



RICE UNIVERSITY

# ***“Textbook” Knowledge***

Concept Map visualizations with LLMs  
***Graphs:***

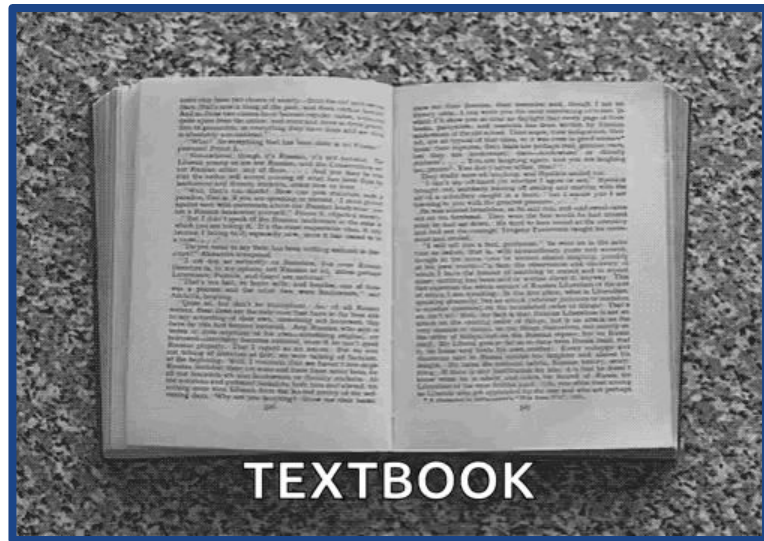
Aldo Alvarez (aa278)

Salaar Assad (sa231)

Jacob Lapp (jl372)

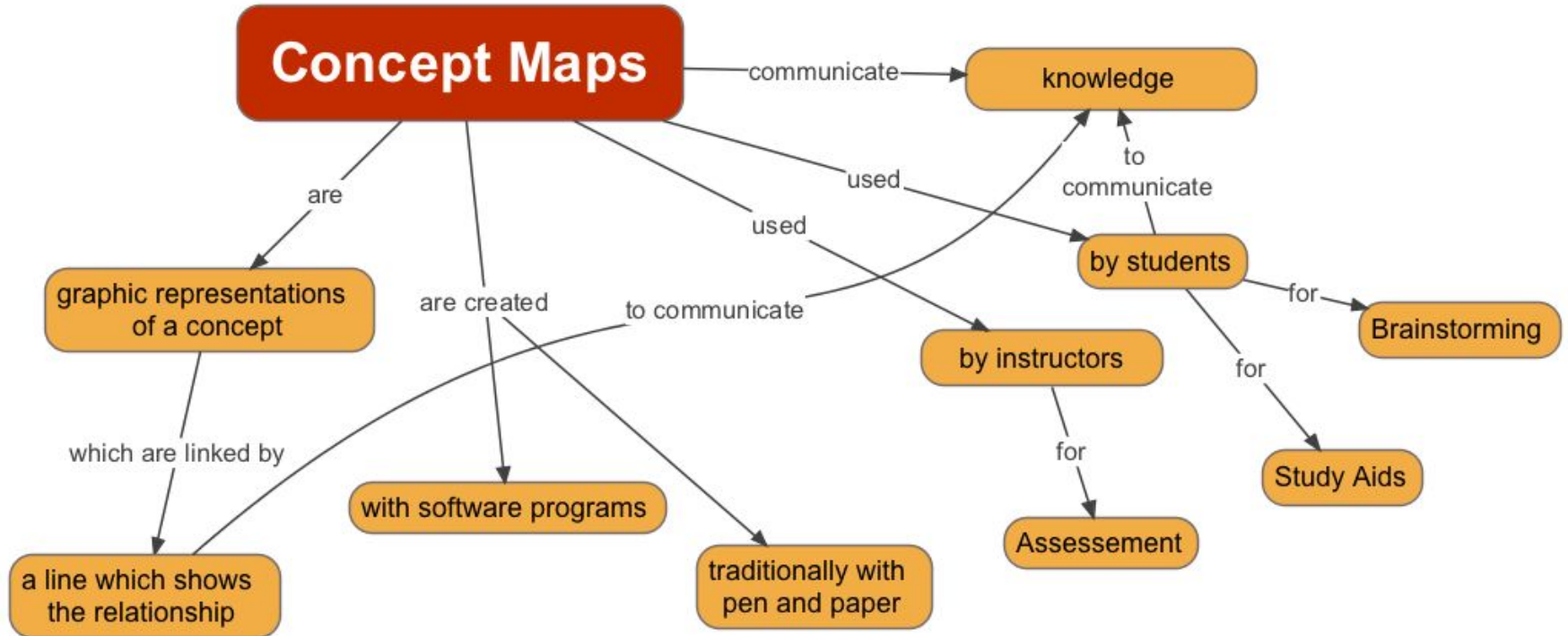
# Motivation

- Textbooks provide large volumes of content.
- Sometimes conceptual links seem unclear between chapters.
- Visual aids could help:
  - track learning progress,
  - reveal concept connections.
- Concept maps can be a useful learning tool.



TEXTBOOK

# Concept Map Example



# Objectives

- Create visual maps of key concept relationships in textbooks.
- Provide a graphical interpretation of interconnected ideas.
- Improve student comprehension and engagement through visual aids.



# Related Work

- Educational text summarization with LLMs

*[Submitted on 15 Nov 2023 (v1), last revised 12 Jul 2024 (this version, v2)]*

## **Benchmarking Generation and Evaluation Capabilities of Large Language Models for Instruction Controllable Summarization**

Yixin Liu, Alexander R. Fabbri, Jiawen Chen, Yilun Zhao, Simeng Han, Shafiq Joty, Pengfei Liu, Dragomir Radev, Chien-Sheng Wu, Arman Cohan

- Knowledge Graphs and LLMs

*[Submitted on 15 Jul 2024]*

## **Graphusion: Leveraging Large Language Models for Scientific Knowledge Graph Fusion and Construction in NLP Education**

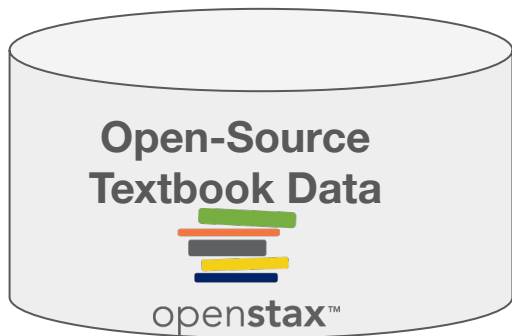
Rui Yang, Boming Yang, Sixun Ouyang, Tianwei She, Aosong Feng, Yang Jiang, Freddy Lecue, Jinghui Lu, Irene Li

## **A Survey of Knowledge Graph Approaches and Applications in Education**

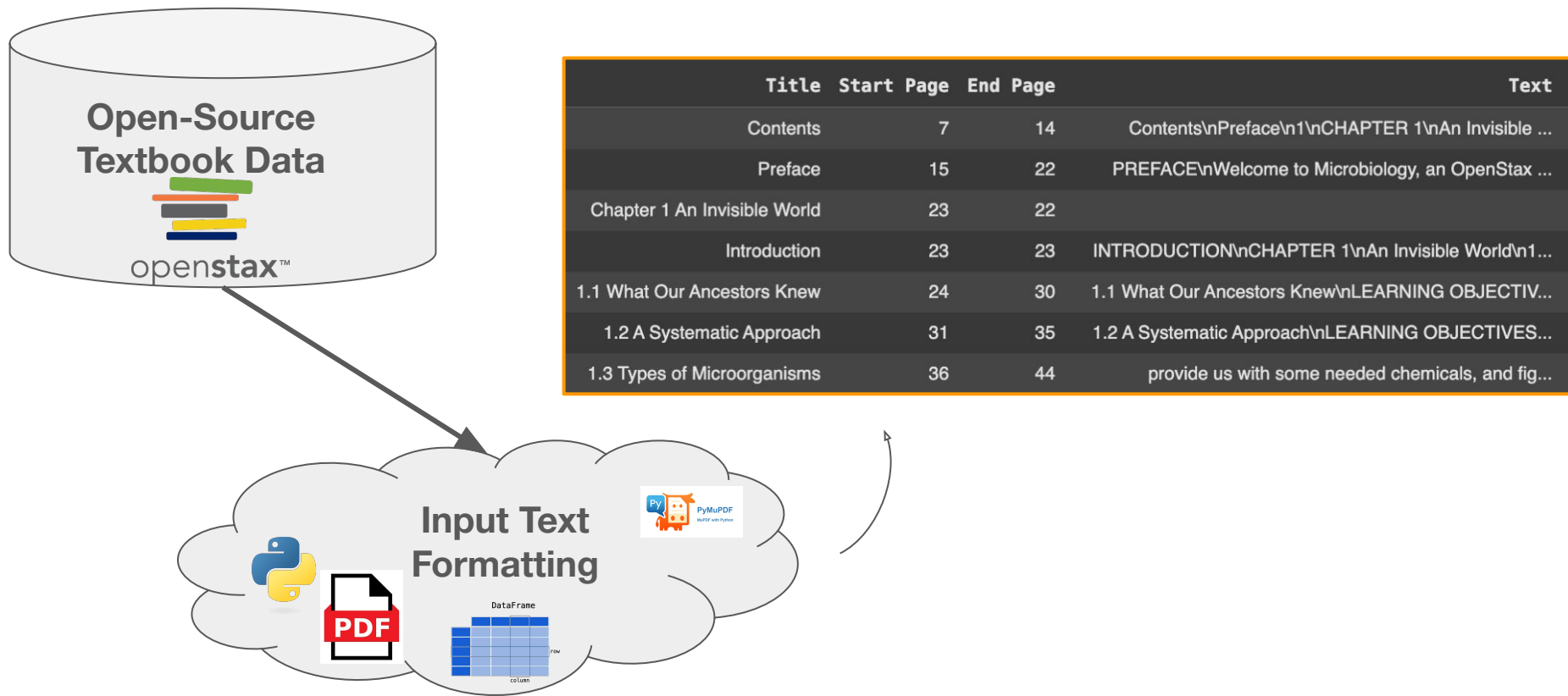
by Kechen Qu<sup>1</sup> ✉, Kam Cheong Li<sup>2</sup> ✉, Billy T. M. Wong<sup>2,\*</sup> , Manfred M. F. Wu<sup>2</sup> ✉ and Mengjin Liu<sup>2</sup> ✉



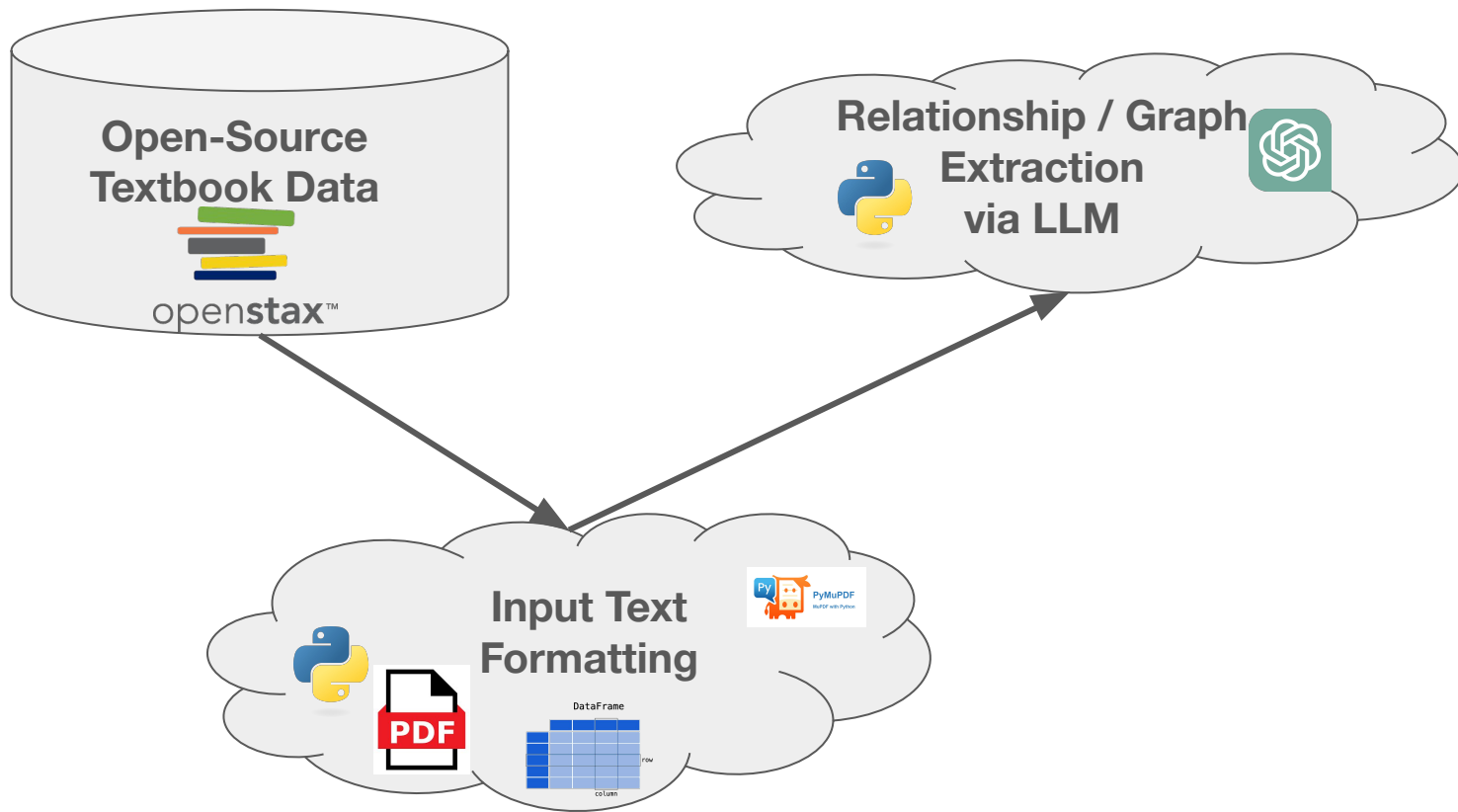
# Architecture



# Architecture

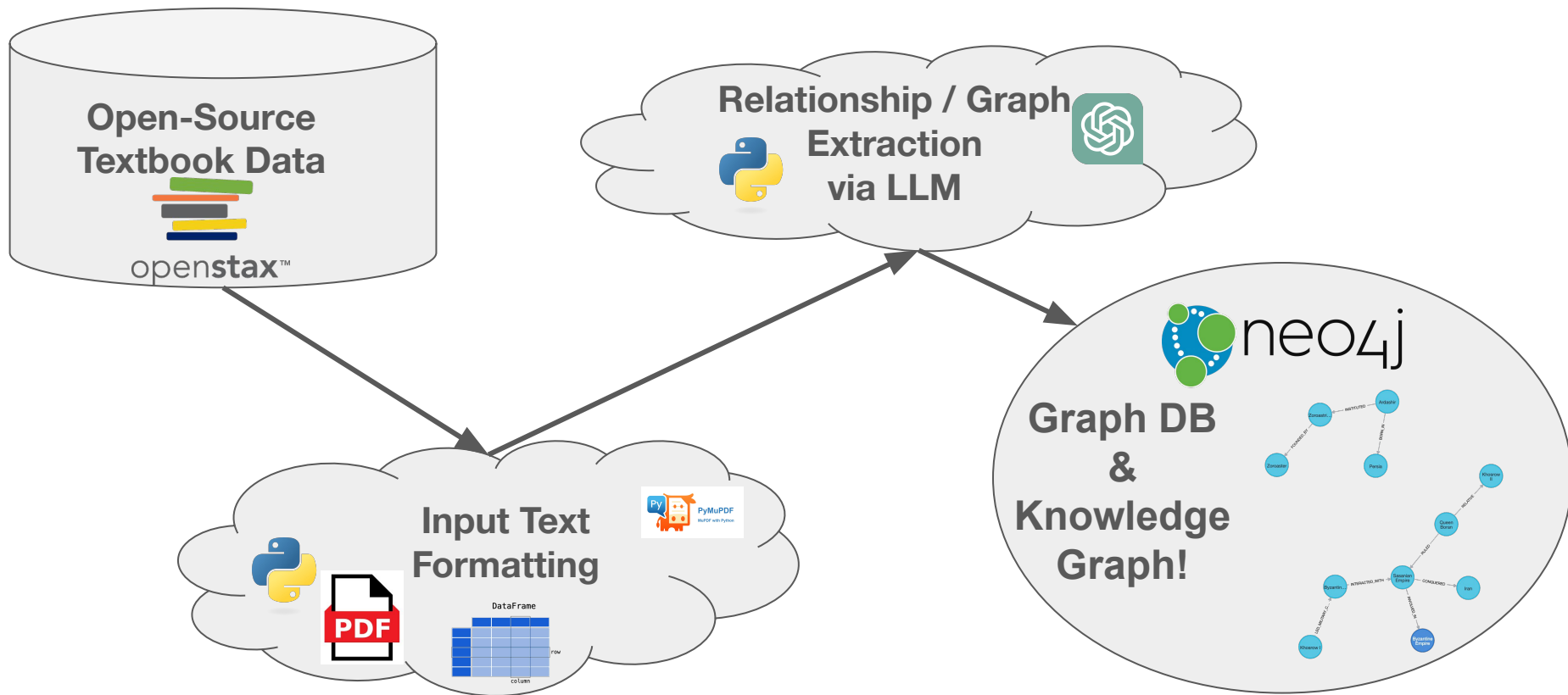


# Architecture



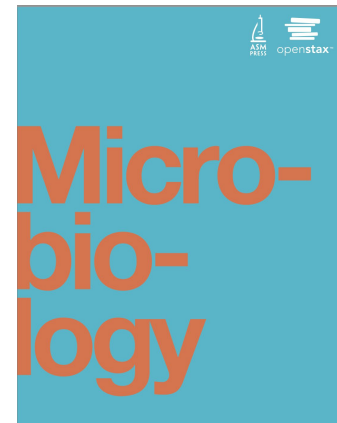
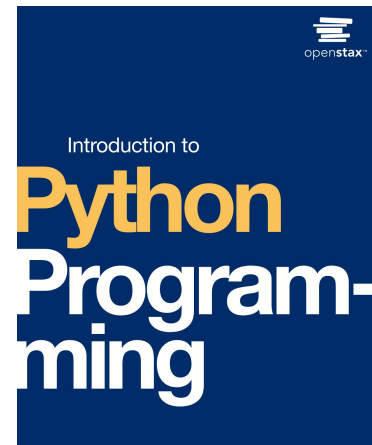
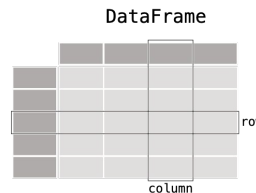


# Architecture



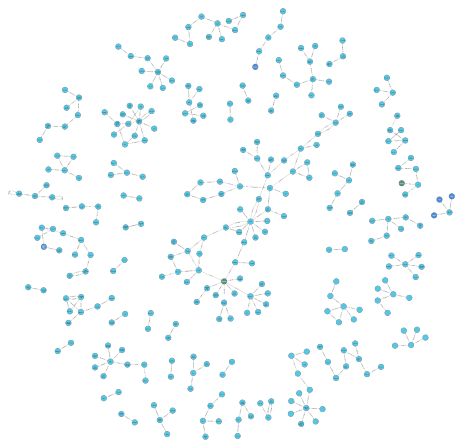
# Experiment Types

1. **Models (LLMs)**
  - a. GPT-3.5-Turbo
  - b. GPT-4-Turbo
2. **Format**
  - a. PDF
  - b. Structured .csv
3. **Provided Node Labels**
  - a. “Basic” node labels
  - b. Csv-extracted keywords as nodes
4. **Subjects (thus far)**
  - a. Microbiology
  - b. World History
  - c. Programming



# Qualitative Results

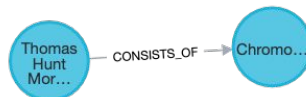
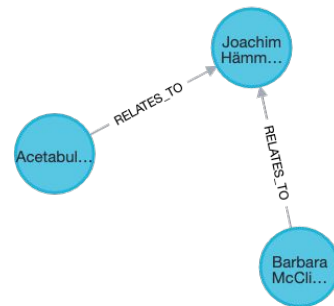
- Best knowledge graphs usually...
  - **Has structured csv format**



Left: Microbiology ch  
10 → PDF



Microbiology ch 10  
→ CSV



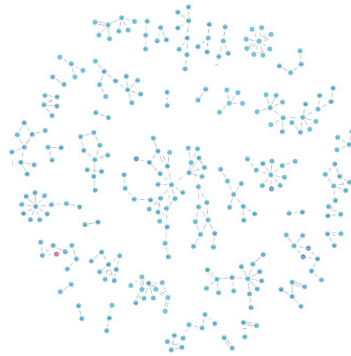
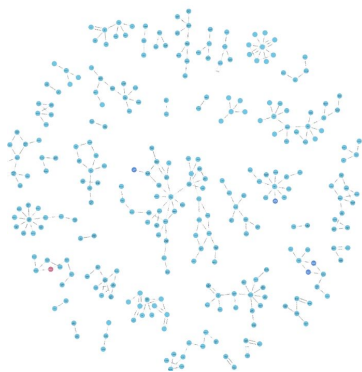
# Qualitative Results

- Best knowledge graphs usually...
  - **Use GPT-4-Turbo**

Microbiology - Chapter 10 -  
GPT 3.5 Turbo - Basic Nodes

CSV Structure

PDF



Microbiology - Chapter 10 -  
GPT4 Turbo - Basic Nodes

CSV Structure

PDF



# Additional Benefits

- Writes easily to **JSON**
  - w/ relationship desc.
- **Flexibility**
  - Descriptions as edge labels
  - “Handpick” nodes
  - Customize info
  - Build viz/app on top of json

```
{
  "type": "CONSISTS_OF",
  "start_node_id": "2",
  "end_node_id": "0",
  "properties": {
    "details": "Dictionary creation involves creating the dictionary object."
  }
},
{
  "type": "CONSISTS_OF",
  "start_node_id": "3",
  "end_node_id": "0",
  "properties": {
    "details": "Dictionary operations involve accessing, evaluating, and modifying dictionary items."
  }
},
{
  "type": "CONSISTS_OF",
  "start_node_id": "4",
  "end_node_id": "0",
  "properties": {
    "details": "Dictionary items are the key-value pairs within a dictionary."
  }
},
{
  "type": "CONSISTS_OF",
  "start_node_id": "5",
  "end_node_id": "4",
  "properties": {
    "details": "Dictionary keys are part of dictionary items."
  }
},
{
  "type": "CONSISTS_OF",
  "start_node_id": "6",
  "end_node_id": "4",
  "properties": {
    "details": "Dictionary values are part of dictionary items."
  }
},
}
```

# Discussion

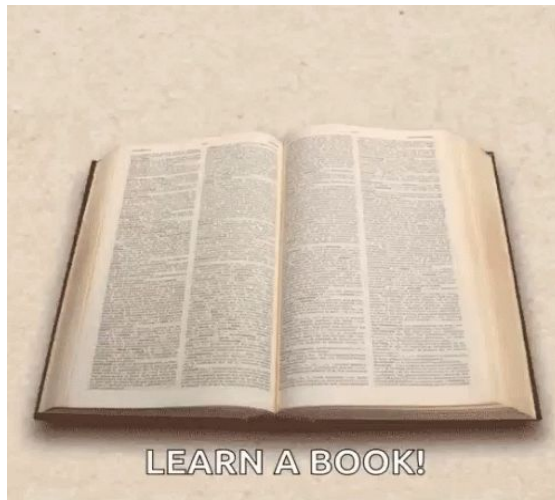
- Concept maps for education improve with:
  - Structured text inputs
  - Customizability
  - “Better” models
    - Clear & Concise
      - Ease of interpretation of large inputs
    - Accurate & Relevant
      - Factuality
      - Optimal keyword selection
      - Informative relationships

# Educational Impact

- Visual representation of knowledge
  - *“A picture is a thousand words”*
  - **Clear & concise** summaries information
- Complementary learning tool/aid
- Handle interdisciplinary concepts
- Our results can improve educational KGs
  - Structured text
  - Customizable



# Thank You!



LEARN A BOOK!