KU-The Future

그래프 특성 벡터의 희소성에 따른 GCN 추론 커널의 성능 분석

Analyzing the Performance of GCN Inferences with respect to Sparsity of Graph Features

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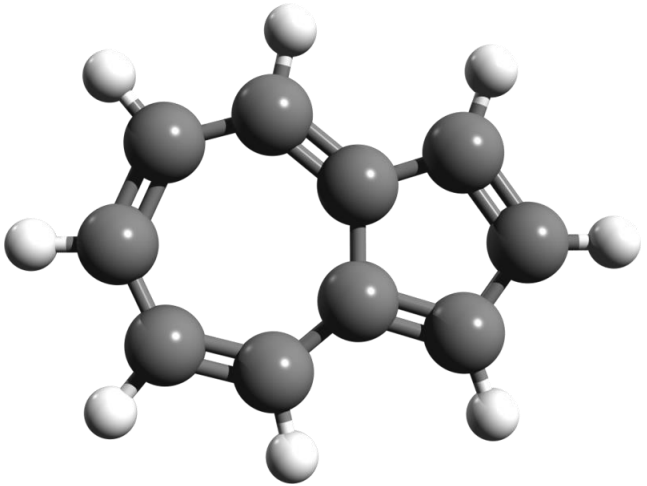
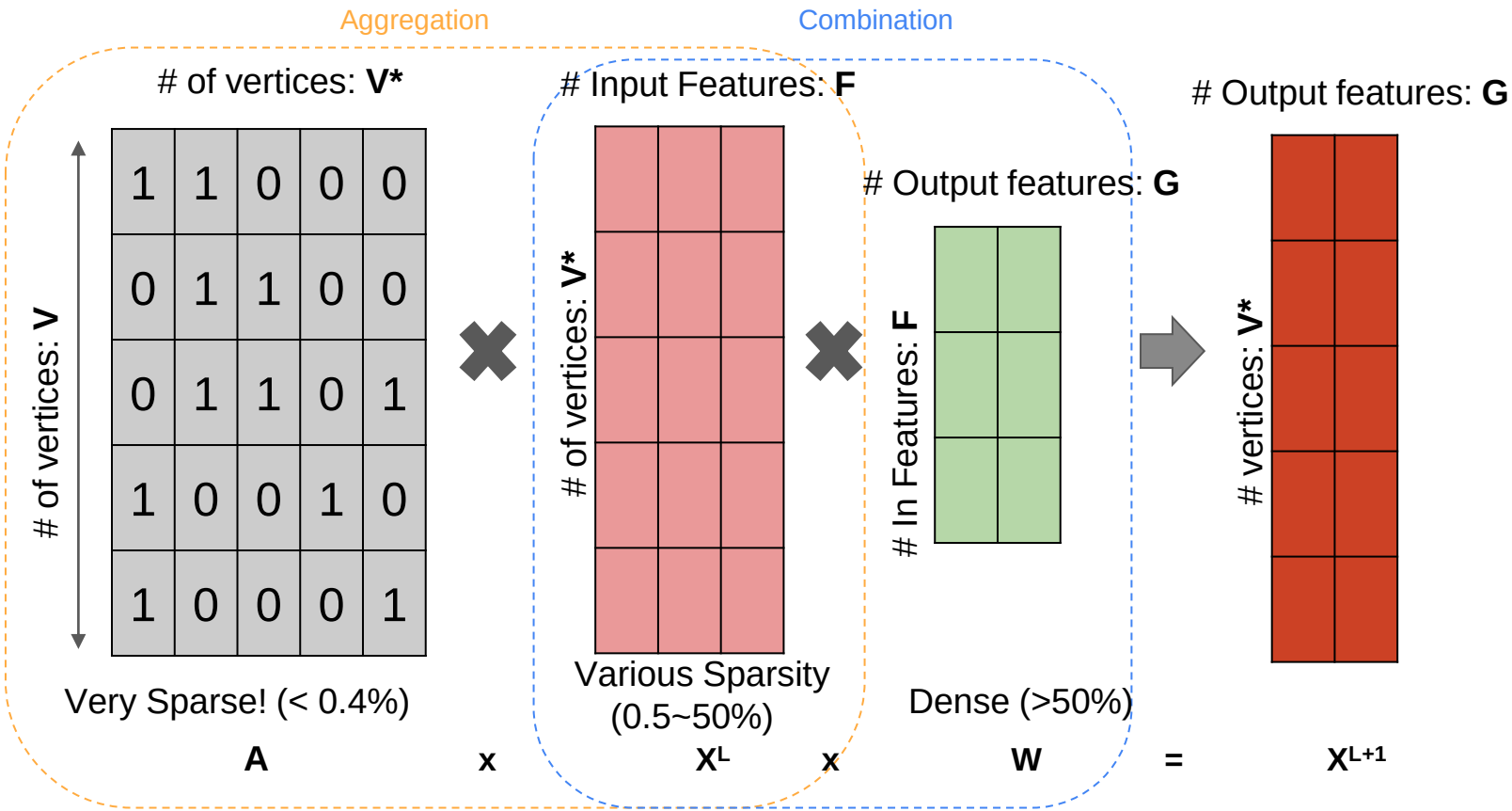
Graphs are everywhere

- Graph data structures represent ***non-euclidean*** data
- Widely used in recommendation systems, bio-chemistry analysis , etc ...



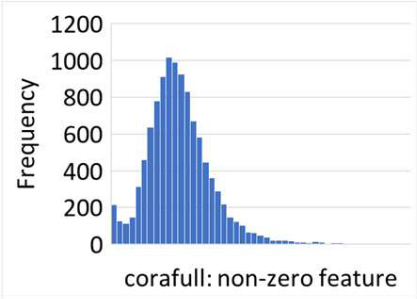
https://appsource.microsoft.com/es-es/product/power-bi-visuals/WA104381236?tab=Overview
https://bcachemistry.wordpress.com/2014/04/11/graph-theory-and-hydrocarbons/

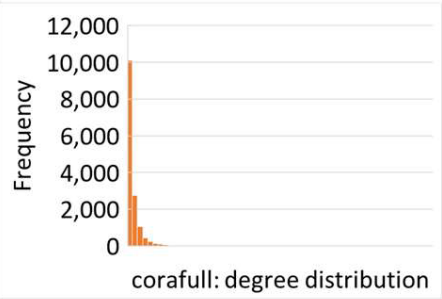
GCN Propagation Rule

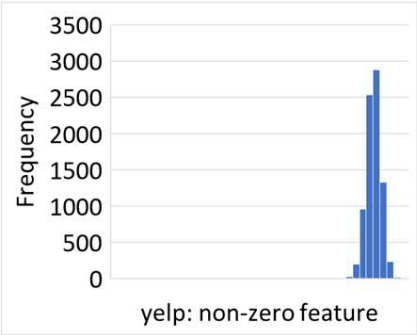


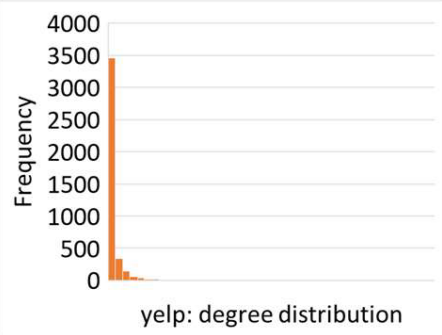
Methodology and Data Characteristics

- Graph adjacency matrices have long-tail distribution
- Graph feature matrices have asymmetric Gaussian-like distribution
- Kernels are constructed based on Fast-GCN









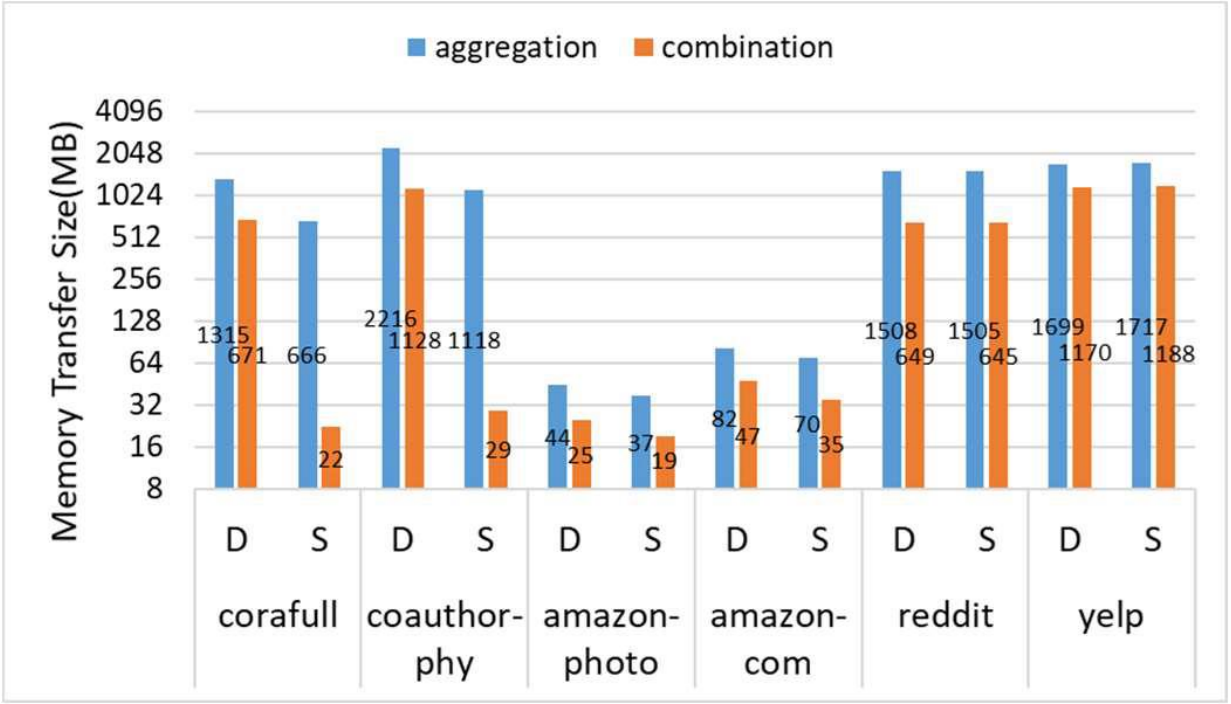
- **System**
  CUDA C/C++ using Cuda toolkit 10.2
  on Intel i7-9700 + NVIDIA rtx 2080
- **Profiler**
  NVIDIA Nsight Compute(2019.5) + NVProf

	Node	Edge	Feature Density(%)	Graph Density(%)
Corafull	19793	8710	0.65%	0.0374%
Coauthor-phy	34493	8415	0.39%	0.0446%
Amazon-photo	7650	745	34.72%	0.4250%
Amazon-com	13752	767	34.85%	0.2728%
Reddit	232965	602	49.55%	0.2100%
Yelp	716848	300	50.90%	0.0028%

Considering Storage Format

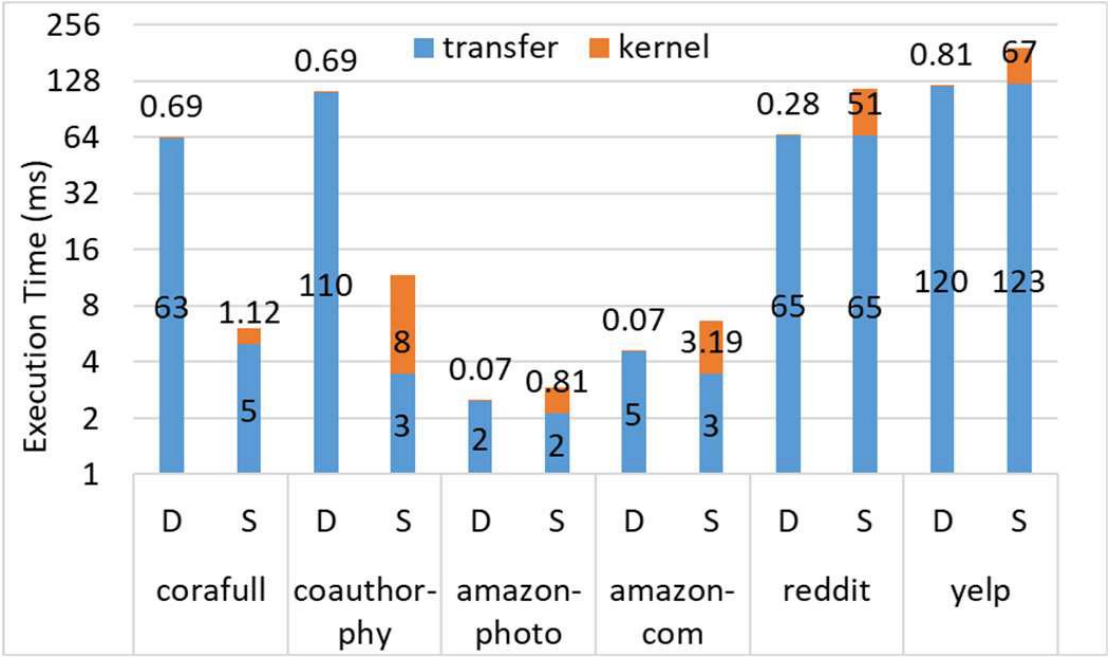
- Memory transfer size: **Aggreagtion > Combination**
- Feature matrix can affect on both of kernels

D: Dense format
S: Sparse format



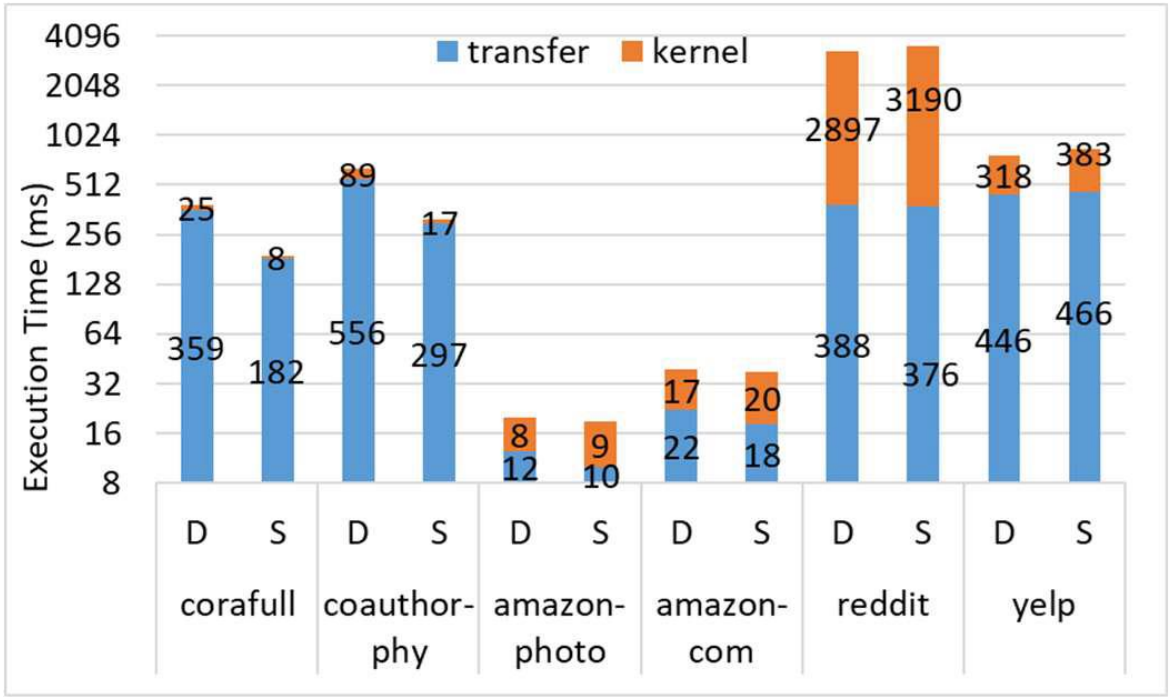
Execution Time: Combination

- The **memory transfer time** occupies a much larger part of the overall execution.
- Compressed format has **good trade-off gain**.



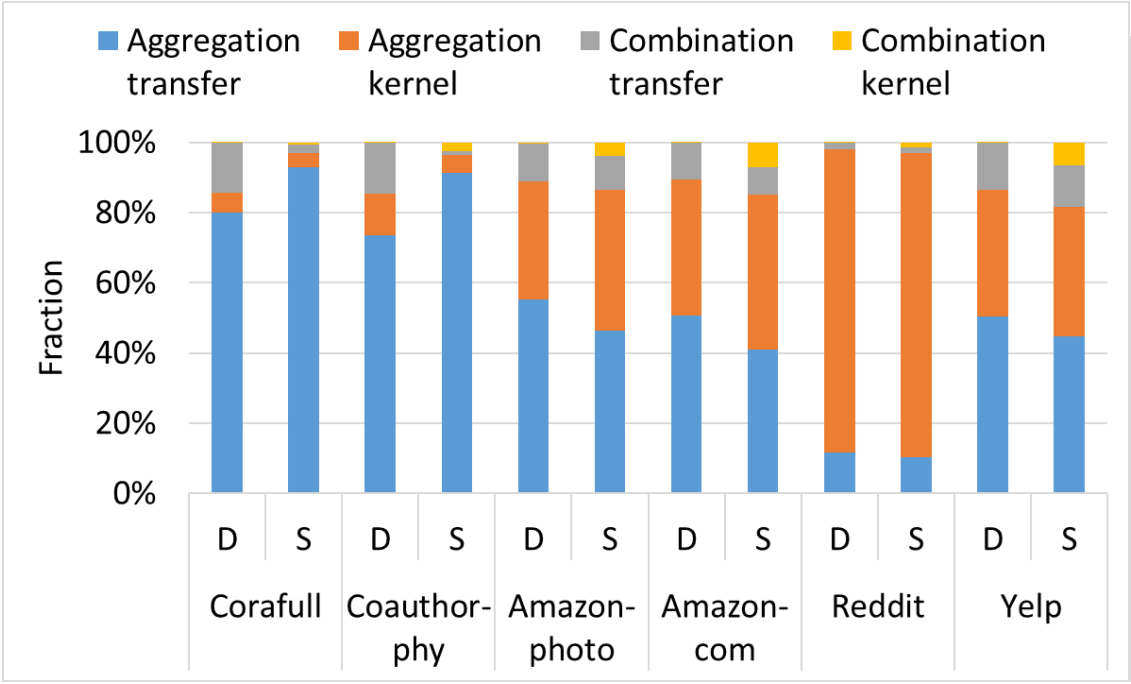
Execution Time: Aggregation

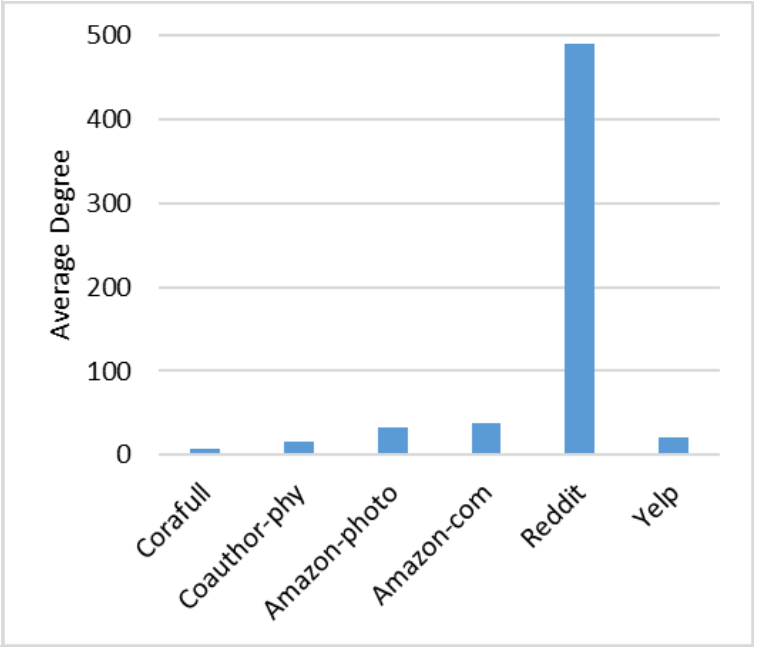
- Fractions of kernel execution time across datasets are varied
  - Corafull~Amazon-com: **Data transfer time** determines the total run-time
  - Reddit~Yelp: **Kernel execution time** determines the total run-time



Relationship between Kernel Execution and Data Properties

- Aggregation phase occupies most of the total execution time.
- The aggregation kernel execution time is proportional to the **average degree**.





Summary & Design Considerations

Summary

- The greater the **degree** (number of nodes x graph density),
  the higher the rate of **execution of the aggregation**.
- Design the kernel considering feature matrix improve the performance differently.

Design Considerations

- Data property-aware kernel execution
  - Selecting an appropriate kernel according to data characteristics.
- Improve the programming model of the kernel
  - Process multiple neighboring nodes at once.
  - Using shared memory to improve data locality.

Thank you