Universiteit Utrecht

CWI Centrum Wiskunde & Informatica

DatAR: Supporting Neuroscience Literature Exploration by Finding Relations between Topics in Augmented Reality

Boyu Xu <b.xu@uu.nl>, Ghazaleh Tanhaei <g.tanhaei@uu.nl>, Lynda Hardman and Wolfgang Hürst

Video of DatAR

SCAN ME

Introduction

An important task for neuroscientists is to understand which experiments would be fruitful to carry out. They need to explore and analyse a large number of neuroscience publications to identify topics of interest to them and understand relations among them.

Our motivation is to provide support for neuroscientists to find potentially fruitful experiments by identifying relations between topics using AR [1, 2].

What is Topic-based Literature Exploration?

Utilising topic-based literature exploration, such as finding relations between brain regions and brain diseases, can aid in analysing numerous publications to identify fruitful experiments. We define a co-occurrence of two topics when, for example, a brain region and a brain disease appear in the same sentence in a publication's title or abstract, Figure 1.

Figure 1 The brain region *Hippocampus* and the brain disease *Depression* co-occur in the title of the publication *Hippocampus atrophy and the longitudinal course of late-life depression*.

Representative Tasks

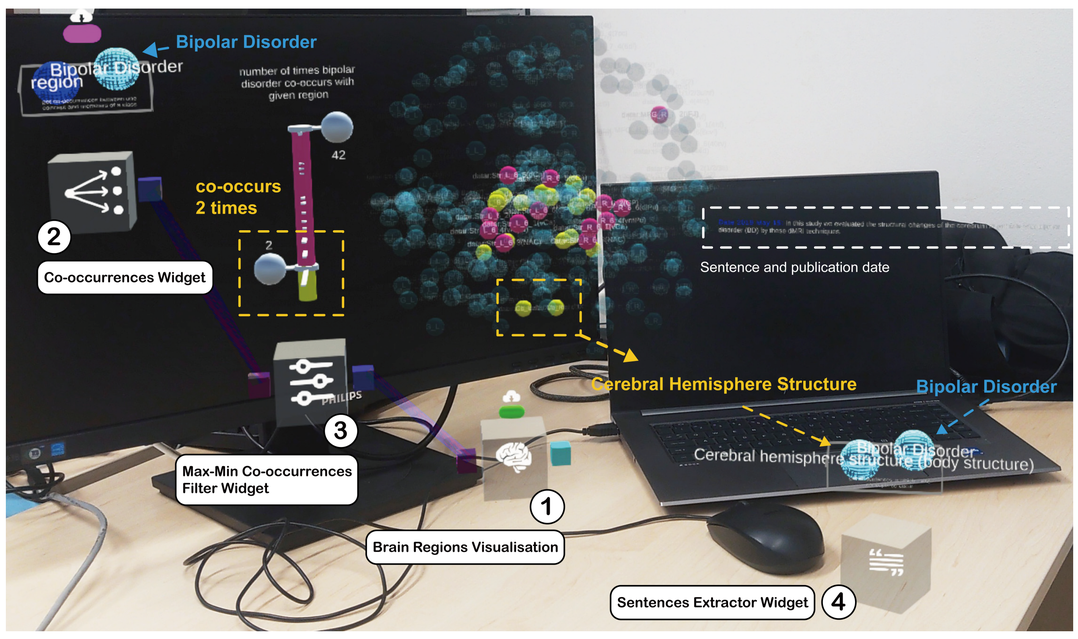
We collaborated with the neuroscientist Danyang Li (a PhD student in neuroscience at the Institute of Neuroscience of the Chinese Academy of Sciences) to define representative tasks.

She wanted to uncover seldom-mentioned brain regions, that are not yet common topics related to *Bipolar Disorder*. **These seldom-mentioned regions could offer useful inspirations for further investigation**.

Brain diseases can also be connected indirectly to brain regions, through genes. She wanted to **find which brain regions are indirectly related to *Bipolar Disorder* to provide additional options for identifying fruitful experiments**.

DatAR Prototype

Finding Seldom-mentioned Direct Relations between Topics



1 **Brain Regions Visualisation:**
The position of each sphere is determined by the 3D coordinates of brain regions.

2 **Co-occurrences Widget:**
Queries the direct co-occurrences between a single brain region and multiple brain diseases or a single brain disease and multiple brain regions

3 **Max-Min Co-occurrences Filter Widget:**
Selects few direct co-occurrences by the max-min filter.

4 **Sentences Extractor Widget:**
Queries which sentences indicate the direct relation between the specific brain region and brain disease.

Figure 4 The brain disease *Bipolar Disorder* co-occurs twice with the brain region *Cerebral Hemisphere Structure*.

Finding Relations between Topics

Direct Relations between Topics

This co-occurrence implies **a direct relation** between the brain region and the brain disease. Figure 1 illustrates a direct relation between the brain region *Hippocampus* and the brain disease *Depression*. We count the co-occurrences of two topics in the document collection to find out which co-occurrences are frequent or rare in the neuroscience literature, Figure 2.

Left a brain region: *Hippocampus* **Middle** co-occurrences of a brain region and a brain disease in sentences of the repository **Right** a brain disease: *Depression*

brainregion	count	disease
Structure of central sulcus	"1001"^^xsd:integer	Hamartoma Syndrome, Multiple
Corpus striatum structure	"821"^^xsd:integer	cortex bone disorders
BRAIN, HIPPOCAMPUS	"623"^^xsd:integer	Depressive disorder

Figure 2 The Brain Science Knowledge Graph repository contains an analysis of sentences in the titles and abstracts of 414,224 neuroscience publications in PubMed [3] with a total of 10000 co-occurrences. For example, the brain region *Hippocampus* (left column), co-occurs 623 times (middle column) with the brain disease *Depressive disorder* (right column).

Indirect Relations between Topics

While there may be no direct relations between a brain region and a brain disease in the literature, each may have a direct relation with another topic, such as a gene. We call this an indirect relation.

For example, there is no direct relation between the brain region *Hippocampus* and the brain disease *Alexander Disease* in the PubMed corpus that we use, Figure 3. There are, however, 211 co-occurrences of *Hippocampus* with *GFAP Gene*, and 7 co-occurrences of *GFAP Gene* with *Alexander Disease*. We thus describe the relation between the topics *Hippocampus* and *Alexander Disease* as indirect, in this case through the intermediate topic *GFAP Gene*.

a

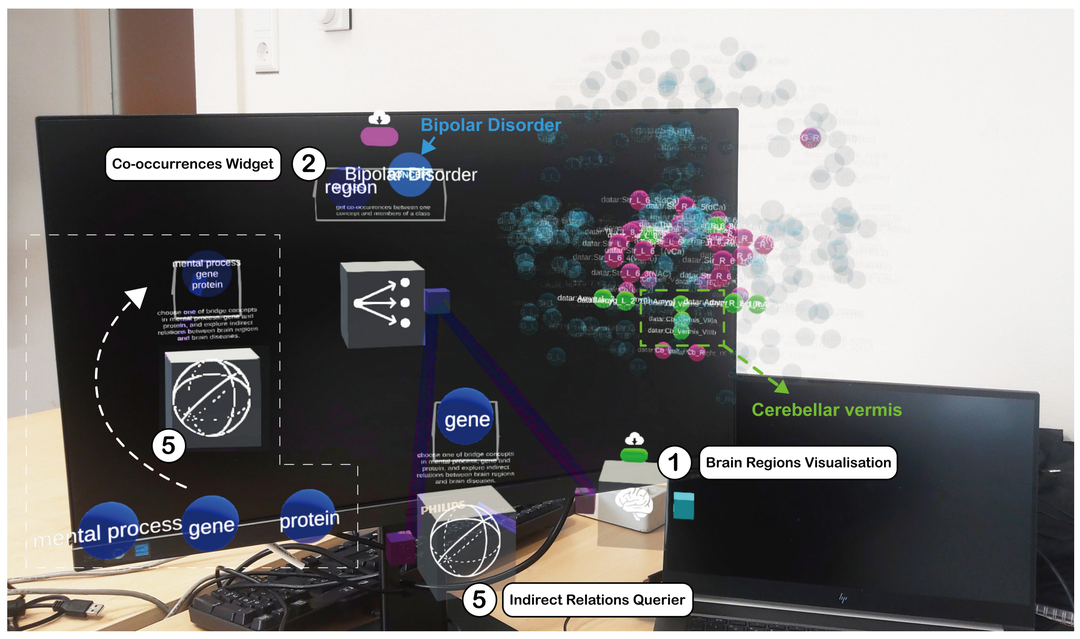
Left: Brain Regions: *Hippocampus*, *Thalamic Structure*, *Amygdaloid Structure*	Middle: co-occurrences	Right: An Intermediate Topic: *GFAP Gene*
brainregion	number of co-occurrences	gene
BRAIN, HIPPOCAMPUS	"211"^^xsd:integer	GFAP gene
Thalamic structure	"37"^^xsd:integer	GFAP gene
Amygdaloid structure	"10"^^xsd:integer	GFAP gene

b

Left: An Intermediate Topic: *GFAP Gene*	Middle: co-occurrences	Right: Brain Diseases: *Alzheimer's Disease*, *Alexander Disease*, *Depressive Disorder*
gene	number of co-occurrences	disease
GFAP gene	"13"^^xsd:integer	Alzheimer's Disease
GFAP gene	"7"^^xsd:integer	Alexander Disease
GFAP gene	"3"^^xsd:integer	Depressive disorder

Figure 3 The brain region *Hippocampus* has indirect relations with the brain diseases *Alzheimer's Disease*, *Alexander Disease*, and *Depressive Disorder* via *GFAP Gene*. We already know (Figure 2) that *Hippocampus* has a direct relation with *Depressive Disorder* in addition to indirect relations via *GFAP Gene*. There is, however, no direct relation between *Hippocampus* and *Alexander Disease* but through the topic *GFAP Gene* we see that there is an indirect relation.

Finding Indirect Relations between Topics



5 **Indirect Relations Querier:**
Selects an intermediate topic, such as genes, to find indirect relations between brain regions and brain diseases.

Figure 5 The brain disease *Bipolar Disorder* has an indirect relation with the brain region *Cerebellar vermis* via genes.

DatAR

References

[1] Troost, I., Tanhaei, G., Hardman, L., & Hürst, W. (2021, June). Exploring Relations in Neuroscientific Literature using Augmented Reality: A Design Study. In Designing Interactive Systems Conference 2021 (pp. 266-274).

[2] Tanhaei, G., Troost, I., Hardman, L., & Hürst, W. (2022, October). Designing a Topic-Based Literature Exploration Tool in AR-An exploratory study for neuroscience. In 2022 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct) (pp. 471-476). IEEE.

[3] Neuroscience publications in PubMed https://pubmed.ncbi.nlm.nih.gov/ as of February 3, 2022.