The impact of human message ambiguity on the efficiency of collaborative robotics frameworks

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The Problem

Ambiguity refers to the quality of being open to multiple interpretations or meanings.

Ambiguity can arise in situations or contexts where a lack of clarity or precise information creates confusion about what is being conveyed or understood.

The Problem

I saw someone on the hill with a telescope

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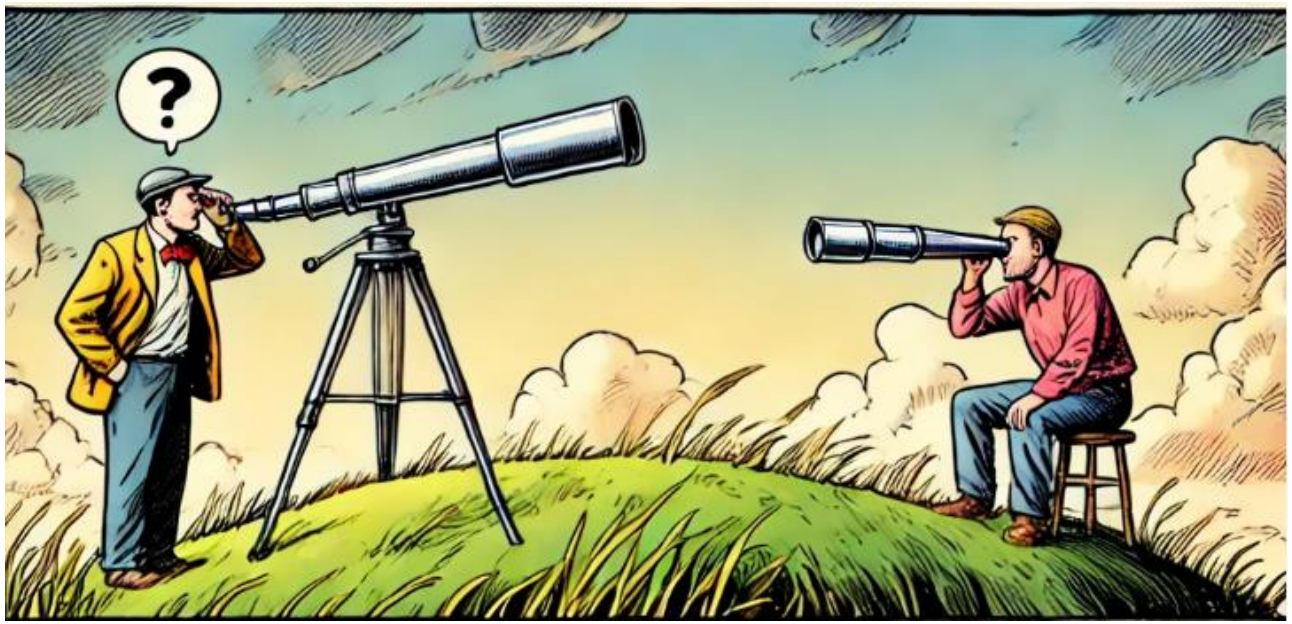
The Problem



I saw someone on the hill with a telescope

The Problem

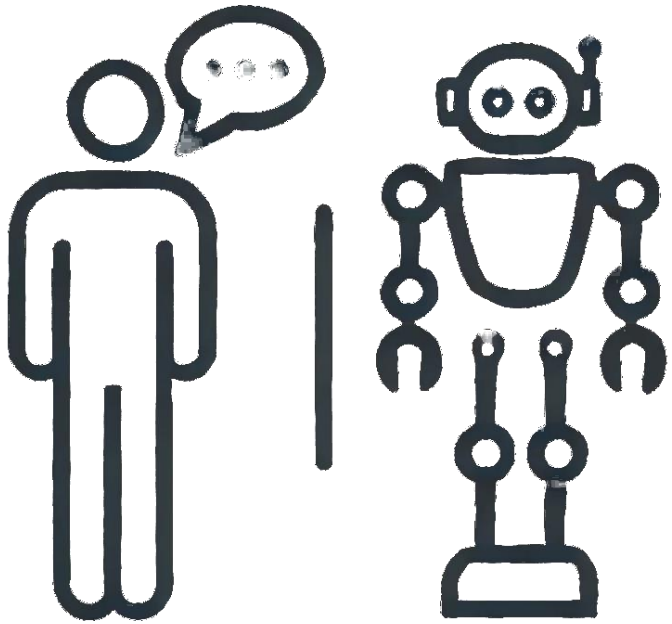
The Problem

Ambiguity means that the meaning of a message is

- unclear
- Vague
- open to interpretation

Ambiguity can lead to

- confusion
- misunderstanding
- conflict
- missed opportunities



The Context

Circular TwAIn

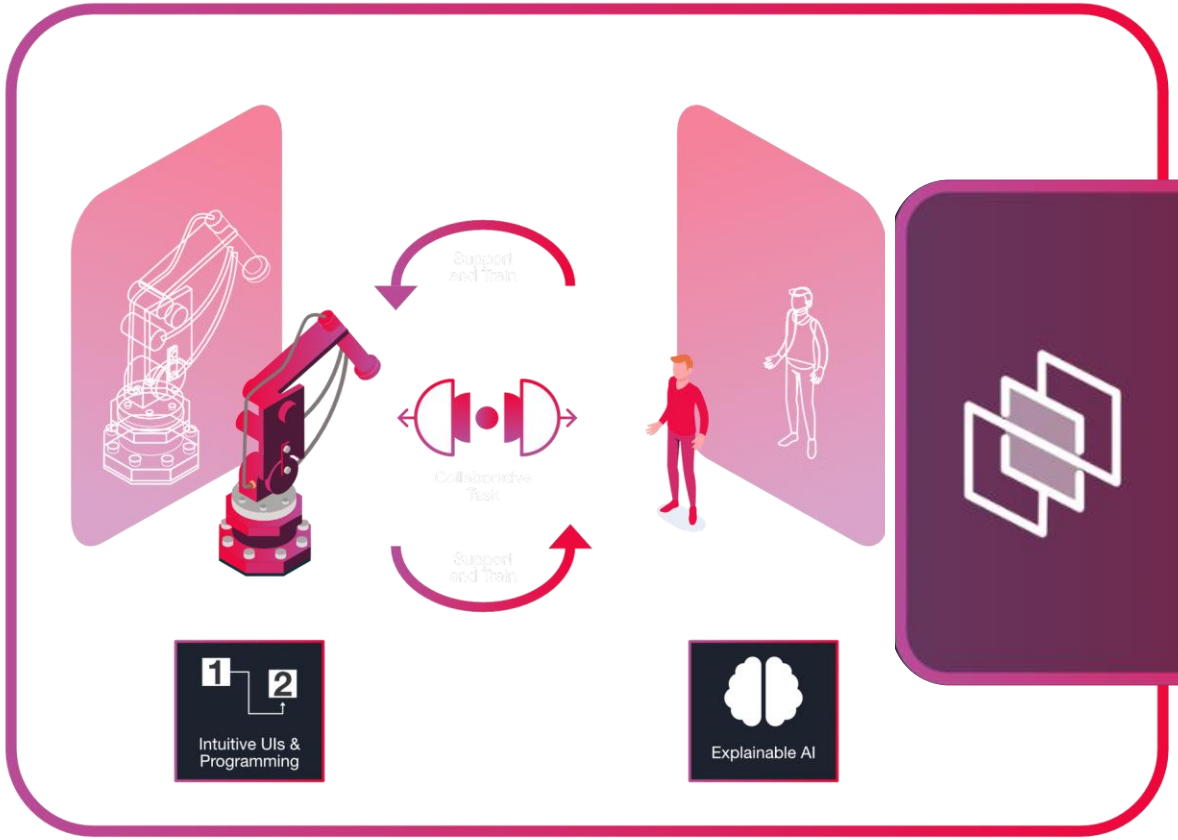
Circular TwAIn develops a novel AI platform for circularity with the aim to increase the performance, resilience, and sustainability of direct manufacturing and process industries.

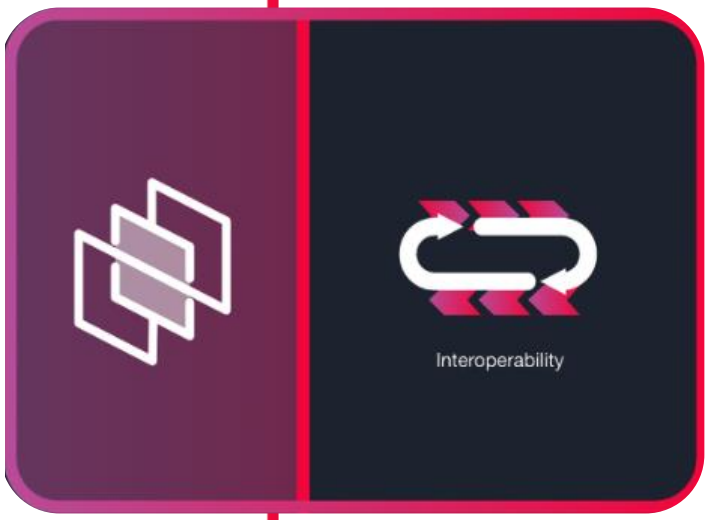
The project is based on 2 fundamental concepts.

Circular TwAIn

Collaborative AI

AI technology is seen as meaningful support for the human worker on the shop floor – not as a replacement. The collaborative approach aims to reach performances that man or machine, acting independently, cannot reach.



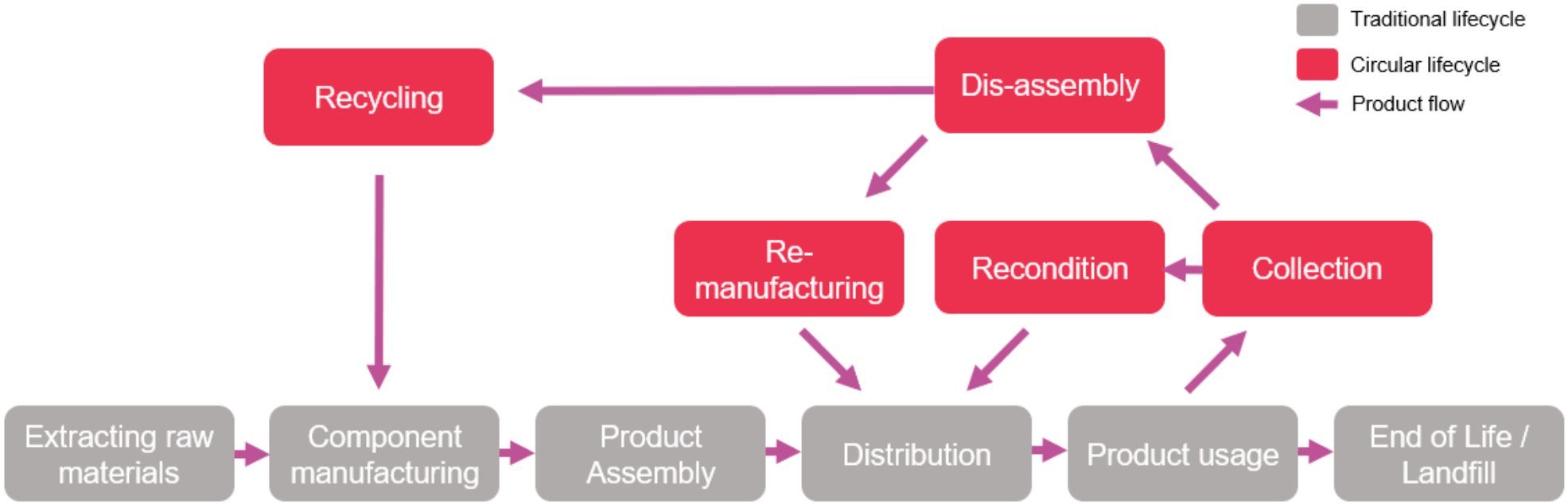


Seamless Data Sharing

Technical and semantical interoperability as well as trustworthiness between all actors of the circular manufacturing system is vital.

The Context

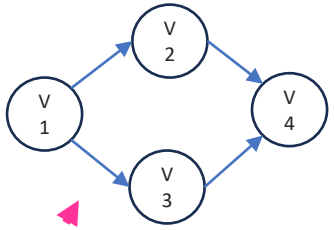
Circular TwAIn




PC case

A. Computer-vision driven product identification for the disassembly of IT equipment


C. Real time planning of the disassembling operations



Circular TwAIn

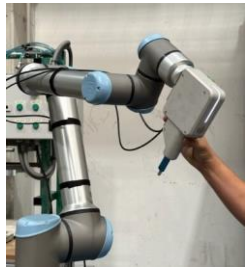
RECYCLING / REFURBISH PROCESS

B. Characterization and assessment of components and subcomponents

```
processor:
    item:
        core_count: '14'
        description: 13th Gen Intel(R)
        Core(TM) i7-13800H
        logical_count: '20'
        manufacturer: GenuineIntel
        physical_count: '1'
```

```
sound:
    item:
        device: 0000:00:1f.3
        manufacturer: Intel
        Corporation     model: 'Device
        51ca (Rev: 01)'
```

D. Collaborative robotics for the support of manual operations



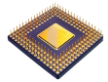


Process DT

E. Market oriented holistic decision-support-system for WEEE de- and re-manufacturing

€ Decision Support

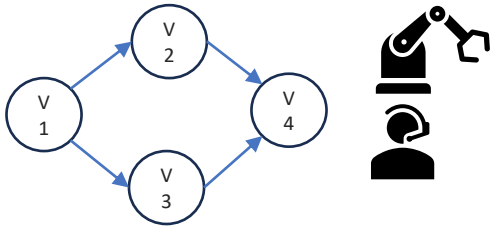
Recycled or Refurbished Components/Products



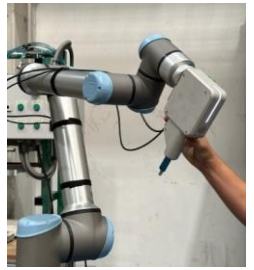
Circular TwAIn

A. Computer-vision driven product identification for the disassembly of IT equipment

C. Real time planning of the disassembling operations



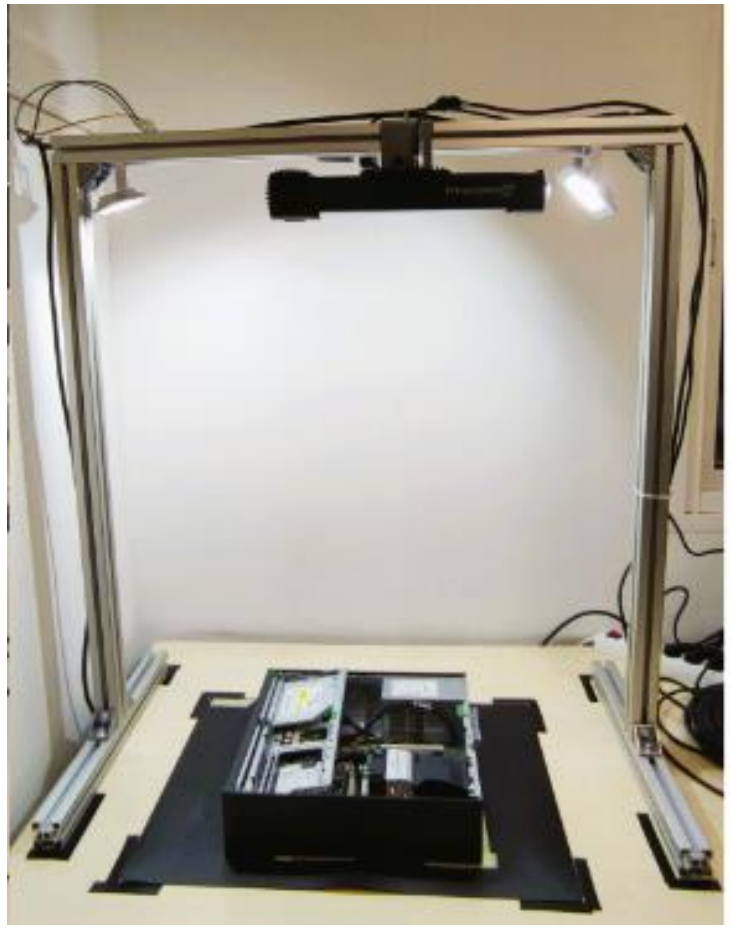
D. Collaborative robotics for the support of manual operations

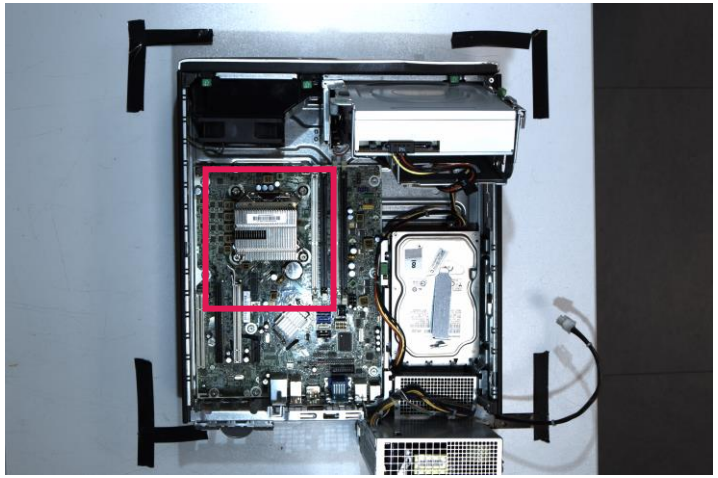


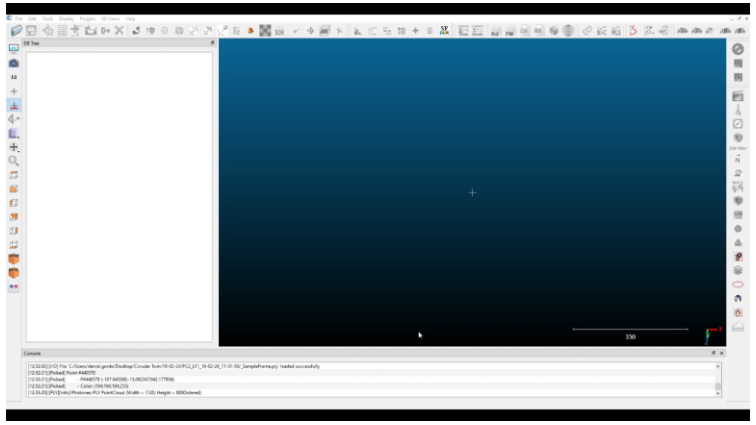
- Lack of data
- Plan definition

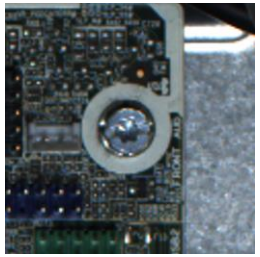
Lack of data

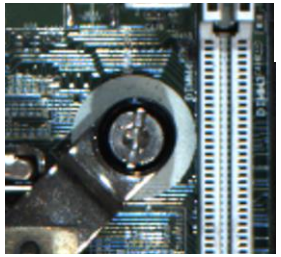
Circular TwAIn

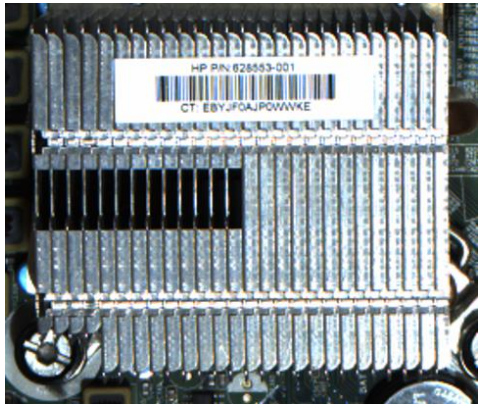






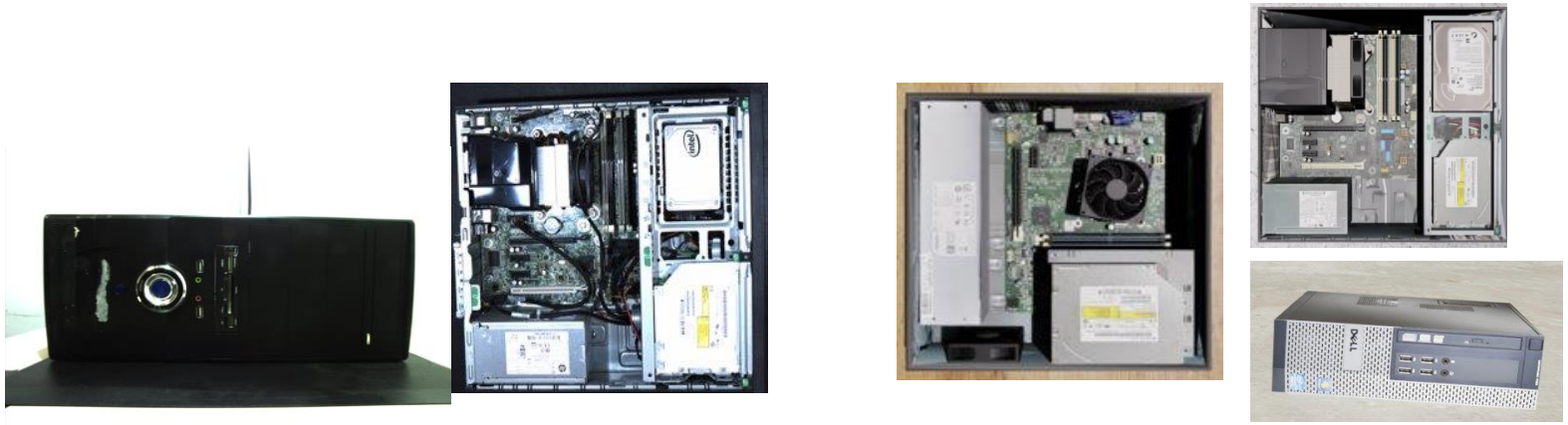


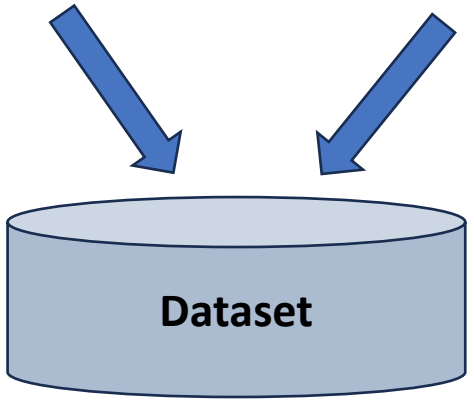




Lack of data

Circular TwAIn



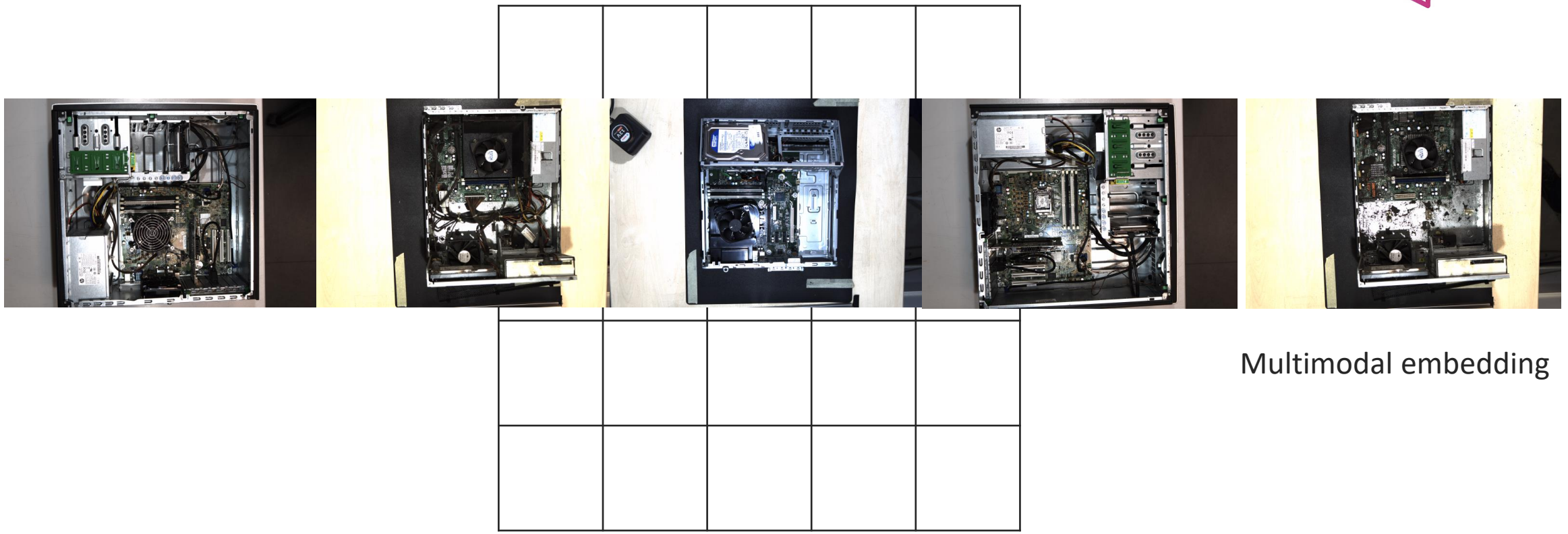


Synthetic data

- Generation of **realistic PC images** using 3D CAD software
- Synthetic data **speeds up** dataset generation process
  - **Automatic data labelling**

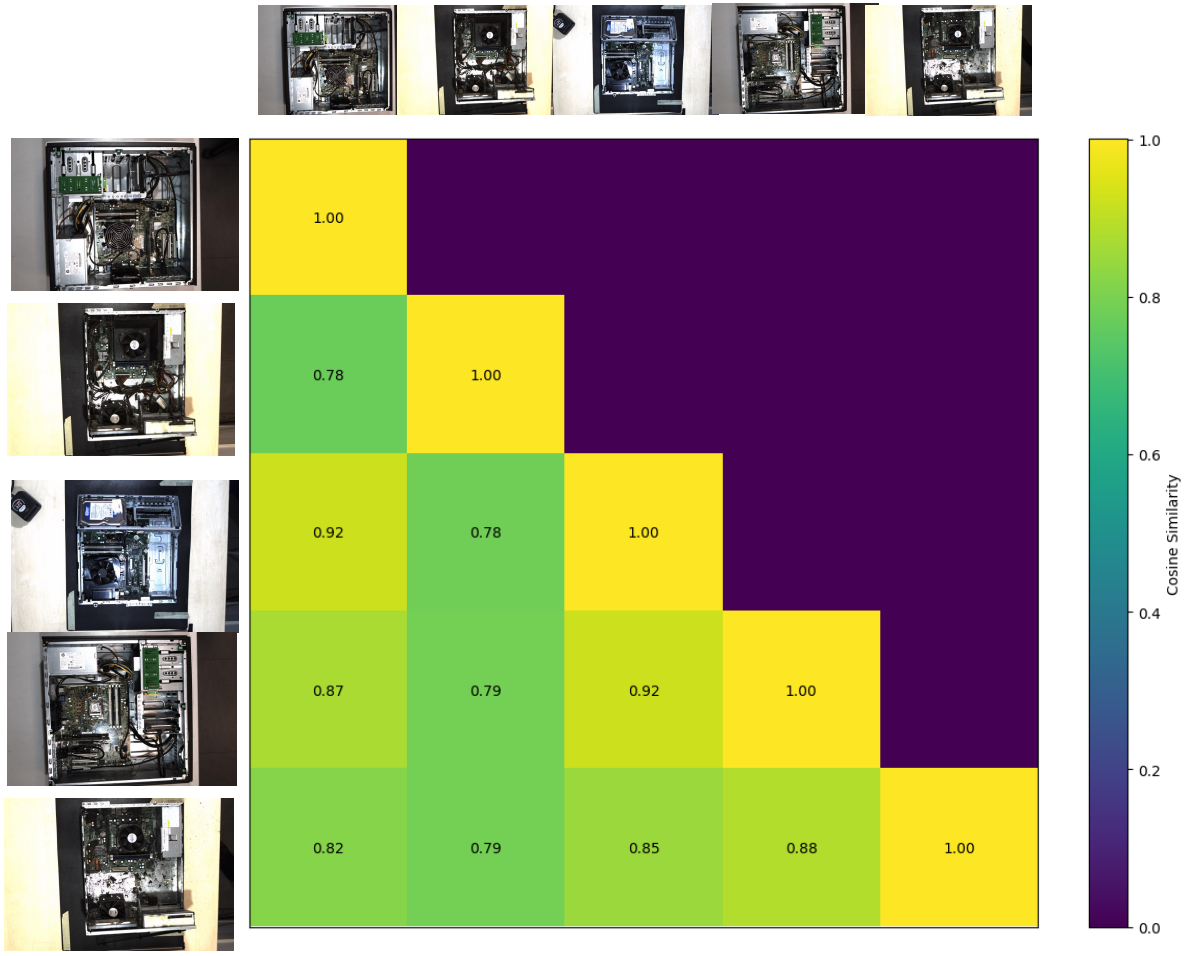
Circular TwAIn

Circular TwAIn

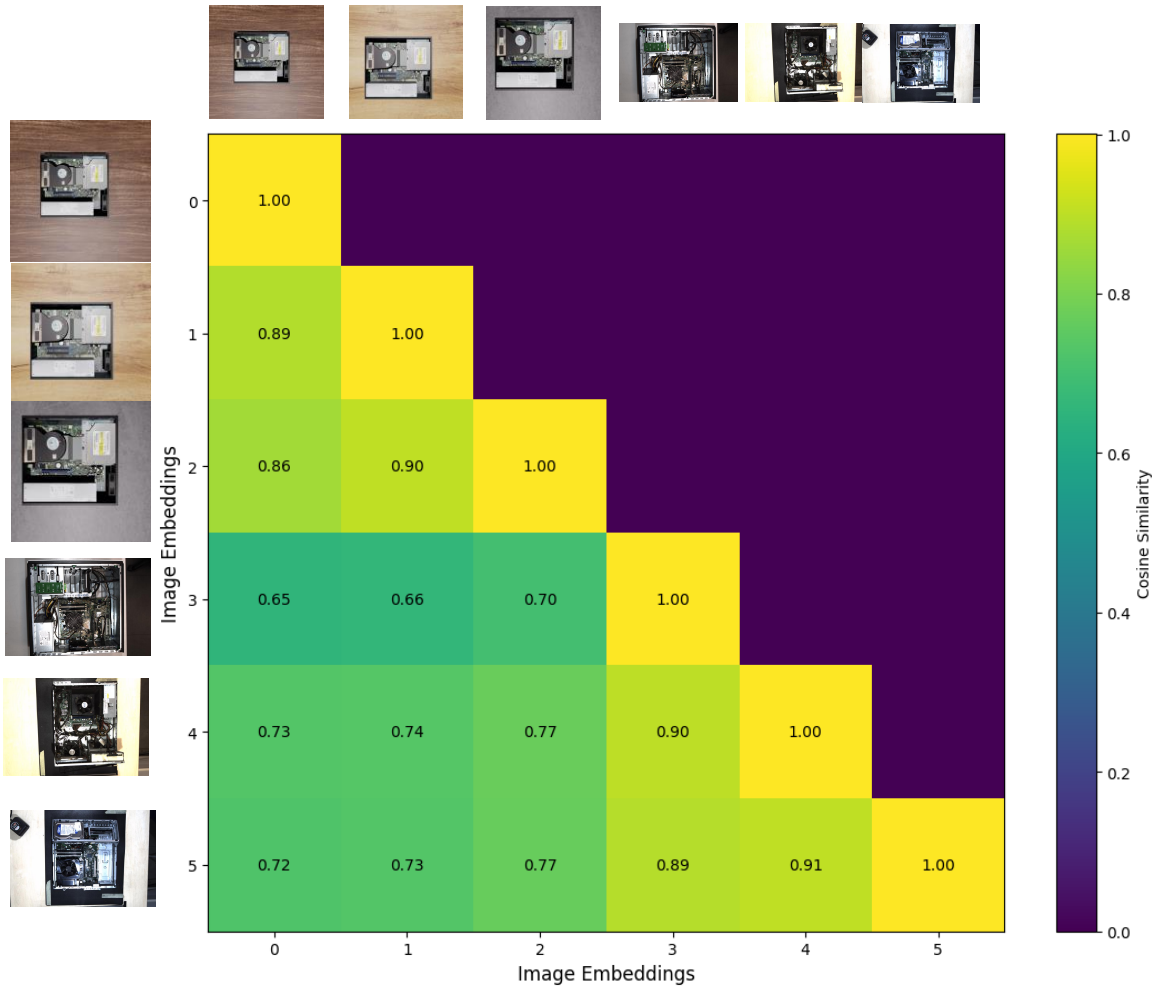


Multimodal embedding

Circular TwAIn



Multimodal embedding


1.00
0.89 1.00
0.86 0.90 1.00
0.65 0.66 0.70 1.00
0.73 0.74 0.77 0.90 1.00
0.72 0.73 0.77 0.89 0.91 1.00
Image Embeddings
Image Embeddings
Cosine Similarity
0.0
0.2
0.4
0.6
0.8
1.0

Facing Lack of data with Language Models

Circular TwAIn

Object to manipulate

Object typically presents large variability

Lack of data

User Promt

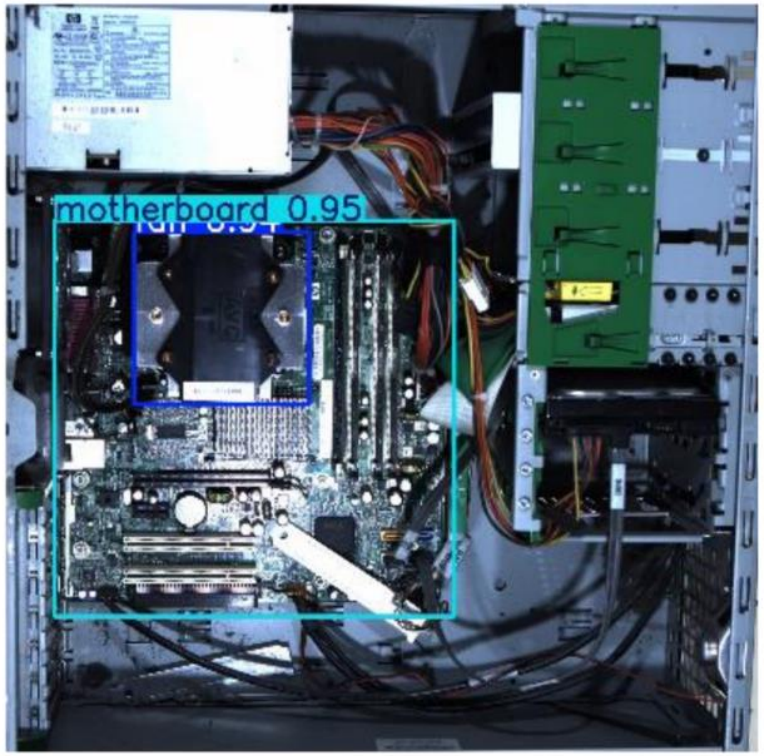
Scence description

Key information/ Ambiguity identification

Matching

Validation

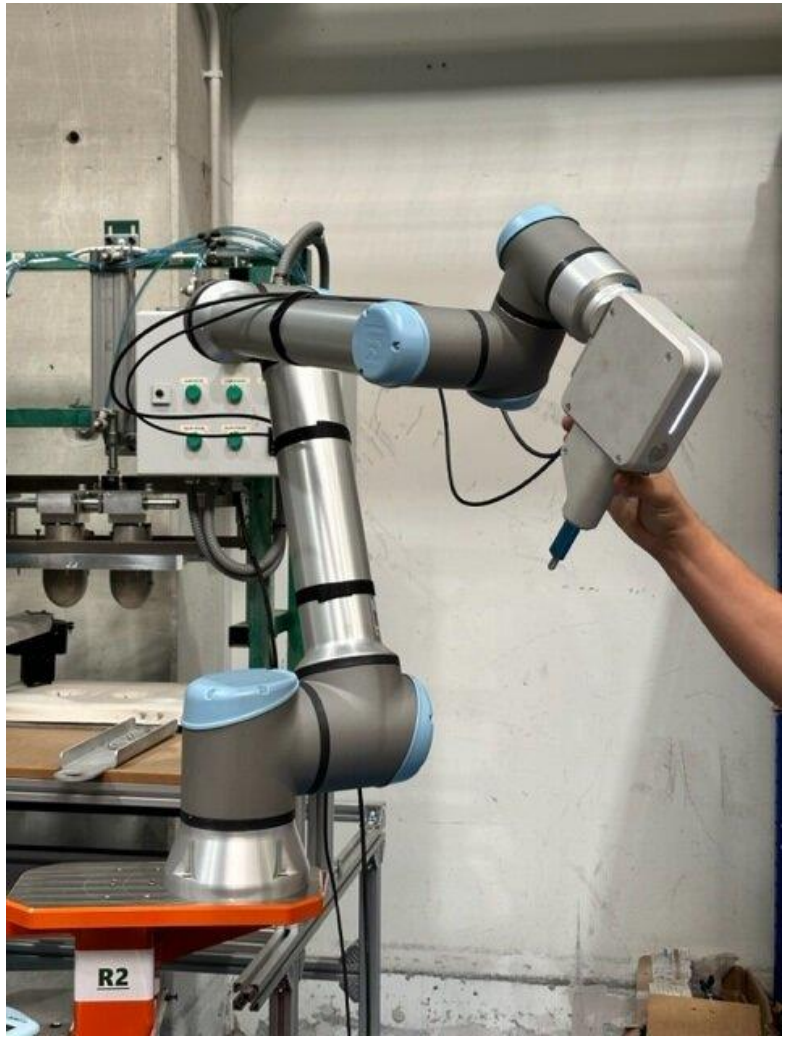
Circular TwAIn

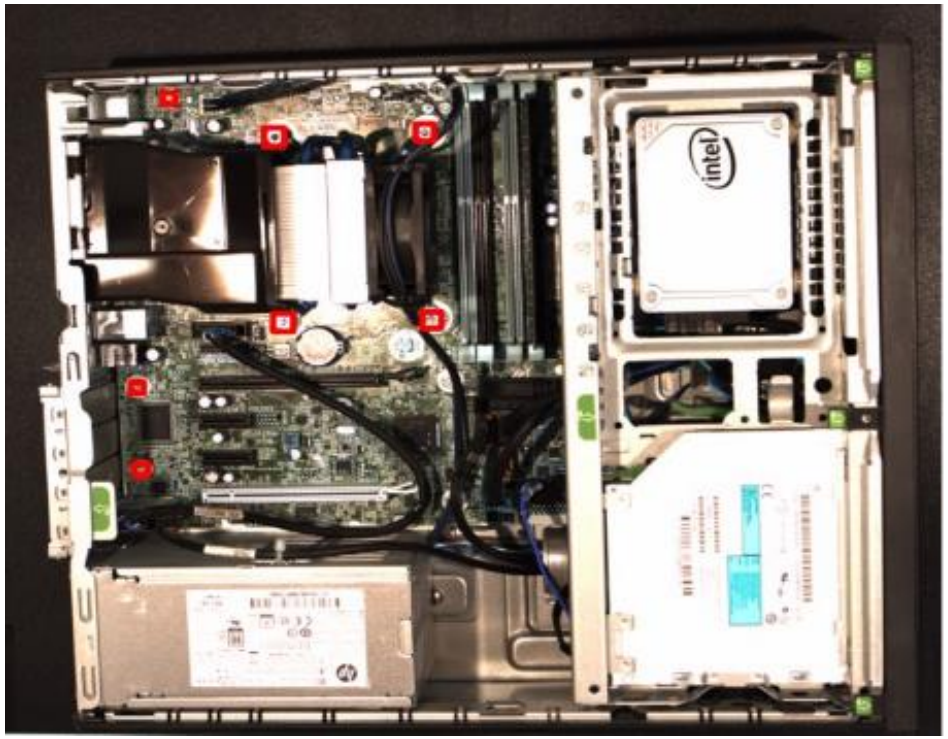


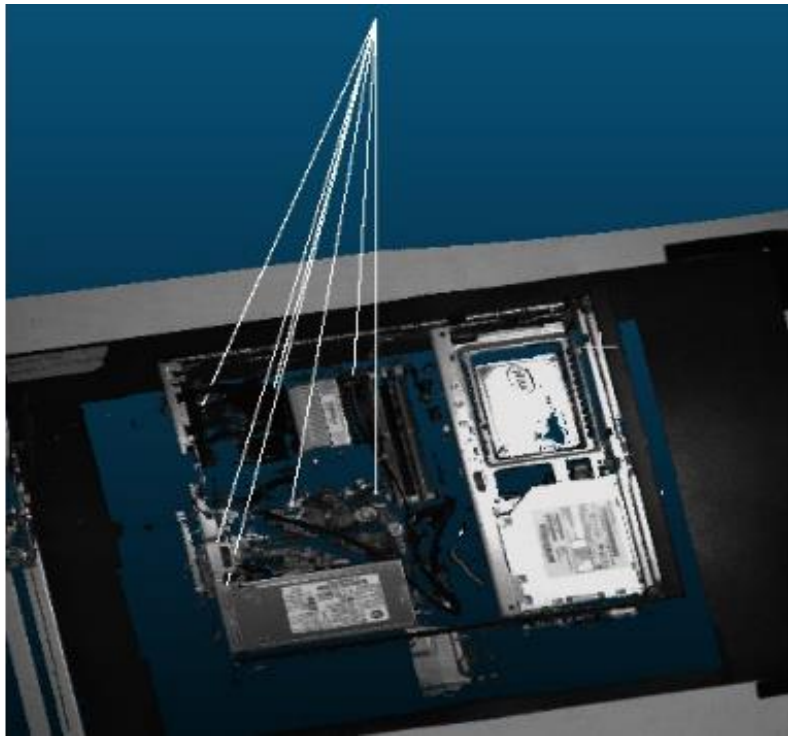
Shaon Sutradhar, Afra María Pertusa Llopis, Daniel Gordo Martín, Gabriel Novas Domínguez, William Nevas Dias, Jawad Masood, and Santiago Muíños Landín Computer Component Disassembly using AI-based Object Detection and Collaborative Industrial Robot for Circular Management of WEEE (accepted and presented) 2nd International Conference on Frontiers of Artificial Intelligence, Ethics, and Multidisciplinary Applications 2024 to be published at Springer book series: Frontiers of Artificial Intelligence, Ethics and Multidisciplinary Applications (Electronic ISSN 2731-8133, Print ISSN 2731-8125)

Human-Robot collaboration

- Collaborative Robot
  - Universal Robot 10e (UR10e)
- Collaborative Screw driver
  - Spin Robotics SD70




intel



'go for the screws that are fixing the fan'

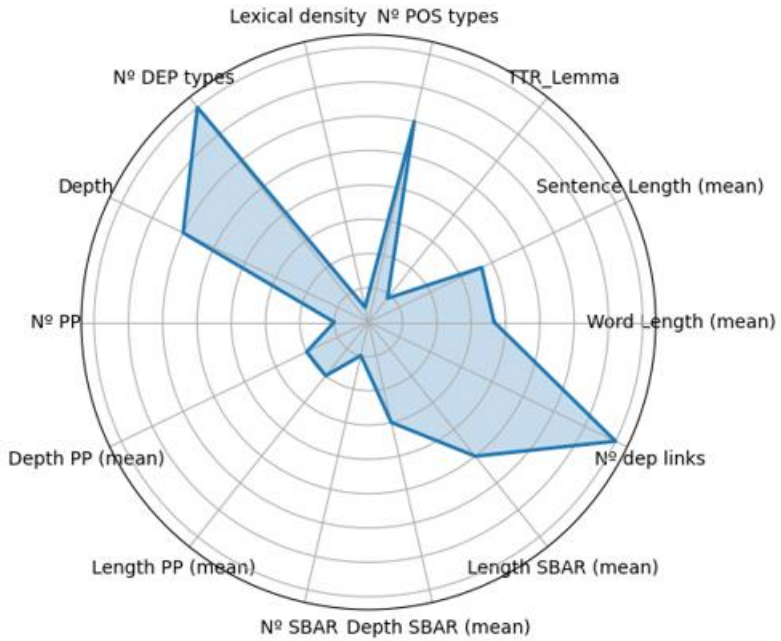
Set of features capturing different aspects of sentence complexity and modeling complexity by weighting metrics.

Circular TwAIn

Metrics

- Raw
  - Average word length
  - Average sentence length
- Morpho-syntatic
  - distribution of part-of-speech types
  - lexical diversity = unique lemmas / number of words.
  - lexical density= content words (verbs, nouns, adjectives and adverbs) / total tokens
- Syntatic
  - Distribution of syntactic dependency types
  - Parse tree depth
  - Subordinate clauses
  - Prepositional phrase
  - Dependency links

'go for the screws that are fixing the fan'



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Circular TwAIn

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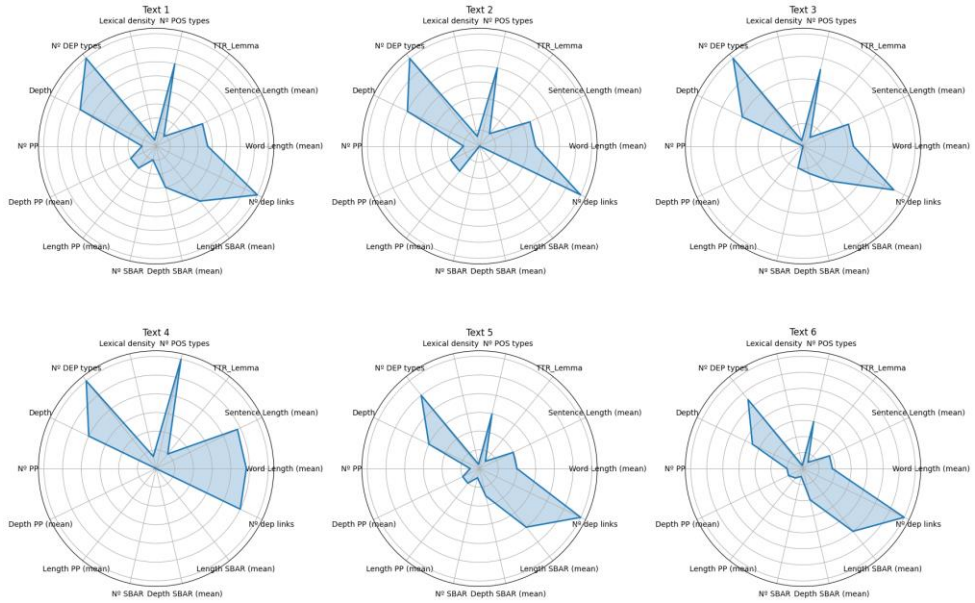
  - Subordinate clauses
  - Prepositional phrase
  - Dependency links

1. 'go for the screws that are fixing the fan'
2. 'I take care of the base plate screw'
3. 'leave me the screws that are more difficult to observe'
4. 'leave me the most complicated ones'
5. 'leave to me the screws in which you have a low confidence rating'
6. 'leave to me the screws in which you have a confidence rate below 80%'



```
'go for the screws that are fixing the fan'
[('go', 'VB'), ('screws', 'NNS'), ('fixing', 'VBG'), ('fan', 'NN')]
```

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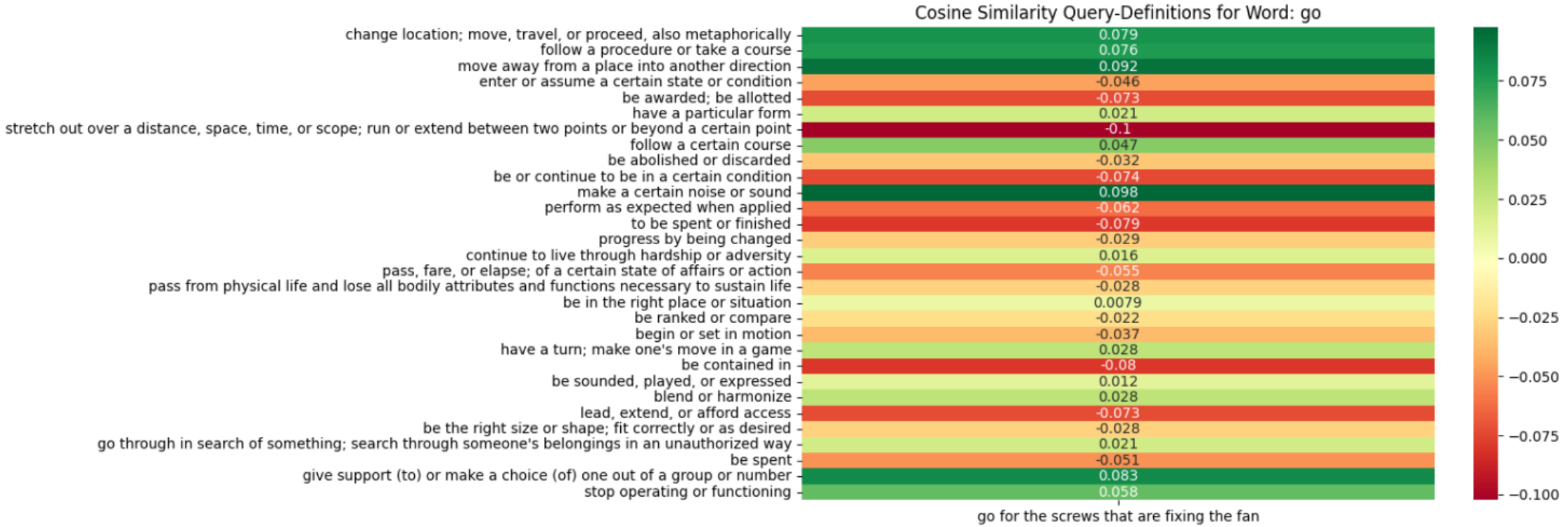
Circular TwAIn



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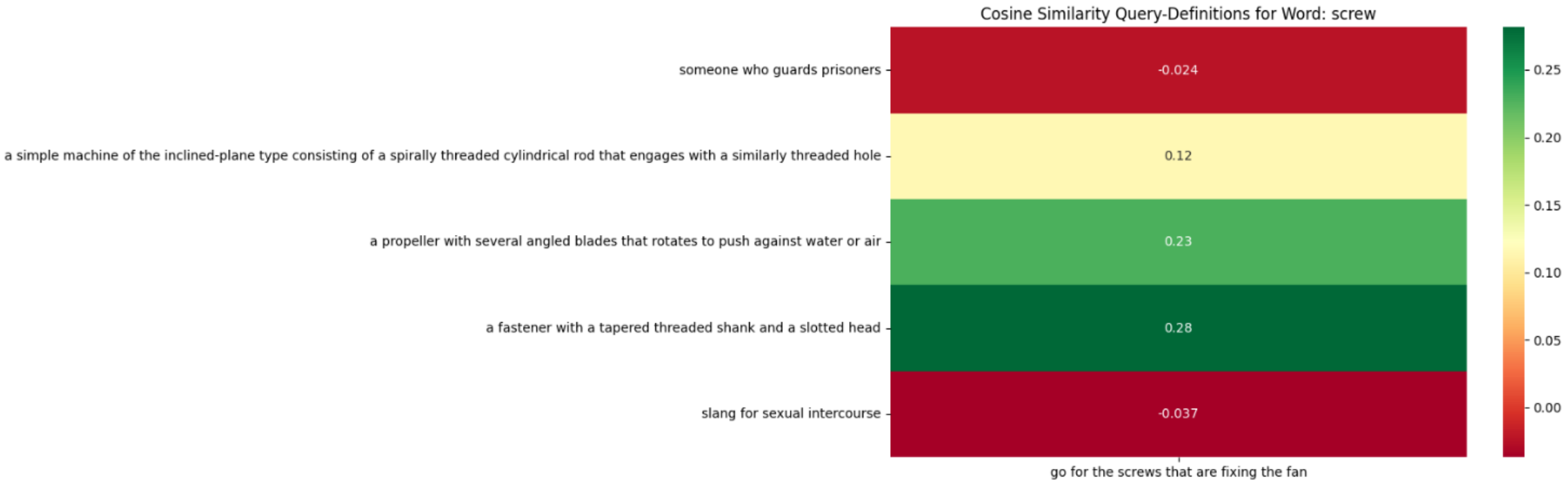
Circular TwAIn



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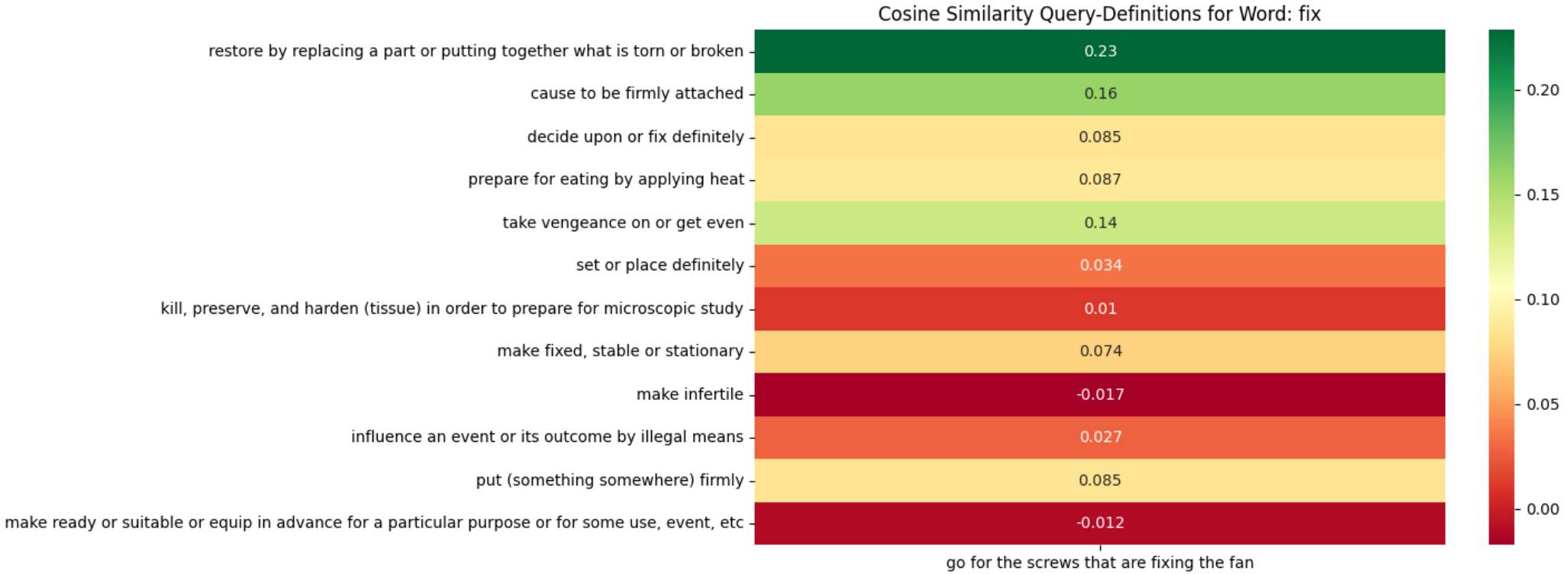
Circular TwAIn



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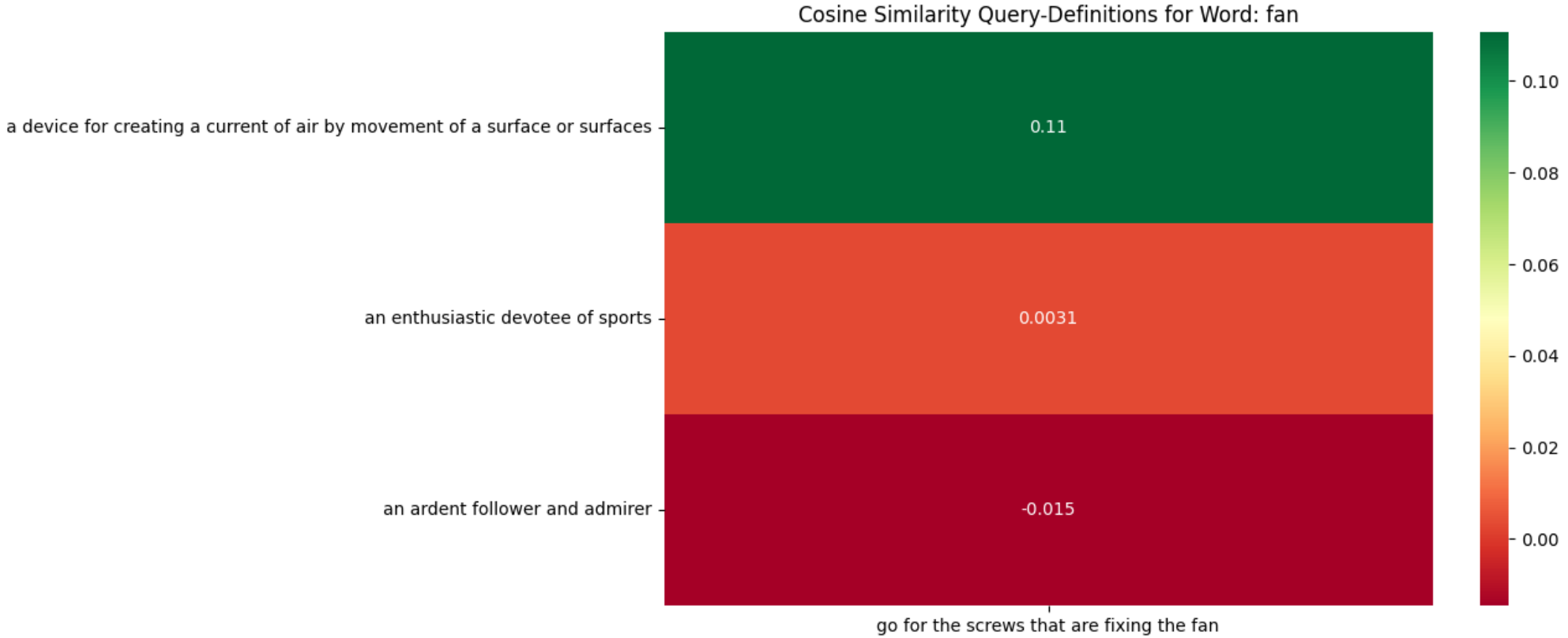
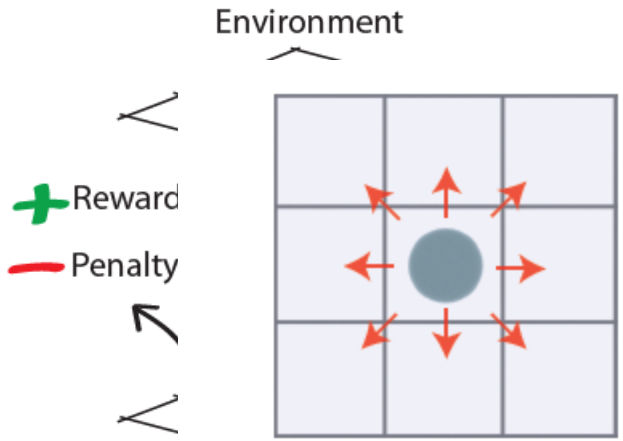
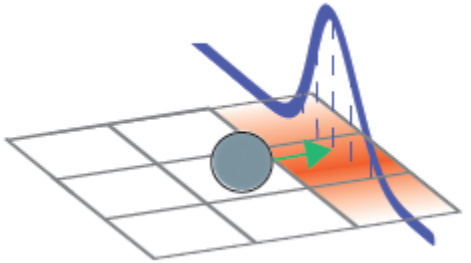
Circular TwAIn



```
'go for the screws that are fixing the fan'
[('go', 'VB'), ('screws', 'NNS'), ('fixing', 'VBG'), ('fan', 'NN')]
```

go (make a certain noise or sound) for the screws (a fastener with a tapered threaded shank and a slotted head) that are fixing (restore by replacing a part or putting together what is torn or broken) the fan (a device for creating a current of air by movement of a surface or surfaces)


Environment
Reward
Penalty



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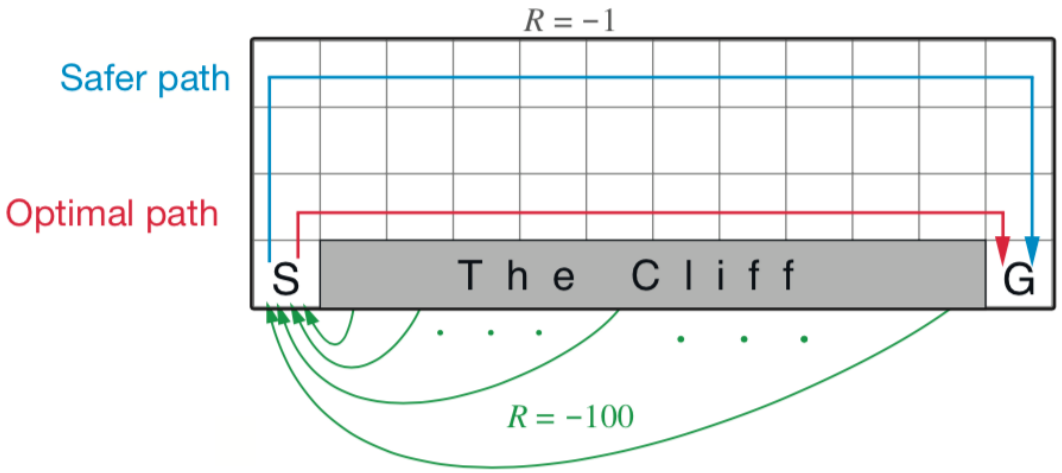
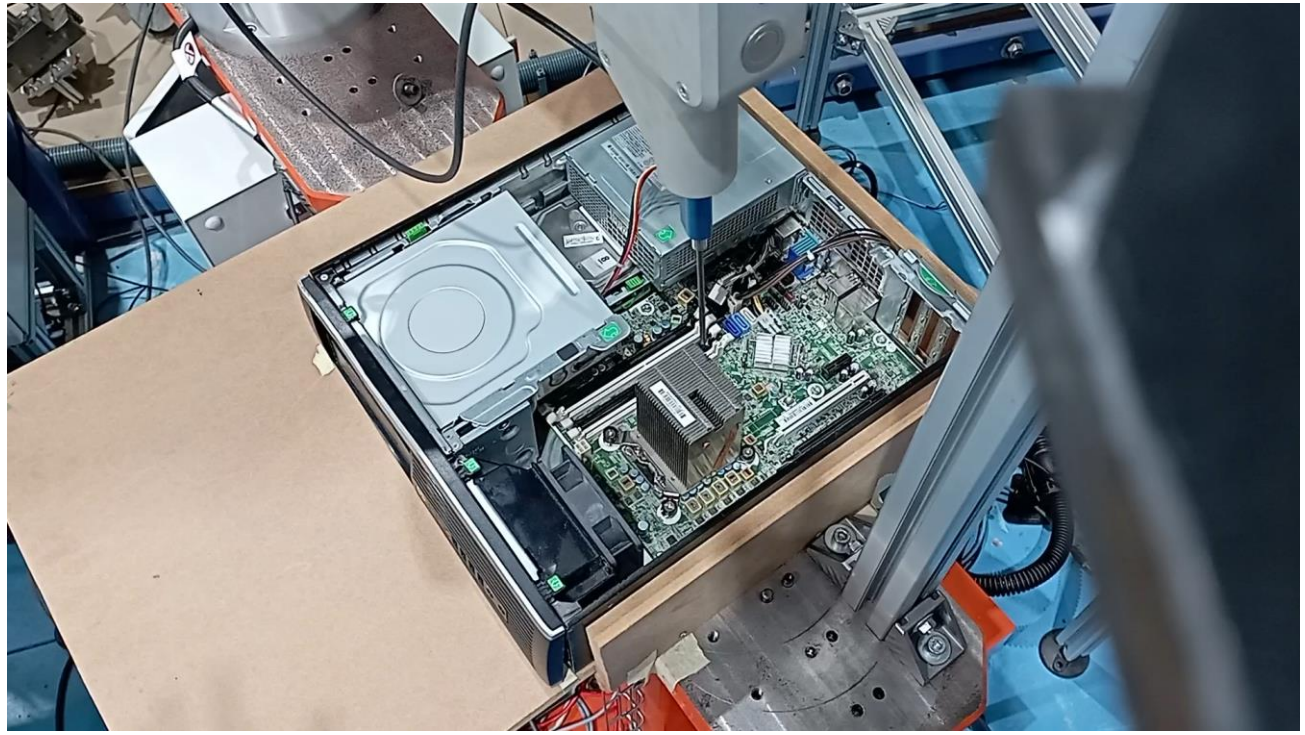
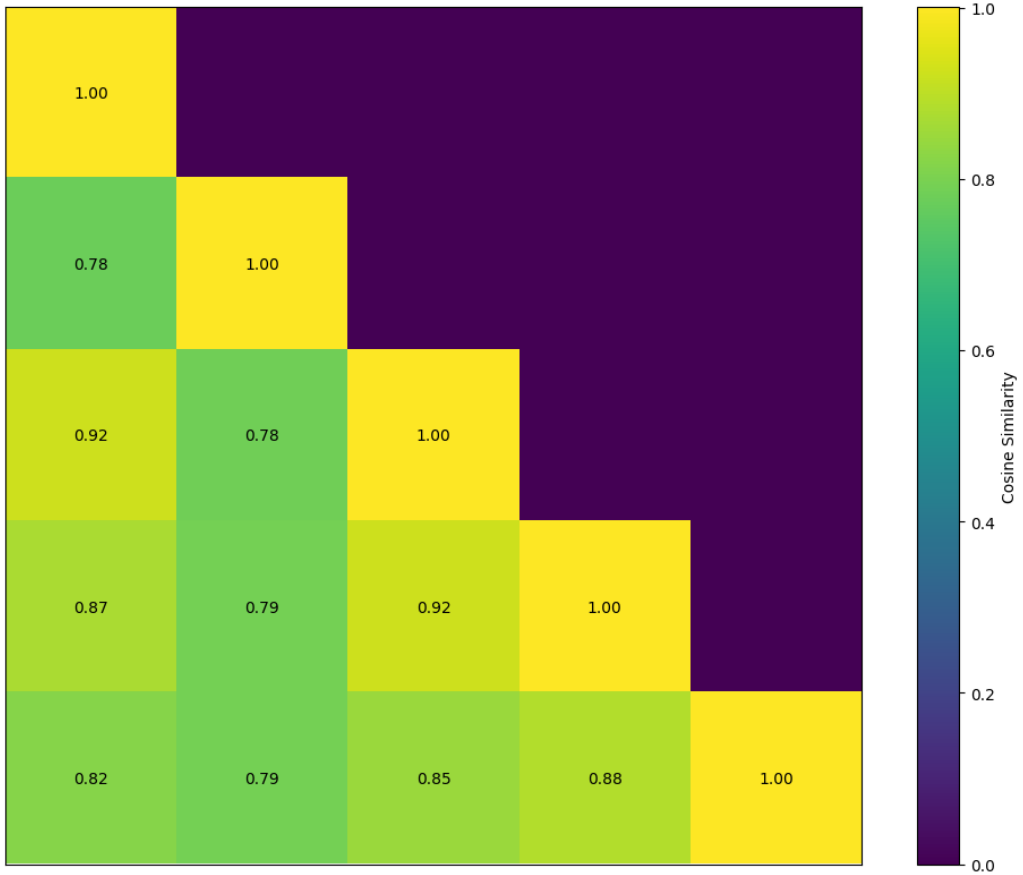




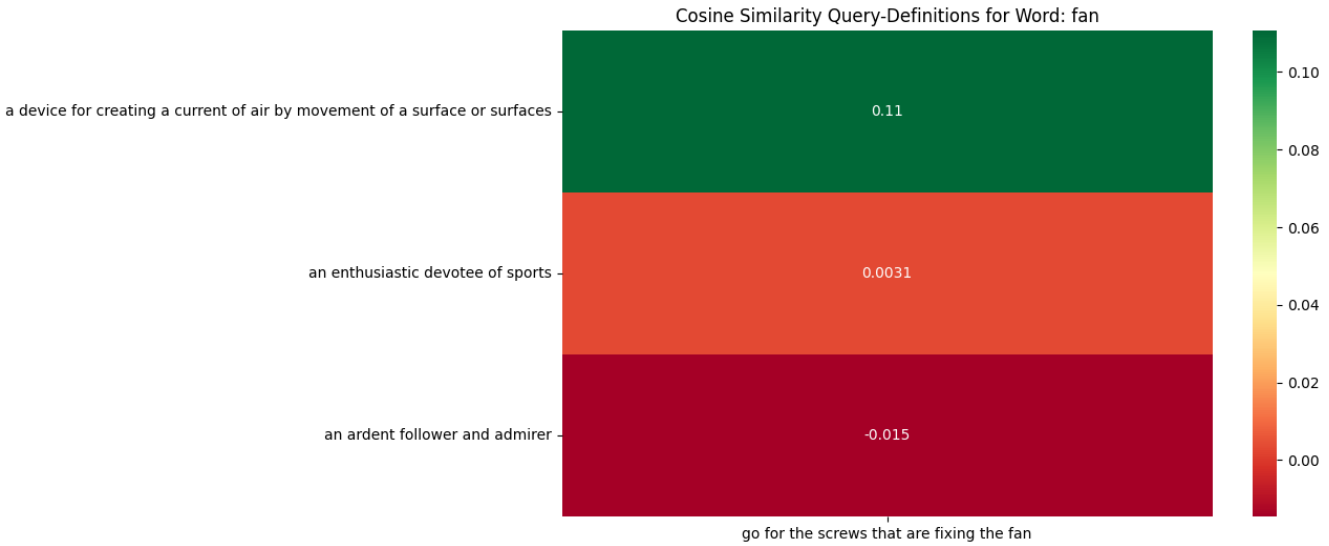
Summary

Circular TwAIn



Impact on perception

Summary



Impact on planning

Limitations, Challenges and Outlook

Circular TwAIn

Limitations & Challenges

- Impact on perception
- Impact on planning

Outlook

- Importance of consistent and clear messages
- Definition of metrics that quantifies que quality of the communication

aimen TECHNOLOGY CENTRE

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santiago.muinos@aimen.es

Thank you!