CS 439 25F
Clustering: k-Means and t-SNE

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Group 24
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Project Description

- This project investigates the label summaries in a Graph City of Paper Citation Network, where each building is a fixed point of degree peeling.
- It identifies salient labels within each fixed point using measures such as TF-IDF and examines their correlations with fixed point peel values and sizes (within a logarithmic factor). The project further explores whether these relationships enable predicting a paper's most probable building association based on the set of words in its title and abstract using Naïve Bayes classification.
- Finally, by representing each fixed point as a meta-node, the project evaluates their topological importance through PageRank, presenting an overall ranking on important labels.

Dataset Description and Sample Snapshots

- **Please note the following dataset size requirement for your project:**
  - **For tabular datasets (DataFrames), the dataset must be at least 8 MB in size.**
    - Example: A dataset with 100,000 records, each containing 20 features stored as 4-byte integers or floats, totals approximately 8 MB.
    - If your dataset is smaller than 8 MB, you may consider augmenting it by adding additional data or derived features (e.g., polynomial features such as squares or interaction terms).
  - **For image datasets** , we consider a typical 32 × 32 pixel image with four RGBA channels (4 Bytes per pixel), roughly 4 KB. To meet the 8 MB minimum requirement, **you will need at least 2,000 such images.**

- Bonus Policy:
  - To incentivize the use of larger datasets, for every additional 8 MB beyond the initial 8 MB, you will receive 3 bonus points, up to a maximum of 30 bonus points.

- Please ensure your dataset meets these requirements before submission.

Dataset Description and Sample Snapshots

- Dataset Name: ogbn-papers100M
  - a directed citation graph of 111 million papers indexed by MAG
  - Vertices: 111M papers
  - Edges: 1.6B citations

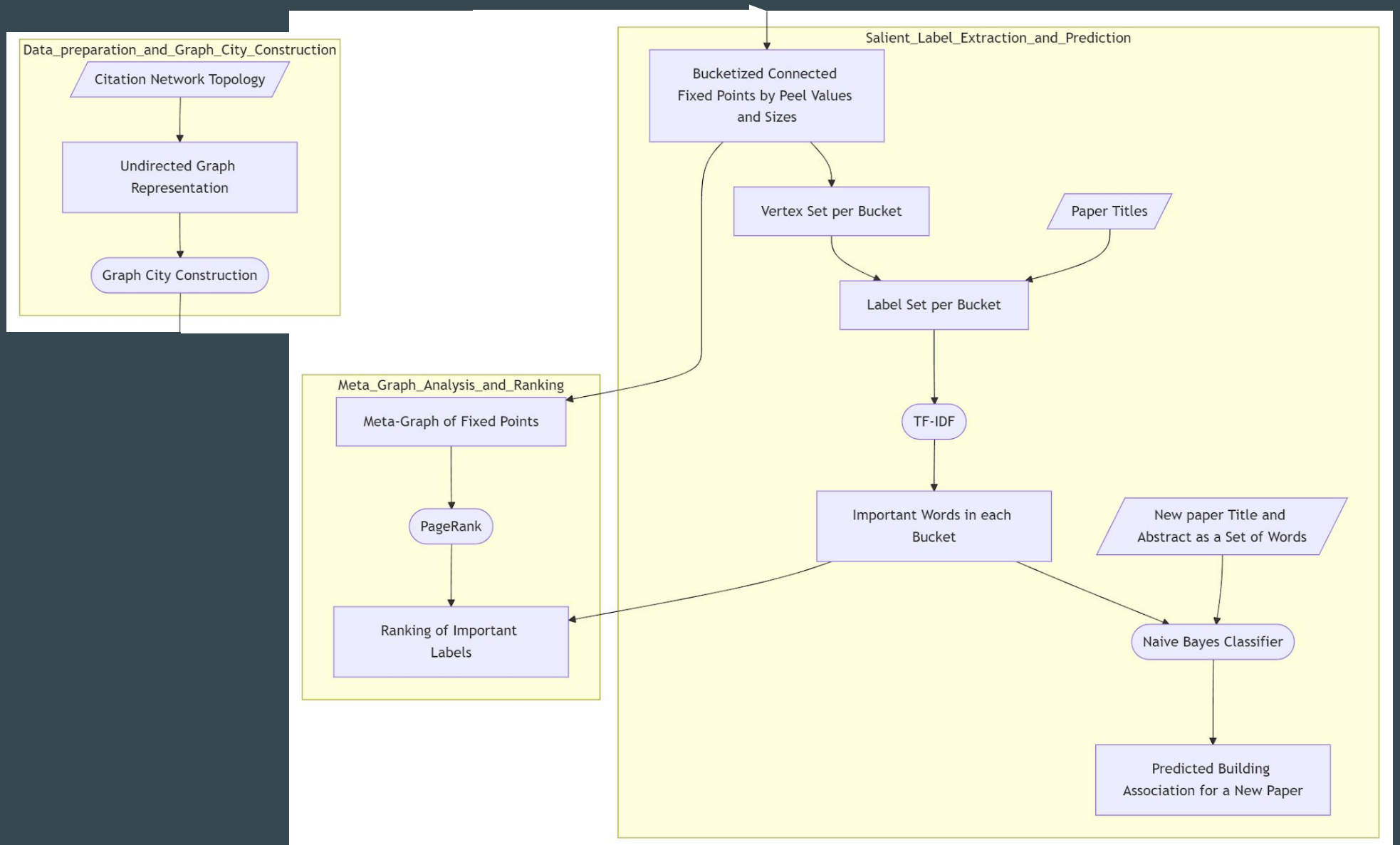
  - Snapshot of dataset format
  - Sample plots of data statistics (deg dist, avg deg, cc sizes dist, avg cc sizes, ...)

Questions to be Addressed

- Which vertex labels are considered “salient” within a Graph City Building? (A building corresponds to what is called a fixed point of graph degree peeling.)
- Do the “salient” vertex labels in each building exhibit correlations with the corresponding building peel values and/or building sizes (within a log factor)?
  If such relationships exist, is it possible to predict the most probable building association for a given paper based on the words it contains?

- Viewing each building as a meta-node, constructing an intersection graph of buildings. Which are more “relevant” to a query in terms of PageRank?
- Analyze the impact of citation directions between “local vertices” in a building and between them and “shared vertices”
- Based on the PageRank distribution of each building, can one construct an overall ranking of “salient” labels of the entire citation network?
- Are there any other “importance” measurements, e.g., betweenness centrality, that can be used to extract topic semantics?

Data Transformation Flowchart



Exploration Algorithms Used

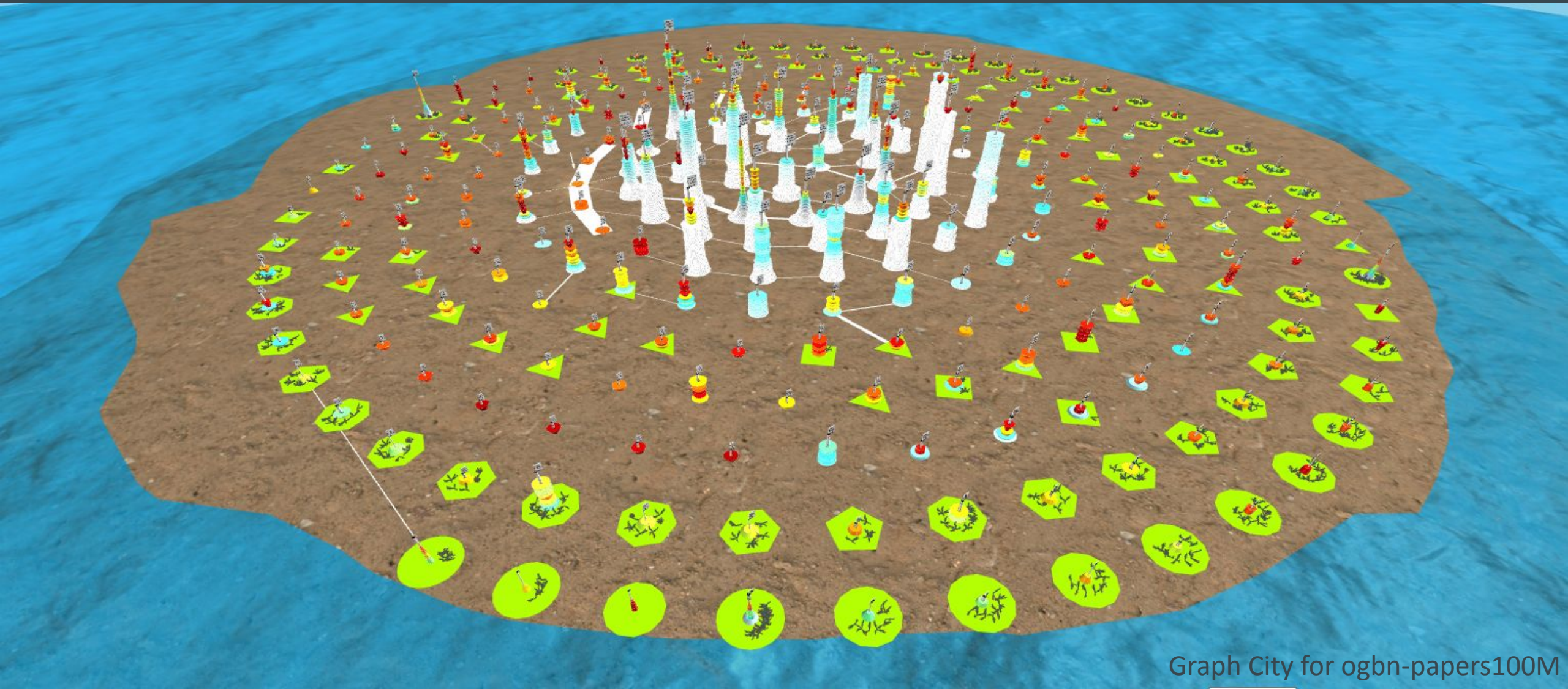
- Data Cleaning
- Graph Cities Processing
  - Vertex Peeling (k-core)
  - Iterative Graph Edge Partition (fixed points of graph degree peeling)
- Label Summarization and Prediction
  - TF-IDF for “salient” labels appearing in each building
  - Naïve Bayes Classifier for the prediction of the probability of a paper being associated with a building
  - PageRank to assign a level of “importance” to the buildings in the Graph City

Computational Platform and Software Libraries Used

- Preprocessing
  - Python: OGB, NumPy, Pandas, NetworkX, NLTK, spaCy
- Graph Cities
  - C++: The Boost Graph Library
  - Python: NumPy, SciPy, Matplotlib, Pandas
  - JavaScript: Node.js, Three.js, D3.js
- Label Summarization and Prediction
  - Python: NetworkX, PySpark, scikit-learn, NLTK, spaCy, wordcloud

Gantt Charts

Visualizations



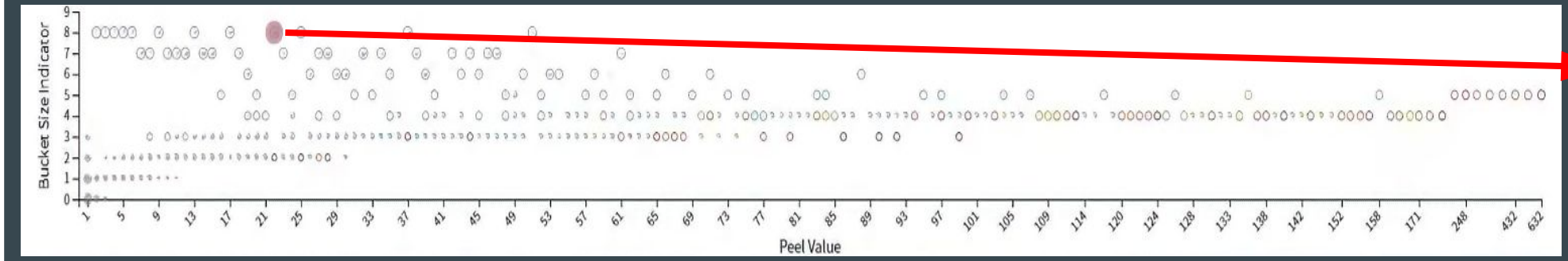
Graph City for ogbn-papers100M

Visualizations

- Label Summaries as Word Clouds of selected fixed points

Dash Board

Bucketized Fixed Points Grid Map Selector



Label Summary

Word Cloud

Predict the probability of a paper being associated with a building / building bucket

Title

Abstract

Papers Titles with Selected Labels

Interesting Findings and Conclusions

Deliverables

- Source Code (either in a .zip directory or a link to a GitHub repo.)
- Video Demo (at most 3-4 minutes, with captions or voice over)
- Project Report (a .pdf file following ACM / IEEE conference format)
- Presentation Slides (a .pptx or .pdf file)

Future Work Extensions

References

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