

```

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),r={state:function(){return n},always:
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),n[t].disable},t[2][0].disable,t[2][1].disa
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block;font-size:inherit;font-weight:normal;lin

```

# ACCIDENT PREVENTION WITH THE HELP OF DEEP LEARNING LANGUAGE MODELS

DR. ANDREAS STÖCKL





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There are many actions that can be taken to prevent **accidents** or reduce their consequences, including regulations such as mandatory helmet use as well as investments in infrastructure or training activities.

**Accident descriptions** (narratives), explicit or within medical anamneses, hold useful information as to which actions could have prevented a particular case and should therefore be promoted.



**Accident location:** Other living area outside

**Injury type:** Tendon and muscle injuries

**Affected body part:** Foot

**Accident sequence:** fallen while cleaning the gutter of an extendable aluminum ladder, torn Achilles tendon + bruised left foot with surgery

A human expert would suggest the following preventive and protective actions here, for example:

1. Set up the ladder on level, non-slip and safe ground!
2. wear suitable, sturdy footwear when using the ladder!
3. do not lean out when working on ladders!

The aim of this study is to develop an **automated procedure** for deriving preventive actions from accident descriptions with the help of machine learning.



This could then be applied to **large amounts of data** and quantitative statements be made about which interventions have which impact on accident prevention.

## HOW DOES A LANGUAGE MODEL PROCESS TEXT?

---

Split into parts – „Tokenization“

Acci | dent | loca | tion | : | Other | liv | ing | area | out | side |

In | jury | type | : | Ten | don | and | muscle | in | juries |

Affec | ted | body | part | : | Foot |

Acci | dent | sequ | ence | : | fal | len | while | clean | ing | the | gut | ter | of |  
an | exten | dable | alu | minum | ladder | , | torn | Ach | illes | ten | don | + |  
bru | ised | left | foot | with | sur | gery

## HOW DOES A LANGUAGE MODEL PROCESS TEXT?

Replace strings with numbers from table - “Dictionary“

56 | 47 | 13 | 564 | 973 | 111 | 433 | 22 | 234 | 935 | 235 |

121 | 333 | 4567 | 564 | 8565 | 2357 | 12 | 9846 | 121 | 2567 |

3322 | 654 | 123 | 866 | 564 | 123 |

56 | 47 | 678 | 235 | 564 | 999 | 1567 | 345 | 19 | 22 | 12 | 234 | 87 | 41 | 87 |  
34 | 768 | 34 | 345 | 233 | 34 | 765 | 23 | 23 | 344 | 766 | 1245 | 85 | 865 | 56 |  
900 | 403 | 203 | 568

# HOW DOES THE AI SYSTEM GENERATE THE REST OF THE TEXT?

Number by number is generated

56 | 47 | 13 | 564 | 973 | 111 | 433 | 22 | 234 | 935 | 235 |

121 | 333 | 4567 | 564 | 8565 | 2357 | 12 | 9846 | 121 | 2567 |

3322 | 654 | 123 | 866 | 564 | 123 |

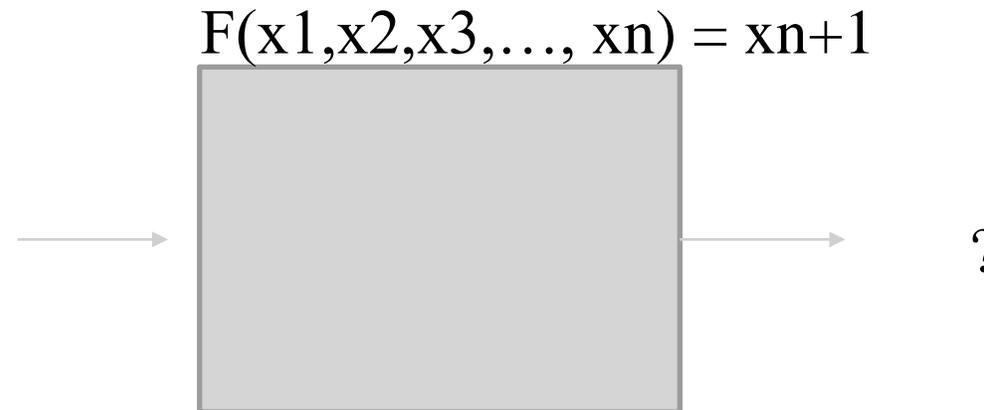
56 | 47 | 678 | 235 | 564 | 999 | 1567 | 345 | 19 | 22 | 12 | 234 | 87 | 41 | 87 |  
34 | 768 | 34 | 345 | 233 | 34 | 765 | 23 | 23 | 344 | 766 | 1245 | 85 | 865 | 56 |  
900 | 403 | 203 | 568

??

# HOW DOES THE AI SYSTEM GENERATE THE REST OF THE TEXT?

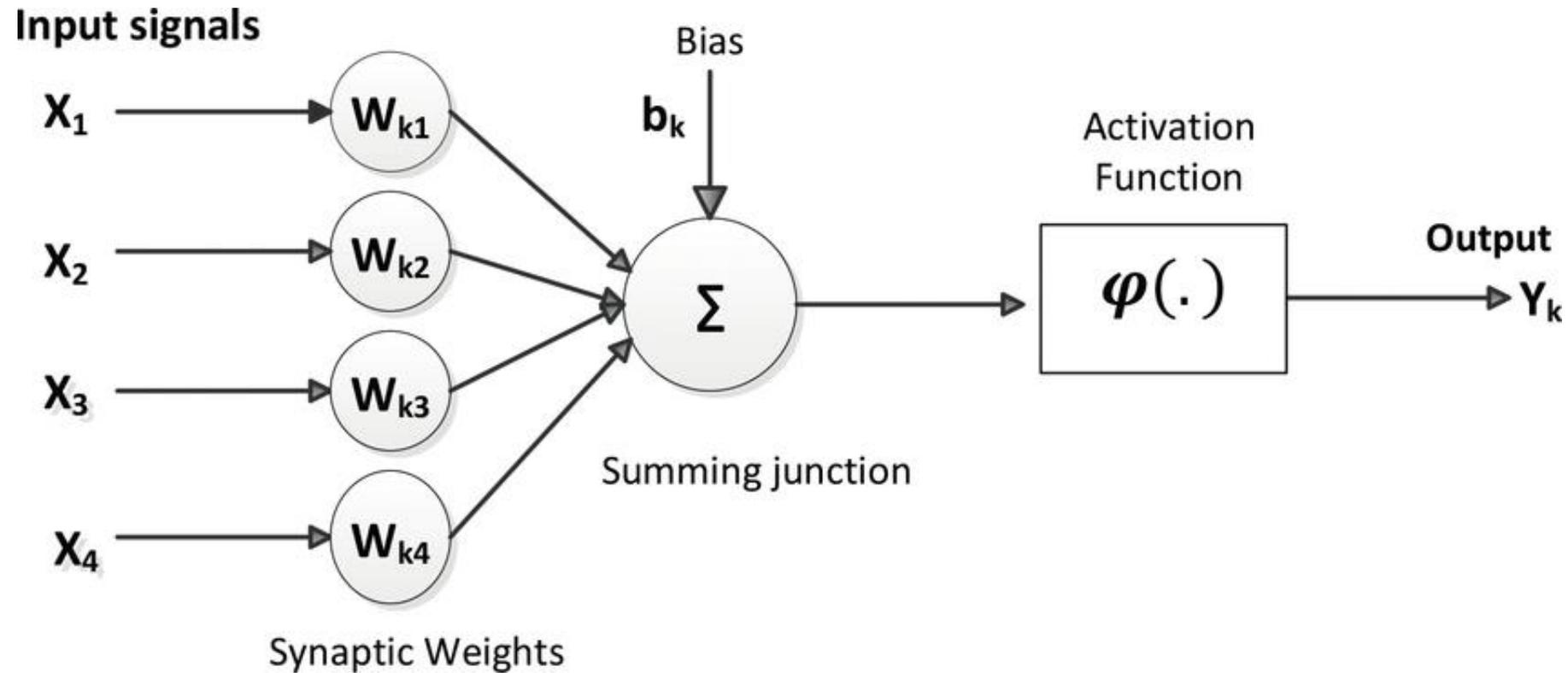
A formula calculates the following from the given numbers.

37 58 117 67  
314 211 44 58  
88 134 49 39  
37 58 314 348  
786 578 234  
348 37 99 176  
222 439 632  
498 333 11 99  
357 219 99 731  
551 99 49 472  
118 898 439



## HOW IS THIS CALCULATION FUNCTION STRUCTURED?

Simple arithmetic operations such as addition, multiplication, etc. are carried out in large numbers interlinked with each other, yielding the new number.



- The rules for calculating the next word are contained in the so-called "**weights**", which are also called **parameters**.

- By setting these numbers, the result of the calculation is influenced.

Is it possible to express such complex tasks as writing a story?

- For any source text!

**MANY PARAMETERS ARE NEEDED!**

---

In our model there were 175 billion parameters

That's what the AI system is all about!

Very calculation-intensive!

Setting the values by experts is not feasible.

The system is "trained" with the help of data.

This process is called "machine learning".

# TEXTS IS REPRESENTED BY A LARGE AMOUNT OF NUMBERS

„Hello“

```
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```

# CAN YOU CALCULATE WITH WORDS?

---

This requires a different presentation with numbers!



**King – Man + Woman = Queen**

Game Changer was a result of Google Research from 2013:

## **Efficient Estimation of Word Representations in Vector Space**

Tomas Mikolov, Kai Chen, Greg Corrado, Jeffrey Dean

## HOW DO YOU FIND THESE NUMBERS?

---

By solving simple tasks! "Word guessing"

Tasks like the following are solved by software ("neural networks").

Example:

**The EU Safety 2022 Conference's .... is "Safety in a digitalized and fast-changing world".**

## HOW DO YOU FIND THESE NUMBERS?

---

By solving simple tasks! "Word guessing"

Tasks like the following are solved by software ("neural networks").

Example:

**The EU Safety 2022 Conference's motto is "Safety in a digitalized and fast-changing world".**

# WORDS CHANGE THEIR MEANING DEPENDING ON THE CONTEXT



Ass



Ass



Ass

# THE NUMBERS ADAPT TO THE CONTEXT

---

An essential step towards solving the "context problem" was again a work from Google



2018:

## **BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding**

Jacob Devlin, Ming-Wei Chang, Kenton Lee, Kristina Toutanova

In 2020, "OpenAI" has further developed language understanding through giant models with the "GPT-3" model.



2020:

## Language Models are Few-Shot Learners

Tom B. Brown, Benjamin Mann, Nick Ryder, Melanie Subbiah, Jared Kaplan, Prafulla Dhariwal, Arvind Neelakantan, Pranav Shyam, Girish Sastry, Amanda Askell, Sandhini Agarwal, Ariel Herbert-Voss, Gretchen Krueger, Tom Henighan, Rewon Child, Aditya Ramesh, Daniel M. Ziegler, Jeffrey Wu, Clemens Winter, Christopher Hesse, Mark Chen, Eric Sigler, Mateusz Litwin, Scott Gray, Benjamin Chess, Jack Clark, Christopher Berner, Sam McCandlish, Alec Radford, Ilya Sutskever, Dario Amodei

We have adapted (“**fine tuned**”) this model to our problem for the derivation of protection and prevention actions and developed a software application.



**Daten**

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## Schutz und Präventionsmaßnahmen

Beschreiben Sie den Kontext und den Unfallhergang. Das AI Modell wird dann Schutz und Präventionsmaßnahmen vorschlagen.

Unfallort

Sporthalle oder überdachte Sportstätte

Sportart

Turnen - Trampolin/Minitrampolin

Unfallhergang

gestern im trampolinpark auf den daumen rechts gestürzt, fraktur

Verletzungsart

Knochenbruch

Betroffene Körperteile

Finger

Verwendeter Schutz

Handschuhe

Empfohlene Präventions- und Schutzmaßnahmen:

1. Tragen Sie Handschuhe, wenn Sie an Gymnastik oder anderen Aktivitäten teilnehmen, bei denen die Gefahr eines Sturzes besteht.
2. Überprüfen Sie die Ausrüstung regelmäßig, um sicherzustellen, dass sie in gutem Zustand und sicher zu benutzen ist.
3. Achten Sie auf Ihre Umgebung und seien Sie vorsichtig, wenn Sie an Aktivitäten teilnehmen.
4. Befolge alle Sicherheitsanweisungen und -regeln, wenn du an einer Aktivität teilnimmst.

## CHALLENGE

---

### Special language

A particular challenge here was the language used, which describes the facts in **keyword-like** terms and with many **abbreviations**, and thus represents an additional hurdle for a language model.

Example:

pat. fuhr im tiefschnee abseits der piste und wollte ueber einen abhang springen, verschaetzte sich aber mit hoehe und stuerzte --> re. elle gebrochen + re. ellbogen lux.; erstvers. + op im kh ze

## EXAMPLE RESULTS

---

Translated from German – with DeepL.com

**Accident location:** pavement, pavement

**Type of sport:** none

**Injury type:** Broken bone

**Protection:** none

**Part of the body affected:** Wrist

**Accident sequence:**

slipped on rolled chippings while walking on pavement

## EXAMPLE RESULTS - RESPONSE

---

Translated from German – with DeepL.com

### **Suggested prevention and protection measures:**

- Avoid walking on loose or uneven surfaces.
- Look ahead when walking and watch out for possible hazards.
- Wear shoes with good traction to avoid slipping.
- Be careful when walking near construction sites or other areas where there may be loose debris.
- If you have to walk on a loose or uneven surface, take your time and be careful.

## MORE EXAMPLES - SPORTS

---

Translated from German – with DeepL.com

**Accident location:** Roadway

**Type of sport:** Cycling - recreational cycling

**Type of injury:** Broken bone

**Protection:** none

**Part of the body affected:** Ribs and sternum

**Accident sequence:**

cycling too fast into a hole in the road and falling over

## MORE EXAMPLES - RESPONSE

---

Translated from German – with DeepL.com

### **Suggested prevention and protection measures:**

- Wear a helmet when cycling.
- Be aware of your surroundings and ride at a safe speed.
- Watch out for obstacles on the road.

## MORE EXAMPLES - LEISURE

---

Translated from German – with DeepL.com

**Accident location:** Indoor stairs

**Type of sport:** None

**Type of injury:** Tendon and muscle injuries

**Protection:** None

**Part of the body affected:** Knee

**Course of accident:**

Tripped and fell while climbing a staircase

## MORE EXAMPLES - RESPONSE

---

Translated from German – with DeepL.com

### **Suggested prevention and protection measures:**

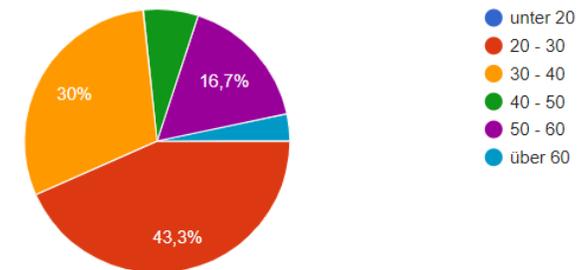
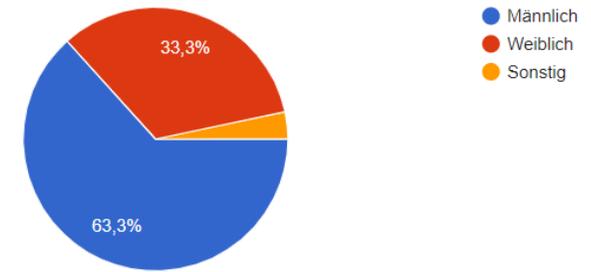
- Use handrails when climbing stairs.
- Wear shoes with good traction to avoid slipping.
- Be careful when climbing stairs, especially if they are slippery or uneven.

Setup

## Can humans distinguish the suggestions generated by the software from those written by experts?

For this purpose, 10 examples of suggestions were generated with the system and mixed with 10 texts written by humans. These 20 texts were then presented to 30 human evaluators, who each had to decide whether the text was written by humans or the AI.

In total 600 decisions.

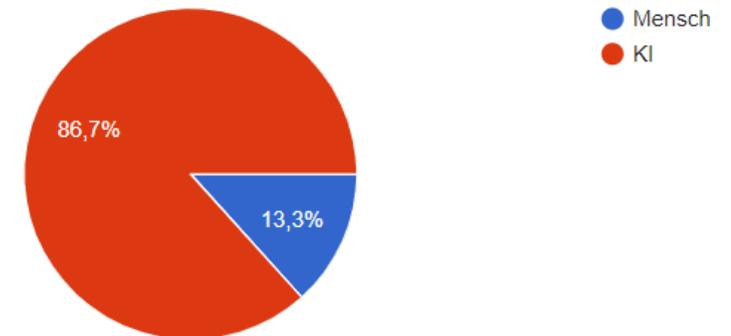
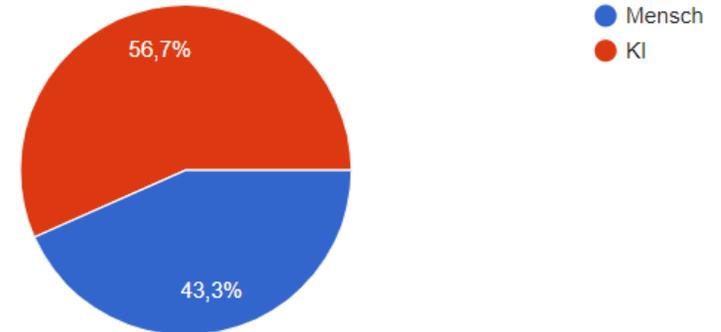


## Results

Of the total of 600 assignments made, just under **62% were correct**, and thus only slightly better than a random assignment, which would have yielded about 50%.

**No single example was correctly assigned** by all test persons, but some were predominantly recognized. For example, one example was correctly assigned to the AI by 26 people out of 30.

Let's take a closer look at this example:



Results

**Accident site:** Construction site

**Type of sport:** None

**Type of injury:** Tendon and muscle injuries

**Protection:** Other protective equipment for DIY, nb

**Part of the body affected:** Knee

**Accident sequence:**

wanted to jump from excavator (approx. 60cm), injured on impact with gravel surface

Results

## Suggested prevention and protection measures:

- Use proper safety equipment when working on or near construction sites.
- Be aware of your surroundings and possible hazards.
- Follow all safety rules and regulations.
- **Avoid working on or near construction sites if possible.**

### Results

In interviews with the testers, it turned out that quite a few of them had developed the theory that **long detailed actions came from the AI** rather than from humans. And this theory was used to identify the examples.

This is indeed in line with the data and helped to identify a little more than half correctly on average.

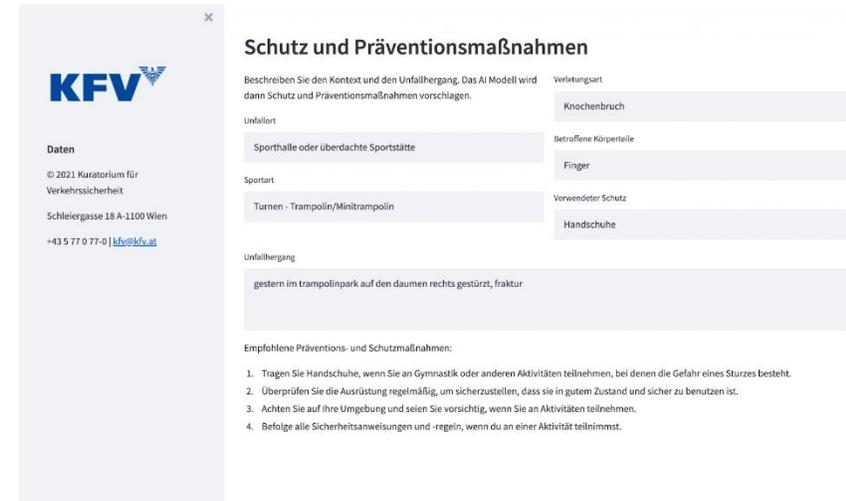
But this says nothing about the quality of the computer-generated ones; on the contrary, **the testers often found the AI answers to be qualitatively superior.**

## Results

The results of the evaluation shows that the results produced by humans can **hardly be distinguished** from those produced by experts.

This means that the AI system can be used to derive actions.

To do this, **large numbers of accident reports** must be evaluated with the procedure and then statistically analyzed.



**KfV**

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Unfallort	Sporthalle oder überdachte Sportstätte	Verletzungsart	Knochenbruch
Sportart	Turnen - Trampolin/Minitrampolin	Betroffene Körperteile	Finger
		Verwendeter Schutz	Handschuhe

Unfallhergang

gestern im trampolinpark auf den daumen rechts gestürzt, fraktur

Empfohlene Präventions- und Schutzmaßnahmen:

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4. Befolge alle Sicherheitsanweisungen und -regeln, wenn du an einer Aktivität teilnimmst.

**Thank you for your attention!**

**Questions?**