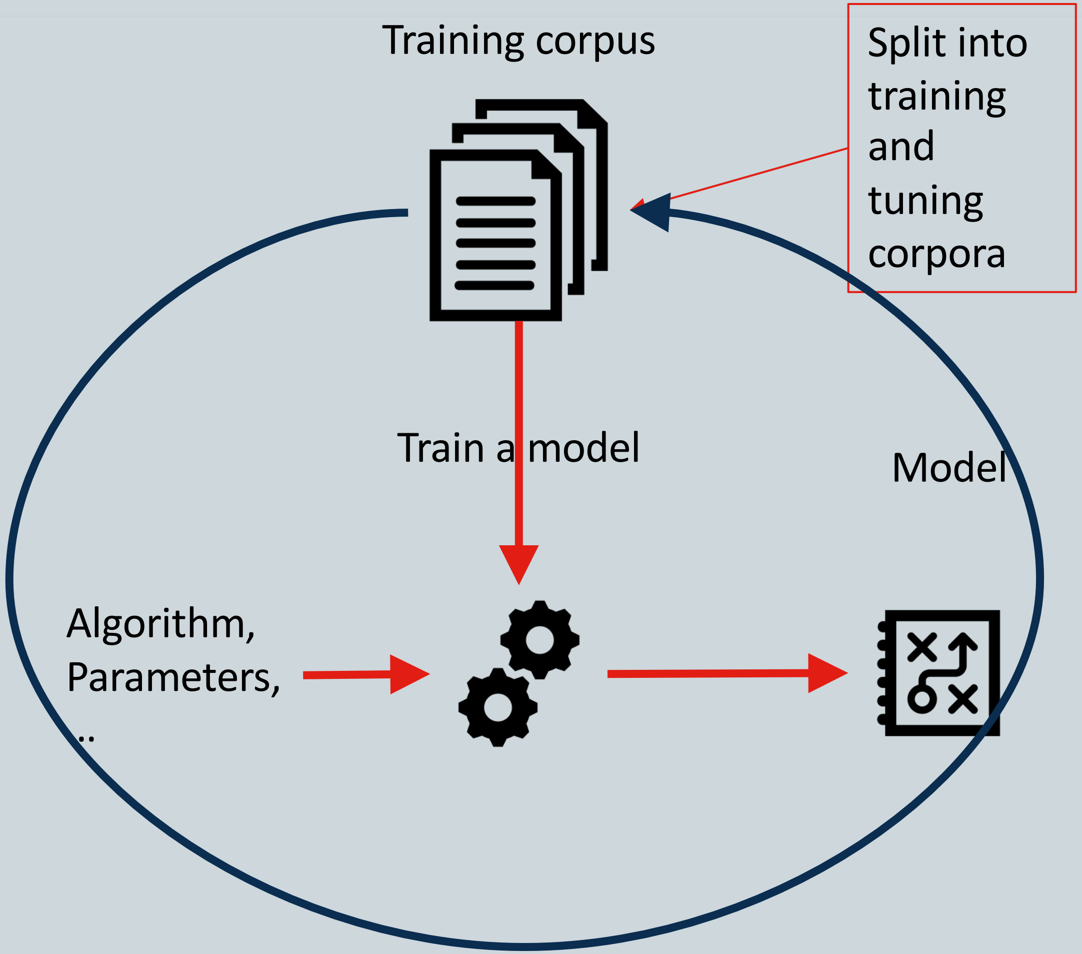
Training corpus

Train a model

Model

Algorithm,
Parameters,
…

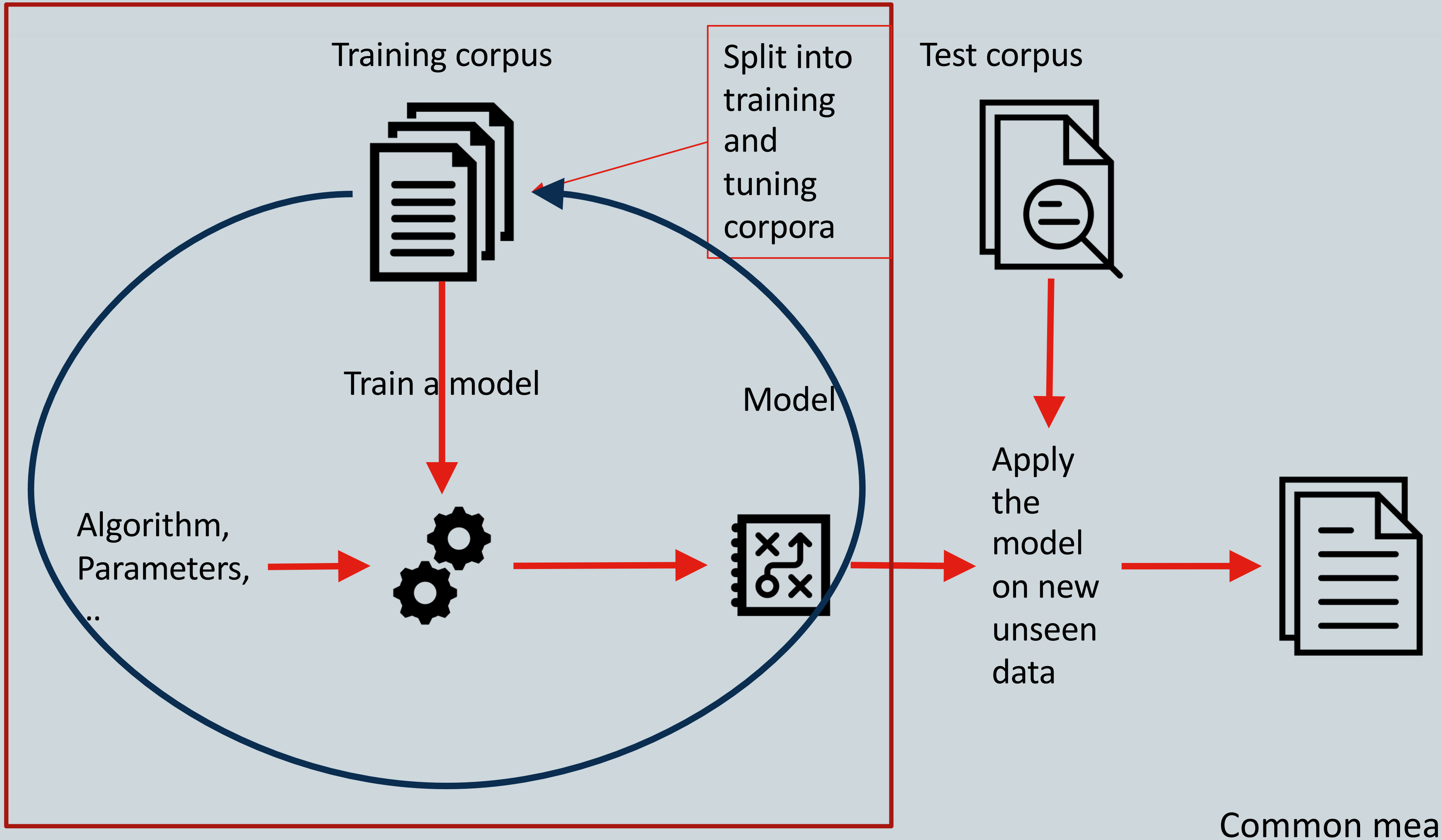
How good is the model?



Common measures:

- Precision, P == positive predictive value
- Recall, R == sensitivity
- F1, the harmonic mean of P and R

How good is the model?



Training corpus

Split into training and tuning corpora

Test corpus

Train a model

Model

Algorithm, Parameters, ..

Apply the model on new unseen data

Common measures:

- Precision, P == positive predictive value
- Recall, R == sensitivity
- F1, the harmonic mean of P and R

Thank you

angus.roberts@kcl.ac.uk

https://www.kcl.ac.uk/people/angus-roberts