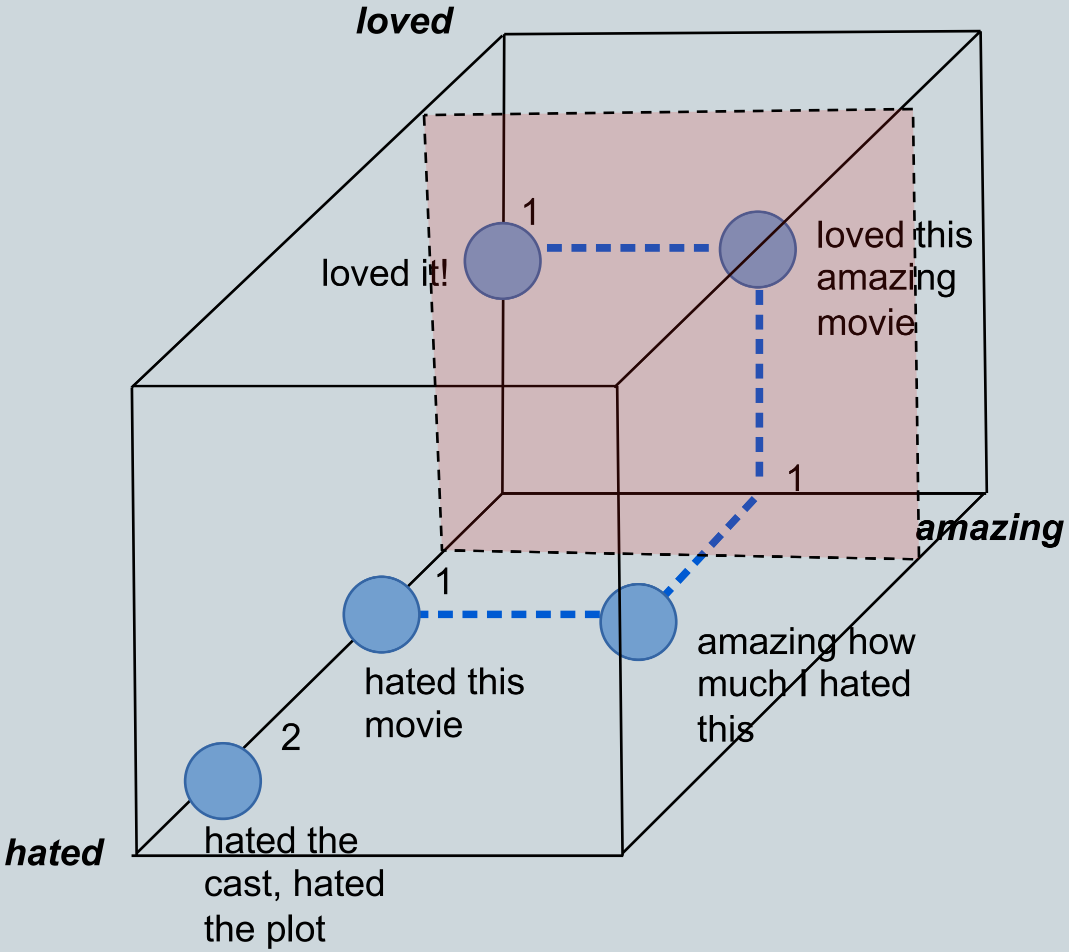
Supervised machine learning for text classification

KING'S College LONDON

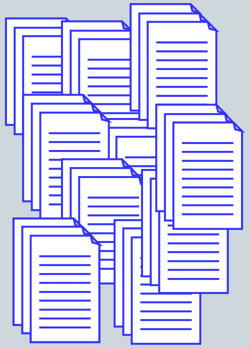
NIHR | Maudsley Biomedical Research Centre

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

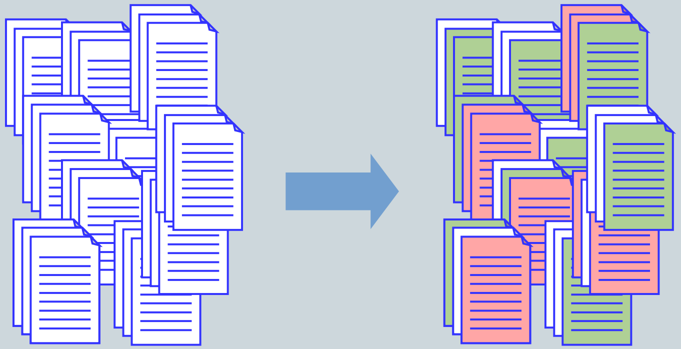


Supervised classification



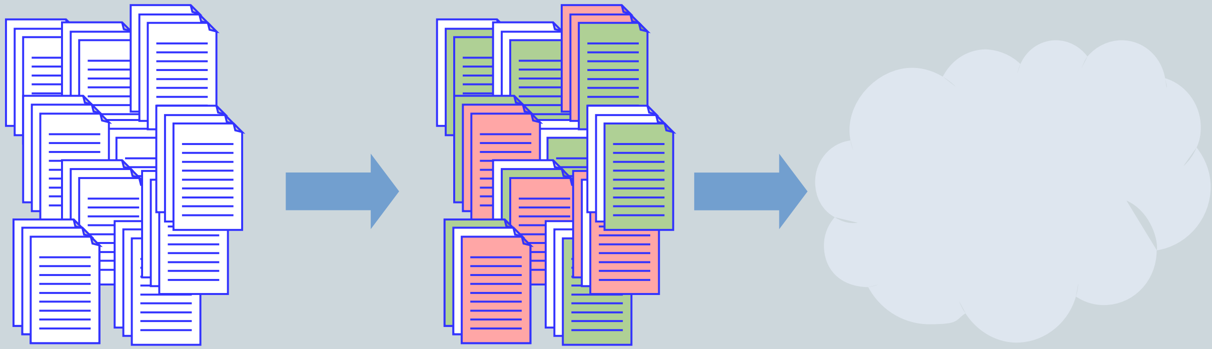
- Take a set of example texts.
- They might be sentences, whole documents, single words, or some other portion of text.
- This is our training corpus.

Supervised classification



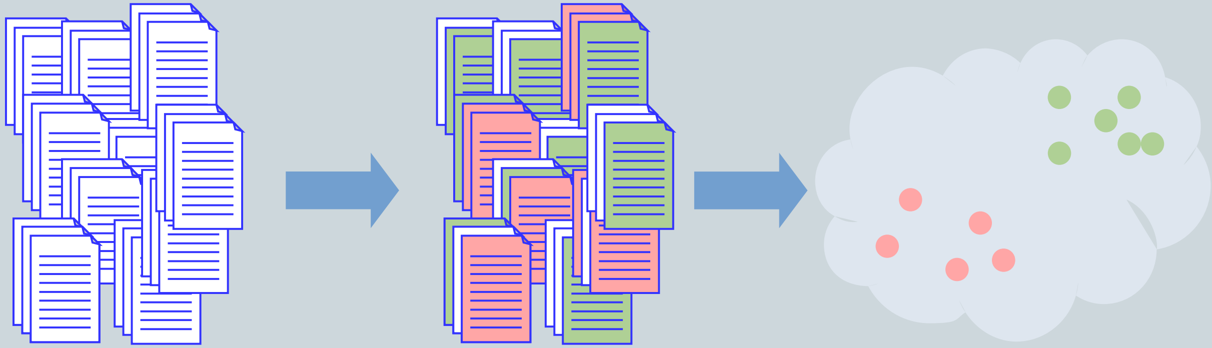
- Label each example, with the classes in our problem.
- Labelling will often be done by human.
- We might be lucky enough to have some existing labelled data, e.g. radiology reports with a code for tumour class attached..

Supervised classification



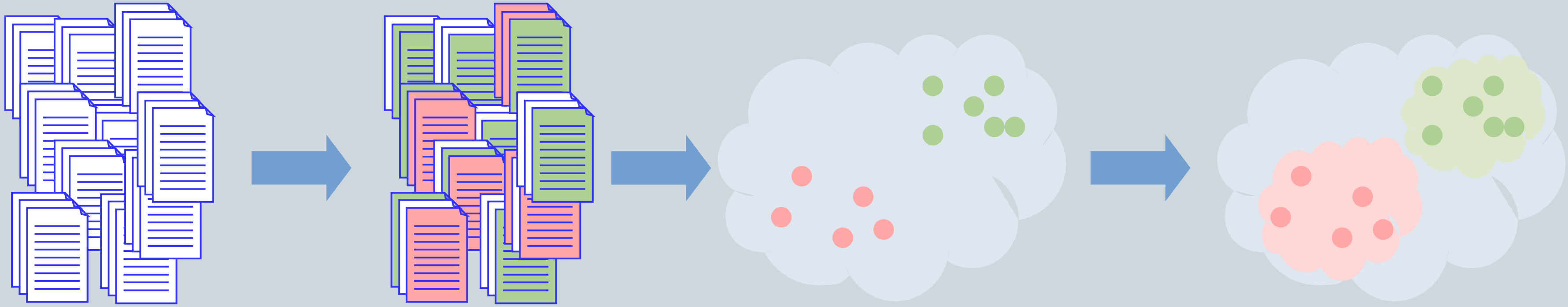
- Select features to represent our texts.
- These might be the presence of words, parts of speech, distances between words, word sequences (ngrams), presence of word groups, sentence lengths, etc.
- We may use numeric representations of words as features, computed in a separate step. In the state of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

Supervised classification



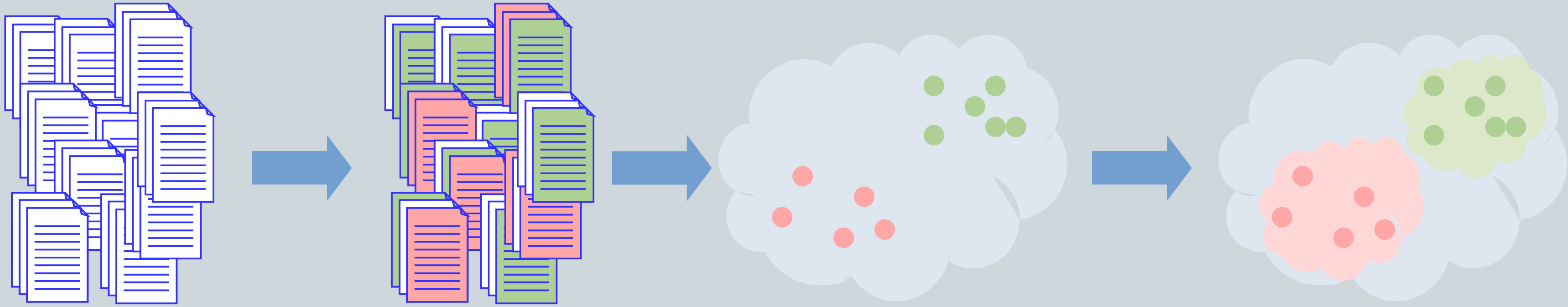
- Represent the texts in this feature space.

Supervised classification



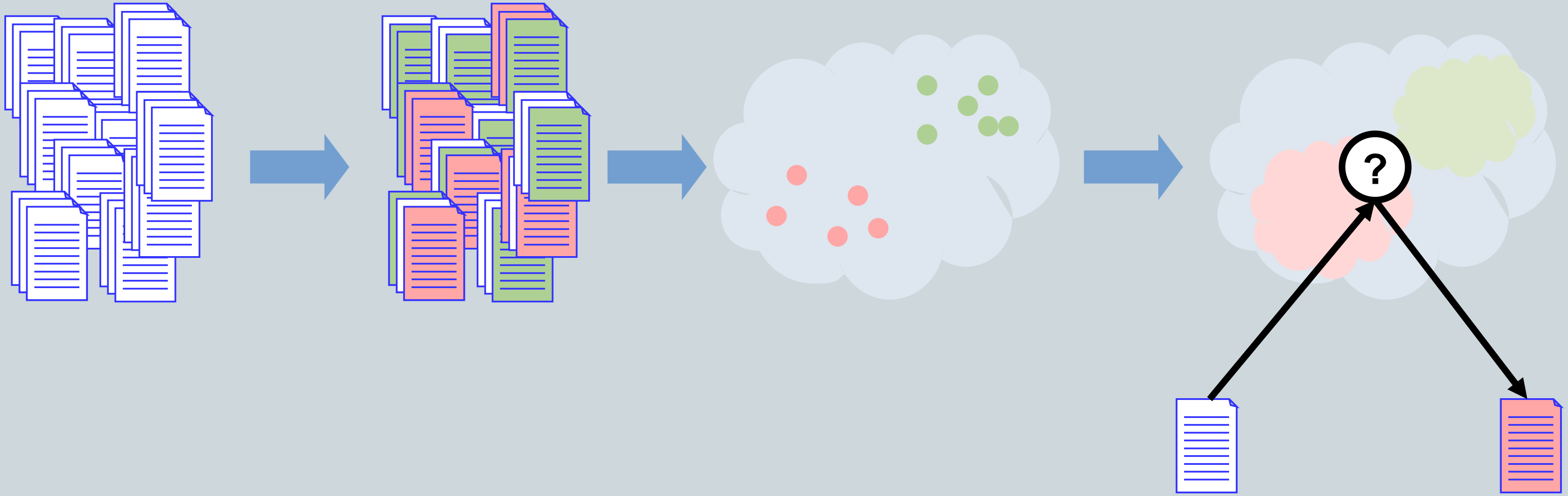
- Compute some separator between classes.
- This will involve measures of distance between points.
- It might also involve methods for projecting multiple dimensions into different spaces in which they are separable (kernels).

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

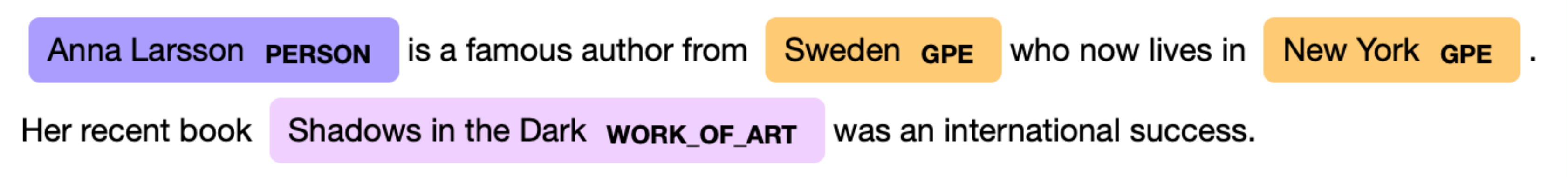


- Classify / label new, previously unseen examples by representing them in the same feature space.

Named entity recognition

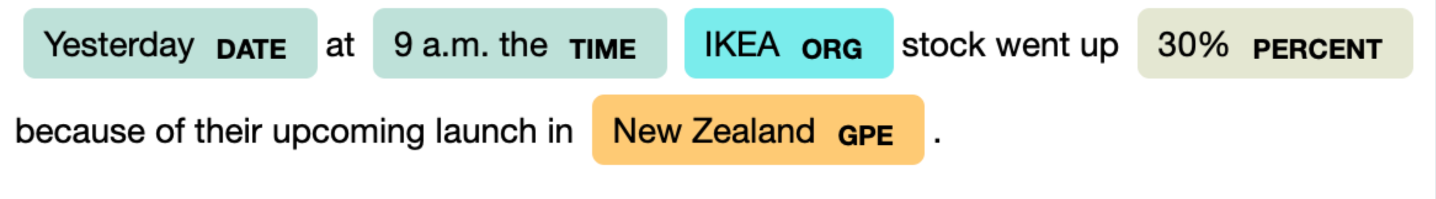
Named Entity Recognition as a classification problem

- 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 .

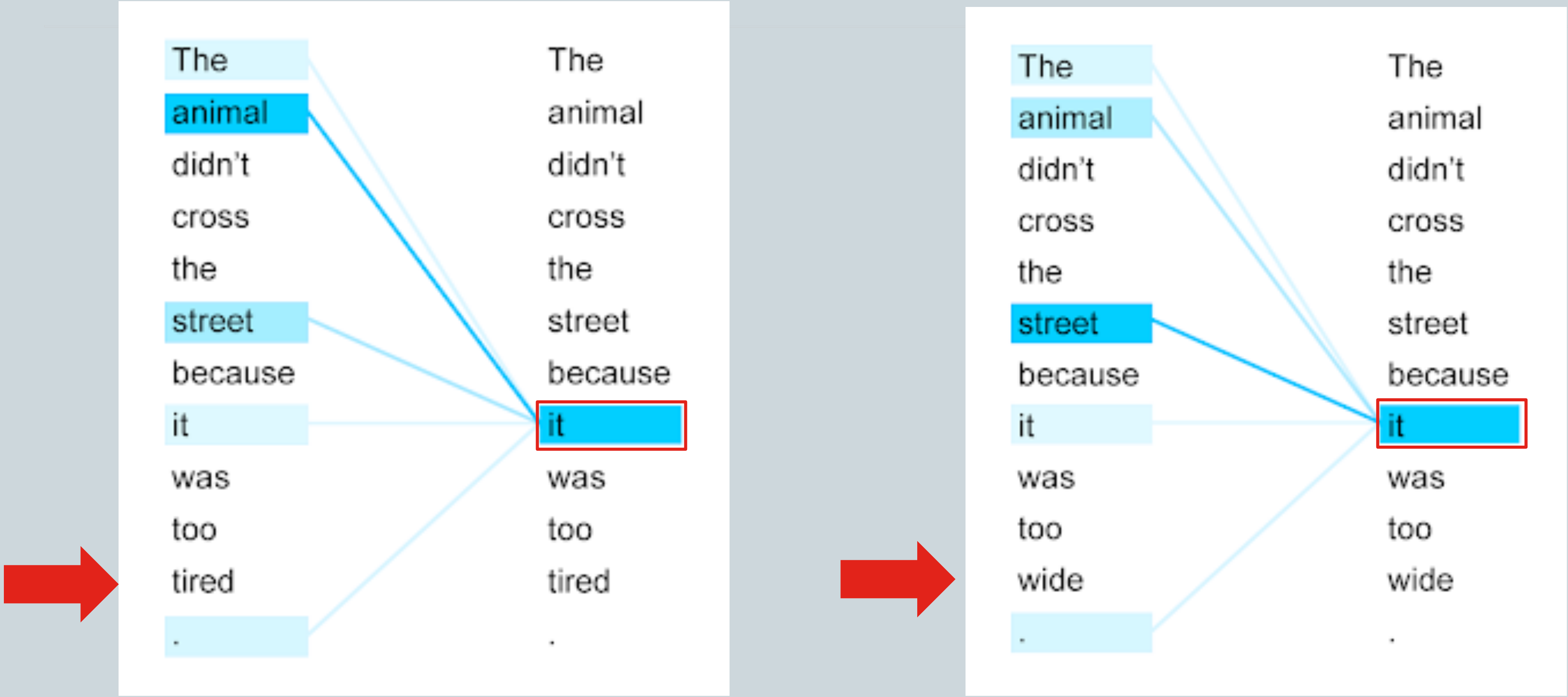
Named Entity Recognition as a classification problem

- 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).

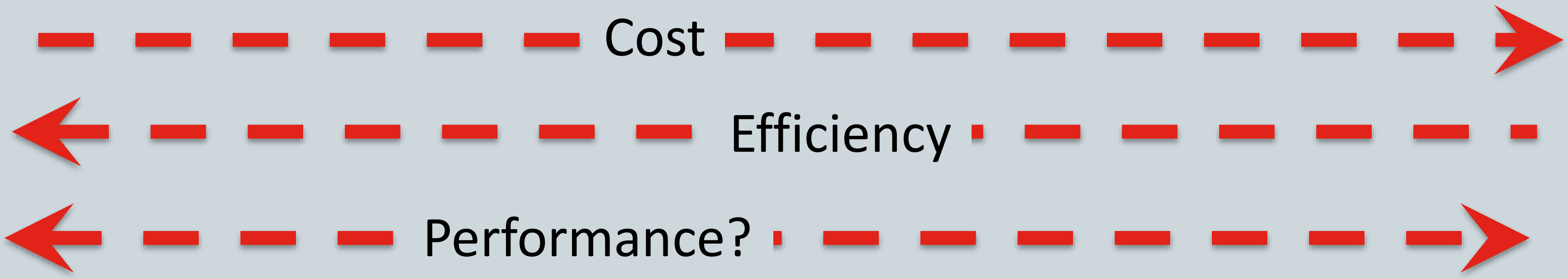
Credit: https://research.google/blog/transformer-a-novel-neural-network-architecture-for-language-understanding/

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

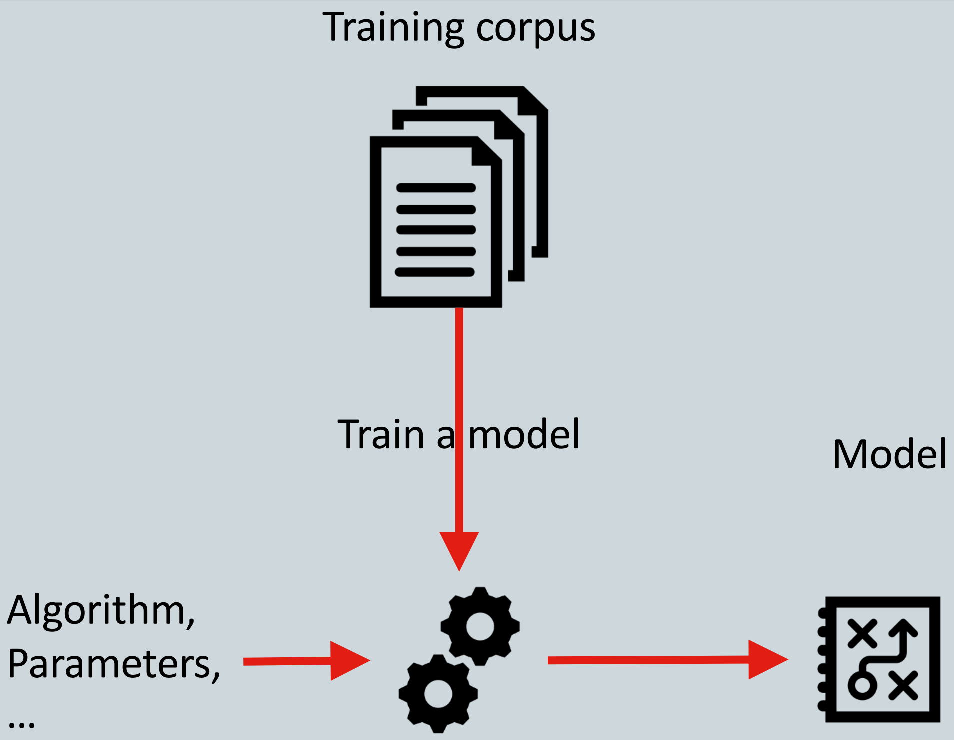
Large Language Models

	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



Testing and evaluating

How good is the model?



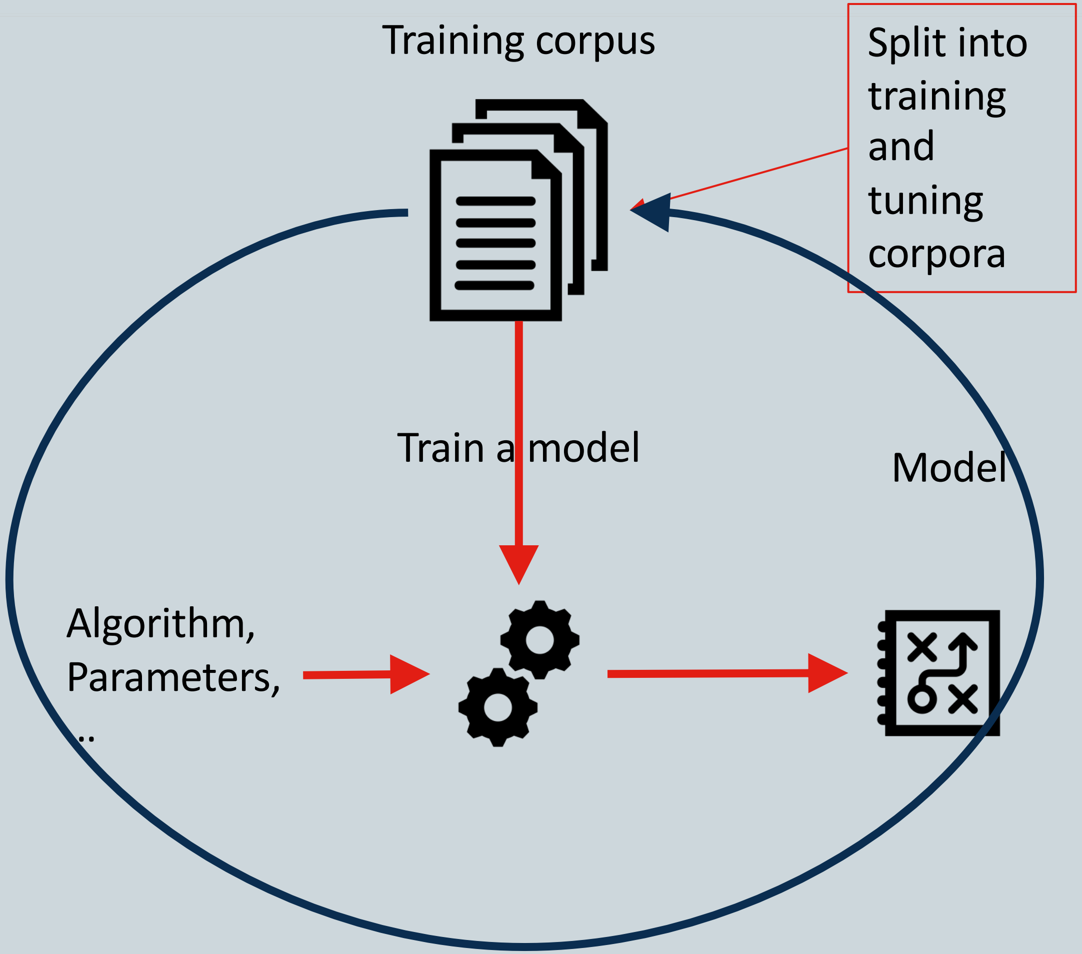
Training corpus

Train a model

Model

Algorithm,
Parameters,
…

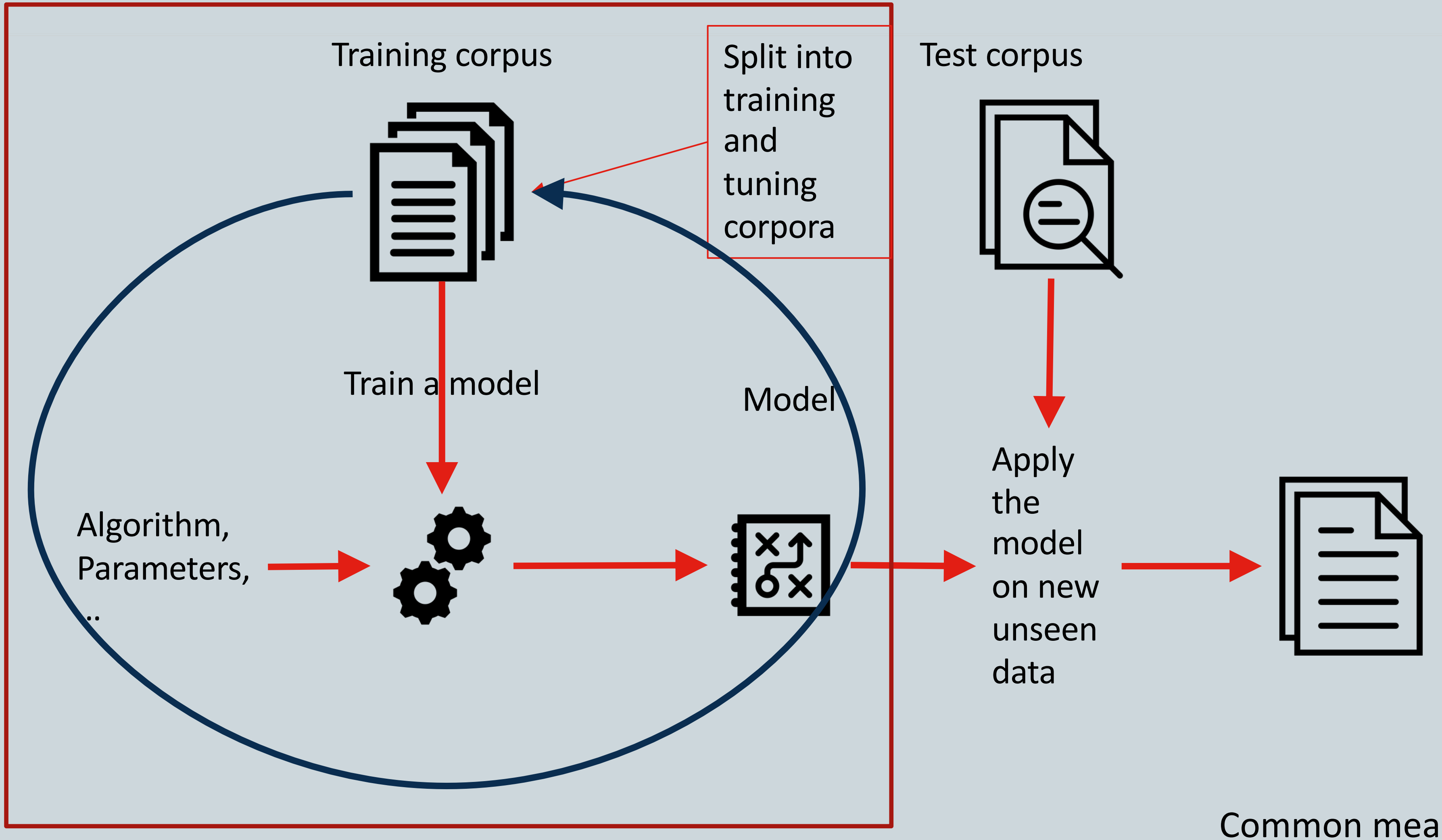
How good is the model?


Training corpus
Split into training and tuning corpora
Train a model
Model
Algorithm, Parameters, ..

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