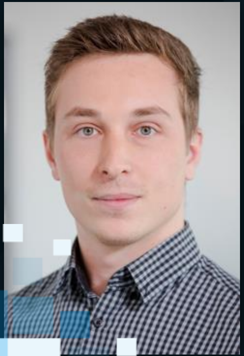
We develop Individual Software &
Artificial Intelligence Solutions



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Our **algorithms** and **solutions** have been **awarded multiple times**

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Literally Recommendable

Using Text Embedding Algorithms in Recommendation Systems

1. **Natural Language Processing (NLP)**
2. Recommendation Systems (RecSys)
3. Hybrid Filtering RecSys powered by word2vec

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1 Natural Language Processing (NLP)

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Big Leaps Forward

How come **machines** have become decent at **understanding humans** recently?

amazon alexa

Hey Siri

Hi. I'm Cortana.

"Ok Google"

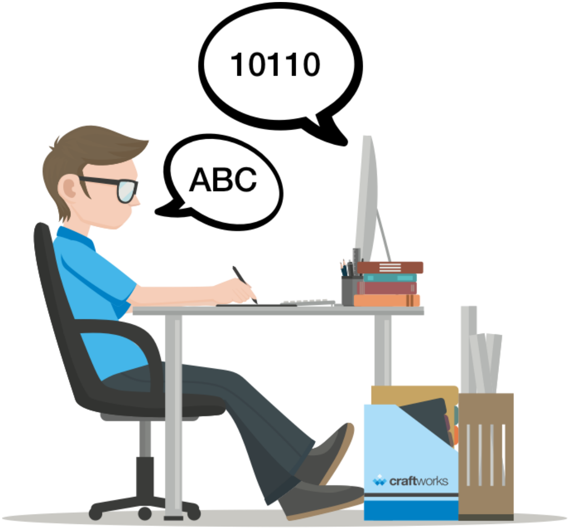
It's Complicated

"Communication is key to a healthy relationship"

… well, it's complicated.

Humans
communicate using
natural languages
(German, English, …)

Nondeterministic



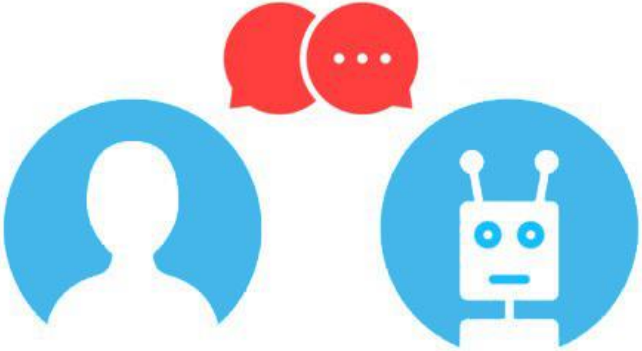
Machines
communicate using
artificial languages
(binary, C++, …)

Deterministic

The Translator

Natural Language Processing is the **translator**.

NLP is a collection of **methods** from **linguistics, statistics** and **computer science** that aims to make *computers “understand” natural language.*



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The Translation Process

Computers excel at **Maths**. So let's turn **text into numbers**:

1. Intelligent humans control machines.
2. Intelligent machines control humans.
3. Be careful with machines.

"Bag of Words"

	be	careful	control	human	intelligent	machine	with
Sentence 1	0	0	1	1	1	1	0
Sentence 2	0	0	1	1	1	1	0
Sentence 3	1	1	0	0	0	1	1

Natural Language is Complex

The **bag of words** method is **ignorant**. For instance, it fails to model:

- word order
- context
- grammar

We lost any information about what truly matters for humans:

The relationship between words/phrases and symbols, constituting *meaning*. **We lack Semantics.**

Company is Key

We need to **preserve semantics** when converting text to a numerical, **machine-readable** form.

HOW?

“You shall know a word by the company it keeps”

J. R. Firth, linguist, 1957

An Old Hypothesis in New Clothes

Distributional Hypothesis:

*Words that appear in **similar contexts** are **similar in meaning**.*

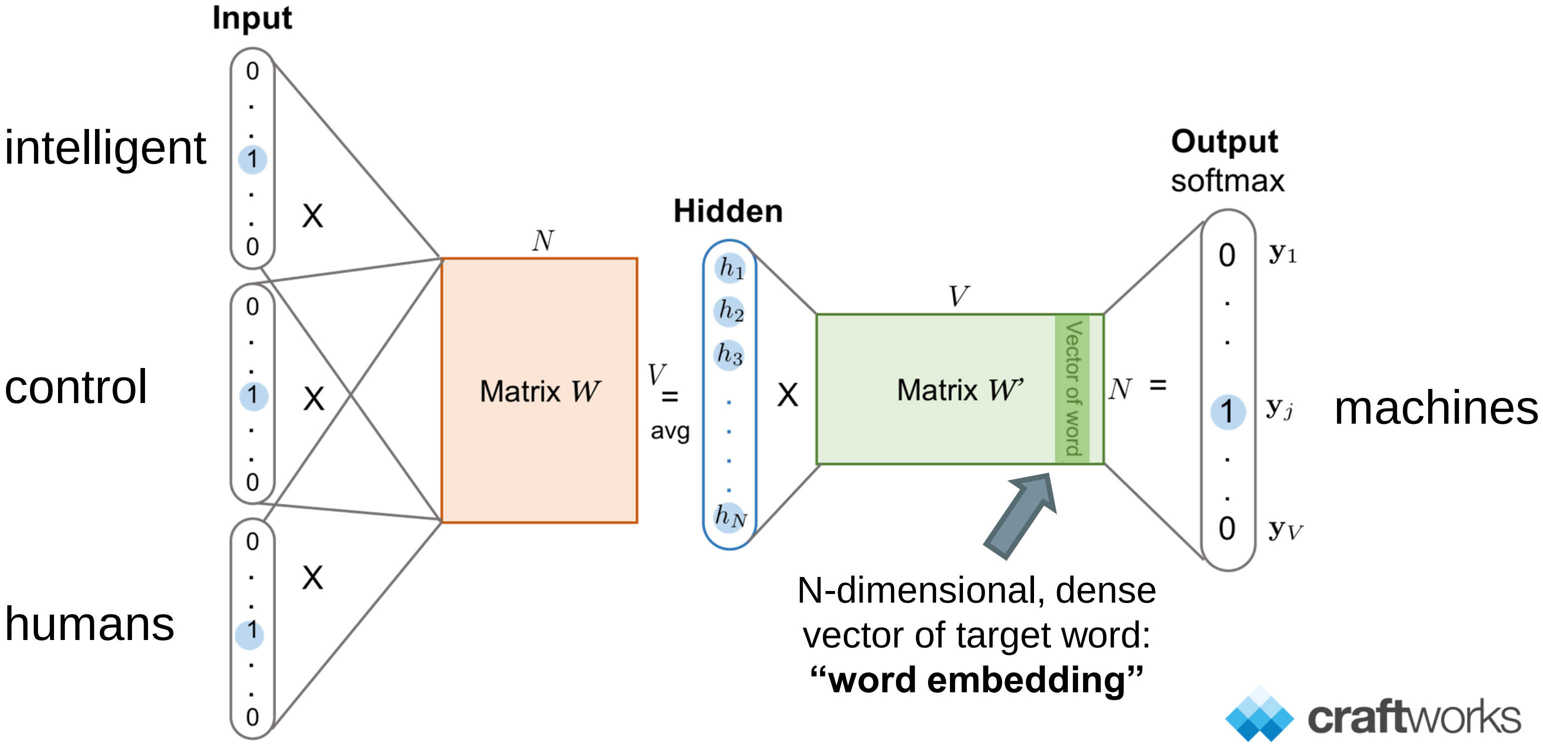
e.g. father ↔ dad

Modern **Text Embedding Algorithms** make use of this idea.

Most notably: **word2vec** by Mikolov et al.

word2vec – CBOW Model in Action

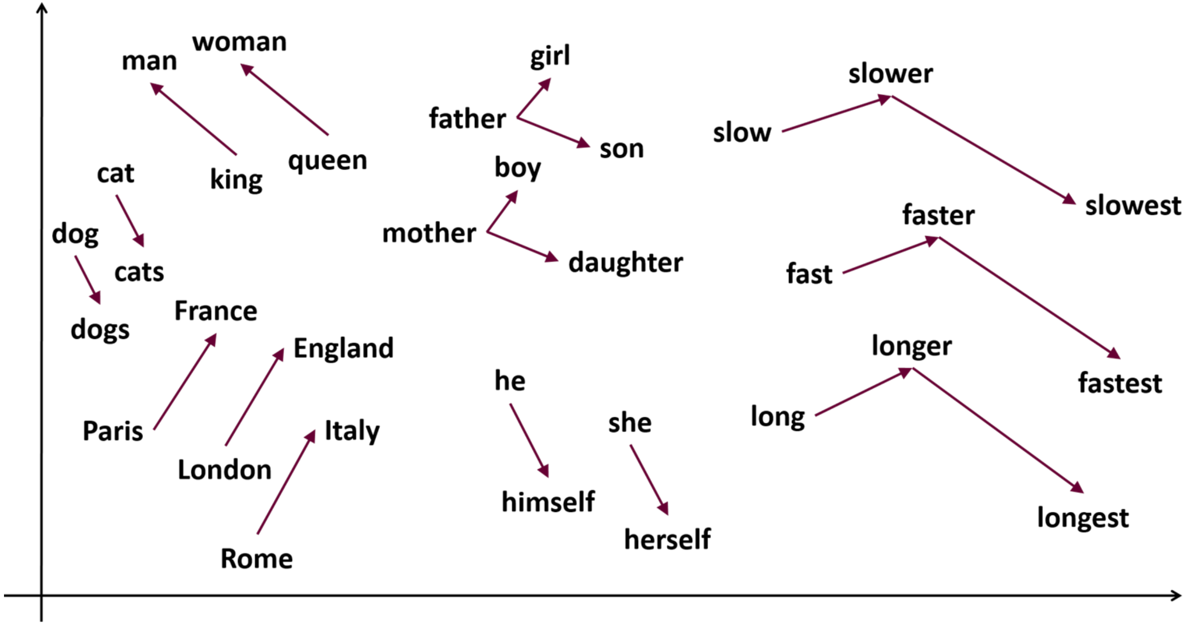
“intelligent machines control humans”



NLP

Semantics in a Nutshell: Dense Vectors

- w2v generates **dense N-dimensional numeric word vectors**
- **similar words ↔ similar vectors** (cosine similarity)



Projection of vectors into 2-dimensional space using t-SNE

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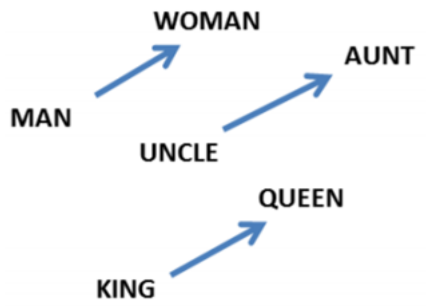
Similarity

Remember:
word2vec is excellent at extracting the **meaning of words.**

similar context → similar meaning → similar vectors



Similarity is not only important when it comes to words ...

RecSys

You are the Average of the Five People you Spend the Most Time with

- **Similarity** also plays a key role in our social relationships

- Typically, our **friends are highly similar** to ourselves and we often **like the same things**

Also **Recommendation Systems** often use **similarity measures** to find out what we like.

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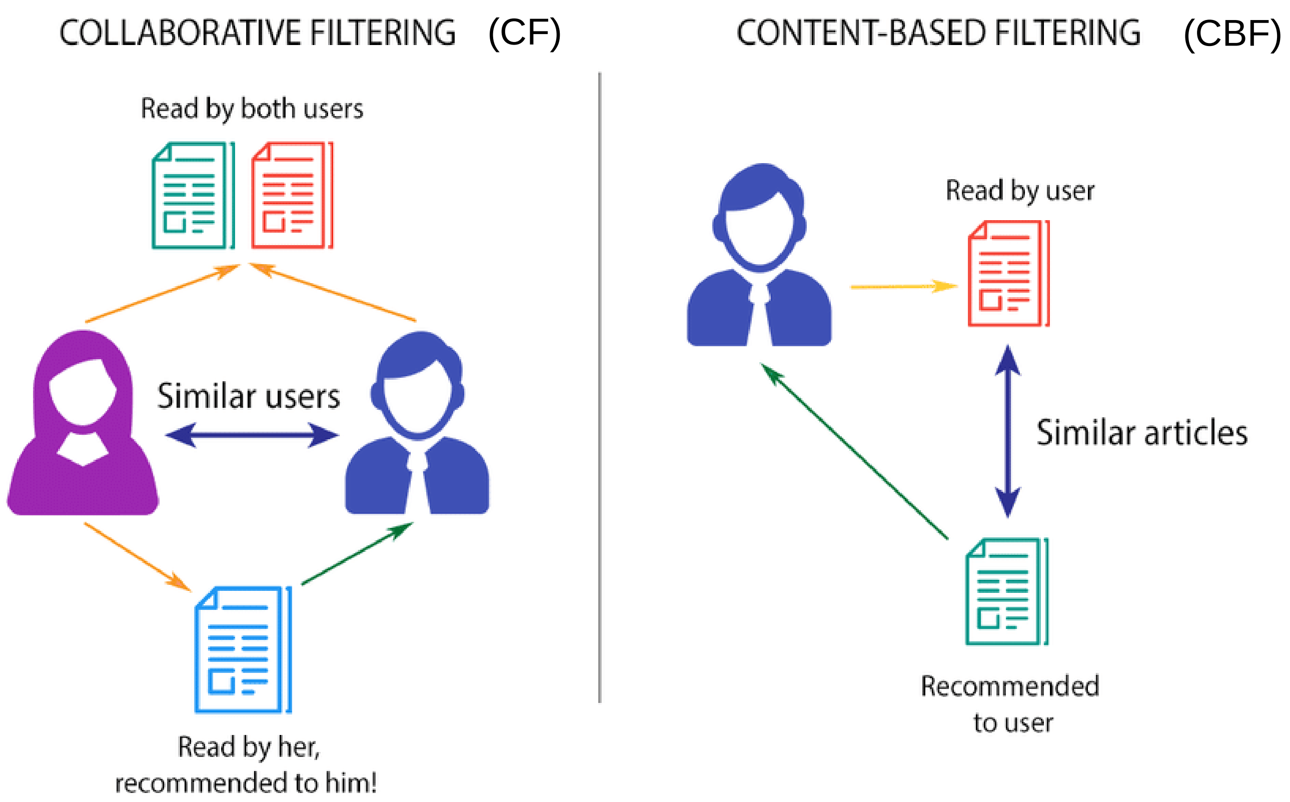
Traditional Filtering Methods in Recommendation Systems



Traditional Filtering Methods have significant Weaknesses

Problems of Collaborative Filtering

- Cold Start problem
- Synonyms
- Gray Sheep

Problems of Content-based Filtering

- Entirely relies on quality of metadata
- “boring” recommendations

Hybrid Filtering

Both Collaborative and Content-based Filtering suffer from **significant weaknesses**.
→ Overcome by **combining both techniques**.

$$f\left(\text{Collaborative Filtering}, \text{Content-based Filtering}\right)$$

$$= \textbf{Hybrid Filtering}$$

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An Enlightening Analogy

“What do **news articles** and **website visitors** have in common?”

Both are **sequences**!

③ Hybrid

A Matter of Perspective

For a website visitor, online news articles are **sequences of words**.

↔

For a news website, visitors are **sequences of articles** they read.

news article = [“intelligent”, “machines”, “control”, “humans”]

↔

news website visitor = [“ArticleID_1”, “ArticleID_2”, “ArticleID_3”]

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Putting it together: word2vec in Hybrid Filtering

For a news website …

- users are sequences of articles

For a news website visitor (user) ...

- articles are sequences of words

users are sequences of sequences of words

User A = [

[“new”, “tensorflow”, “version”, “released”, ...],
[“learn”, “python”, “for”, “machine”, “learning”, ...],
[“next”, “bitcoin”, “hype”, “is”, “coming”, ...]

]

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Putting it together: word2vec in Hybrid Filtering

Training word2vec on our corpus of articles (sequences of words) provides us with N-dimensional **vectors for each word i**.

Aggregation on article level:

$$article\_vector_j = \frac{1}{N} \sum_{i \in K=1}^{N} word\_vector_i$$

Aggregation on user level:

$$user\_vector_c = \frac{1}{N} \sum_{j \in P=1}^{N} article\_vector_j$$

Practical Example

You can find the Jupyter Notebook on the craftworks github account:

https://github.com/craftworksgmbh/wad

3 Hybrid

Putting it together: word2vec in Hybrid Filtering

What do we get from this?

- Mapping of items and users into **shared vector space** brings flexibility

- Computation of similarities and making **recommendations**:
  - User-to-User
  - Item-to-Item
  - Item-to-User

- **Overcoming problems** of traditional methods

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Text Embedding Algorithms in Hybrid Filtering are powerful

Problems of Collaborative Filtering

- Cold Start problem
- Synonyms
- Gray Sheep

Solved!

Problems of Content-based Filtering

- Entirely relies on quality of metadata
- “boring” recommendations

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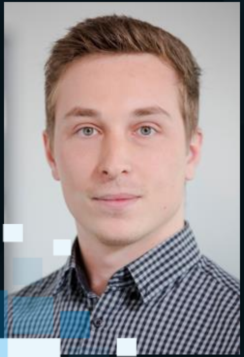

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