GPUMemNet: Deep Learning-based Estimation of GPU Memory Requirement for Neural Network Training Tasks

Ehsan Yousefzadeh-Asl-Miandoab[1] (ehyo@itu.dk), Reza Karimzadeh[2], Bulat Ibragimov[2], Pınar Tözün[1]
(1) IT University of Copenhagen, (2) University of Copenhagen

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GPU Underutilization: Causes and Opportunities

Real-world clusters exhibit only ~50% GPU utilization *

1- GPUs' lack of **fine-grain sharing** and **virtual memory**
2- **Exclusive** GPU assignment by resource managers
3- **Black box** view of tasks and GPUs

Collocating tasks together increase GPU utilization!

* Yanjie Gao et al. "**An Empirical Study on Low GPU Utilization of Deep Learning Jobs**," ICSE'24.

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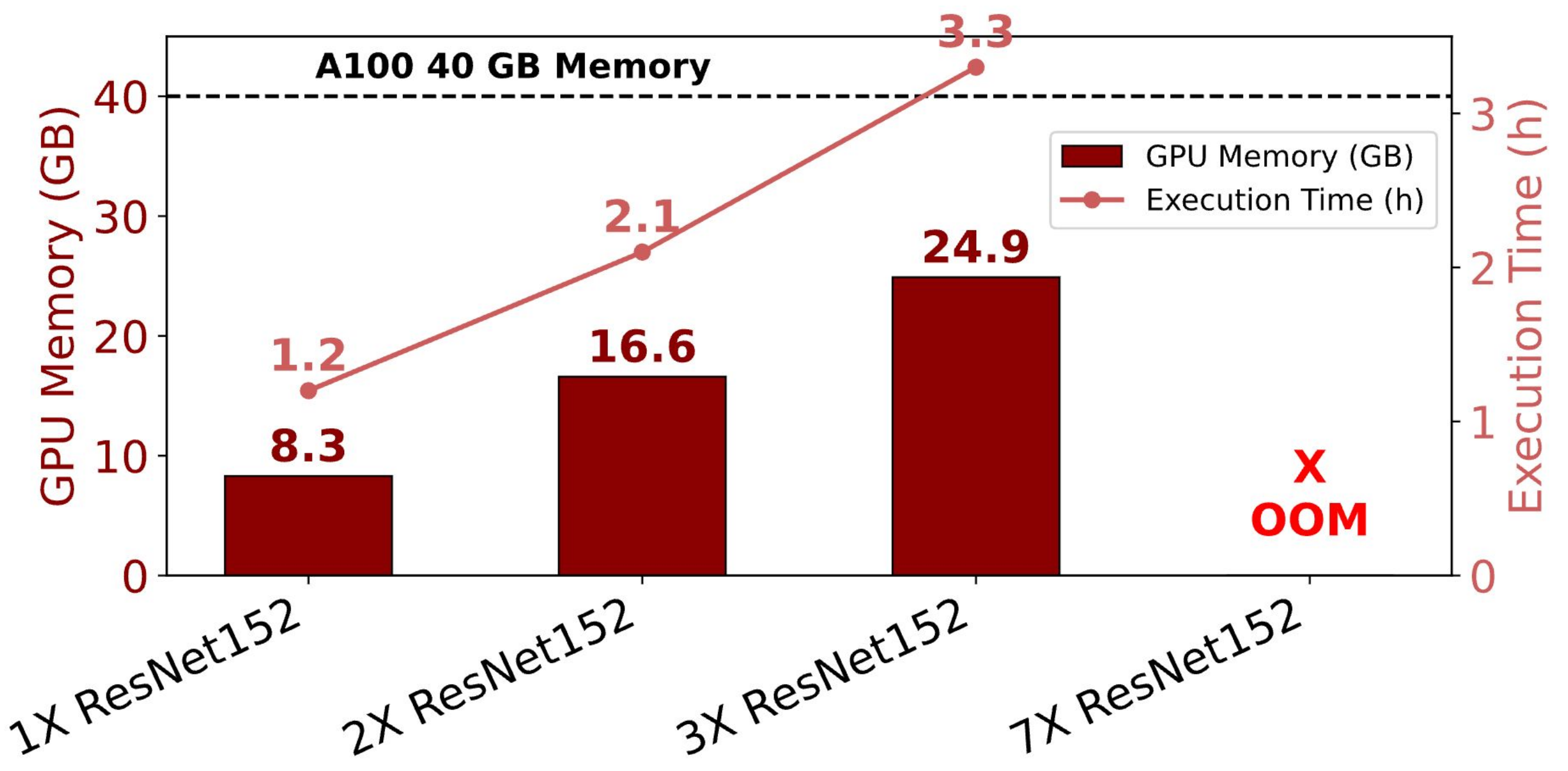
OOM Crashes & Interference!



GPU memory estimation is essential before robust collocating.

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Estimating GPU memory — easier said than done!

- GPU memory optimizations = complex data patterns
  → analytics can't keep up.

Machine Learning excels at pattern recognition.

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ML-based Estimator Challenges

1- Building a representative dataset that generalizes well!

2- Formulating the problem effectively!

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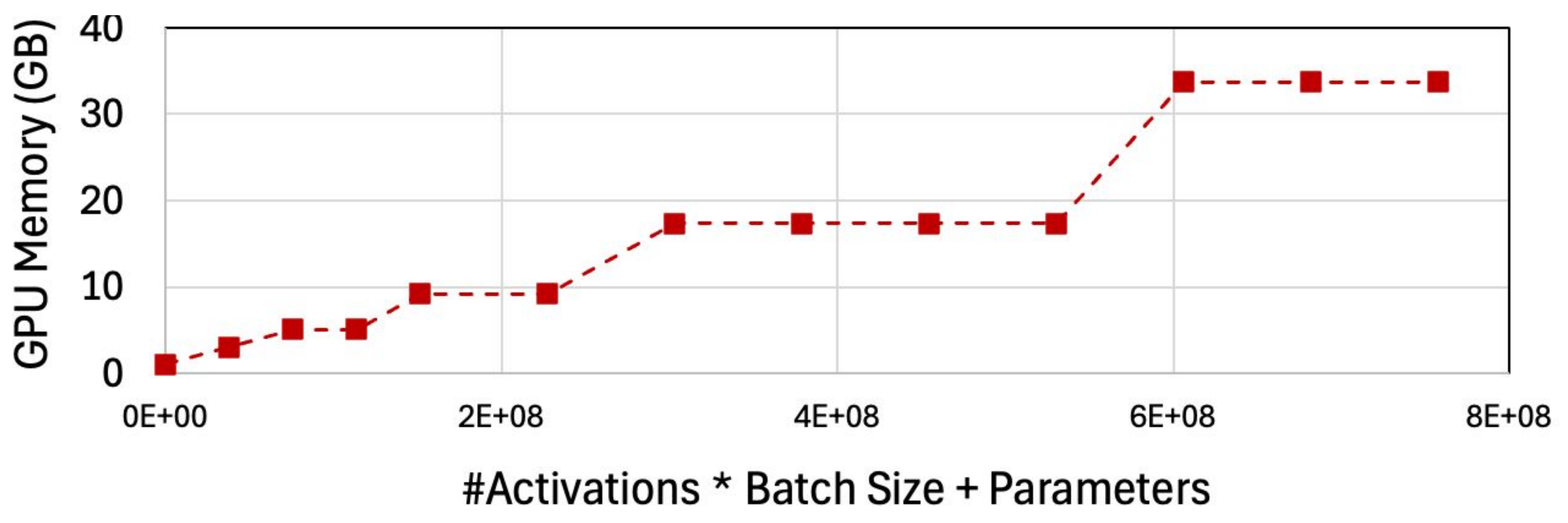
Dataset Building: What Matters

1- Focus on architecture not the model types.
2- Representative range of features.
3- Uniform feature distribution.
4- Diversity of shapes within an architecture.
5- Diversity of layers in practical architectures.
6- Varying input and output sizes.

Staircase growth → a classification problem



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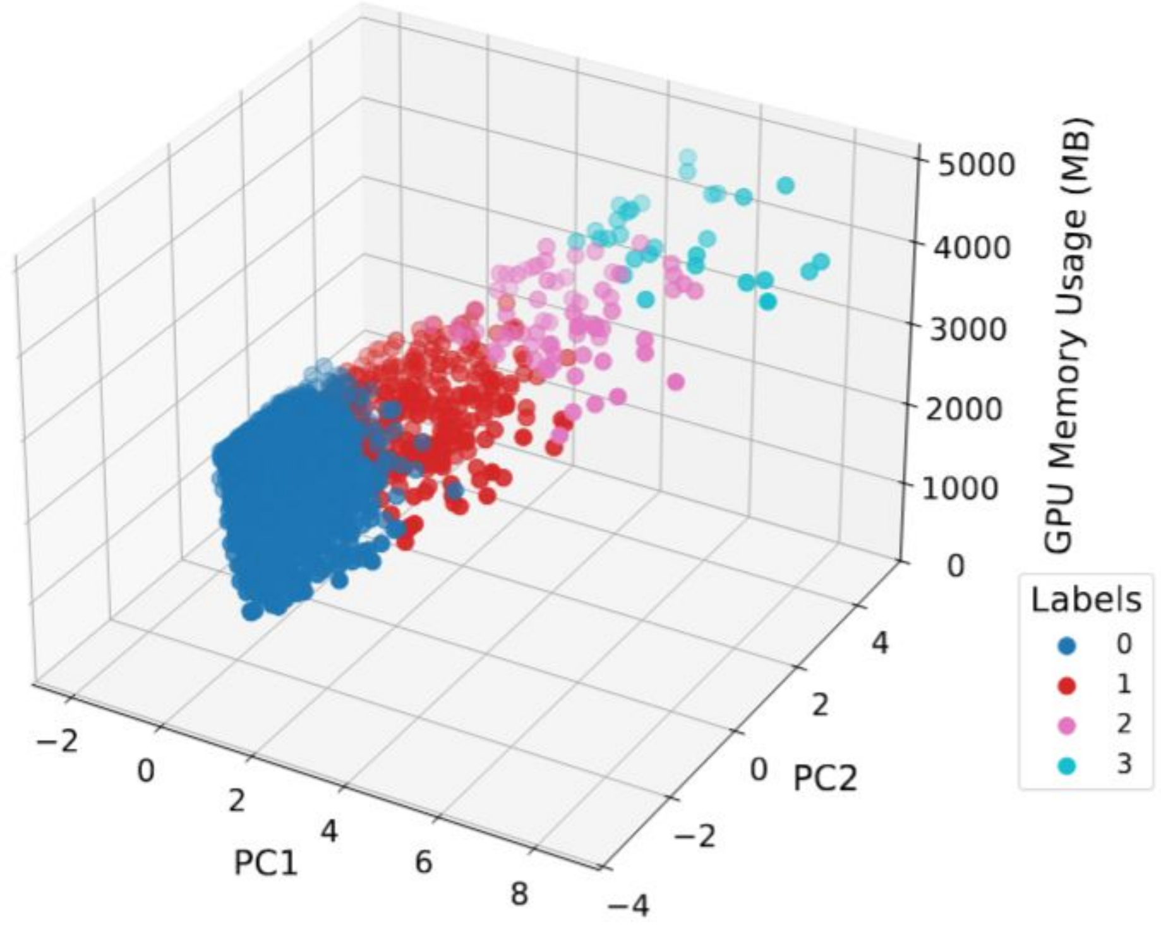
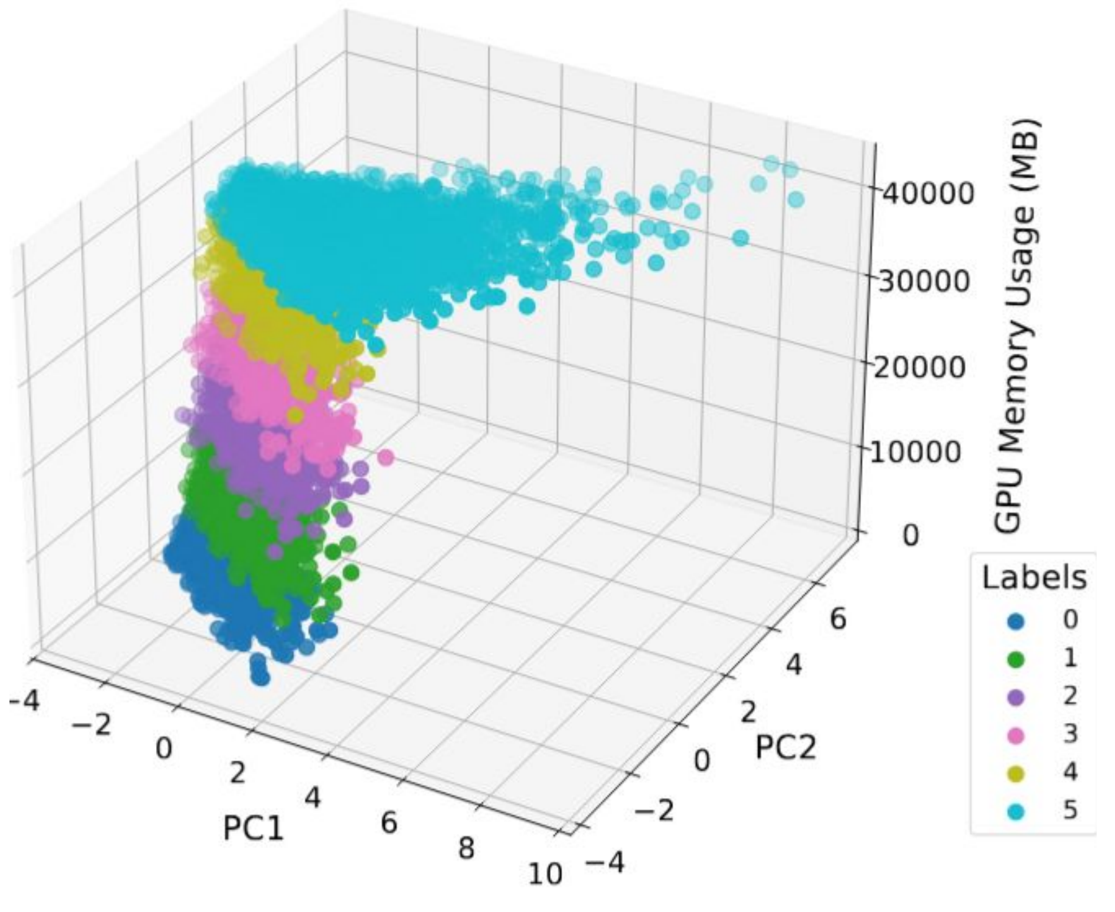
PCA Analysis

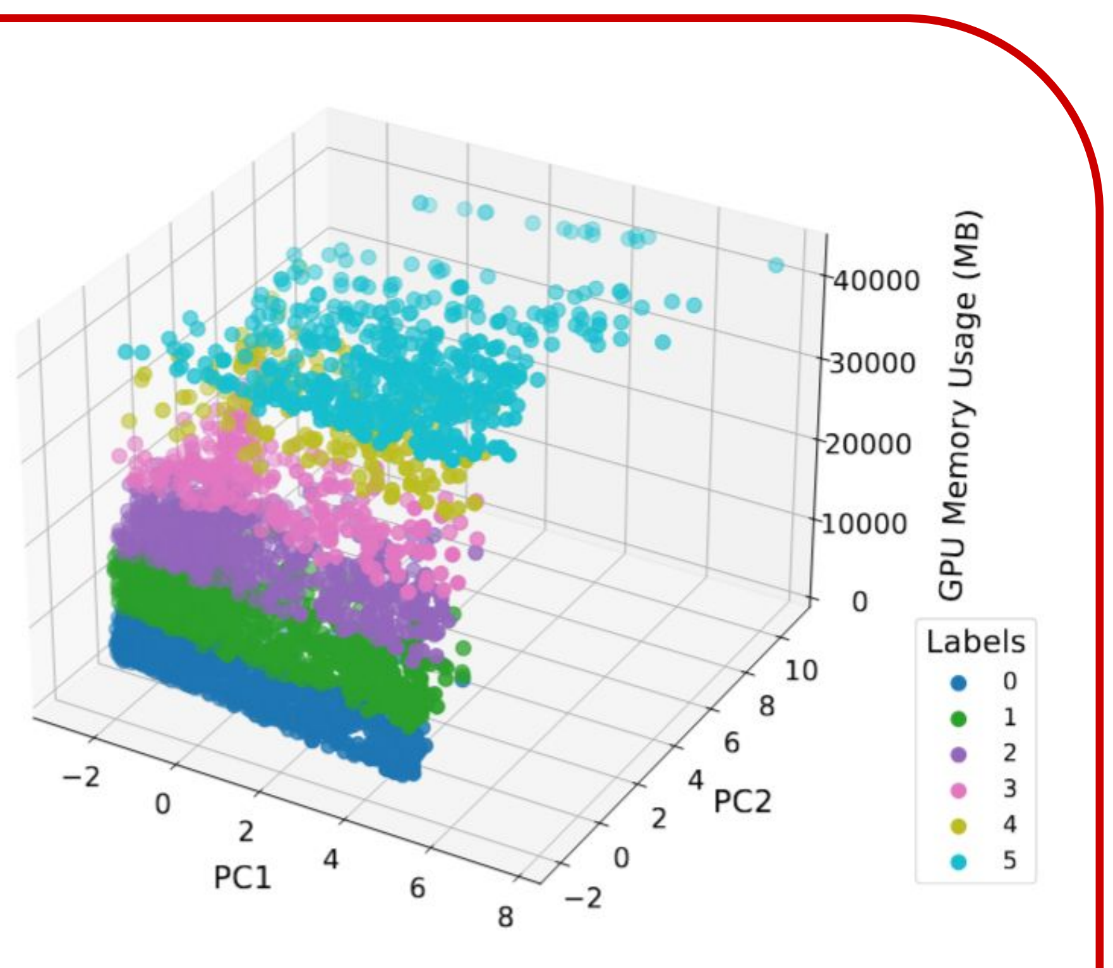
Curated dataset:
- 3K MLPs
- 9K CNNs
- 5K Transformers



MLP



CNN



Transformer

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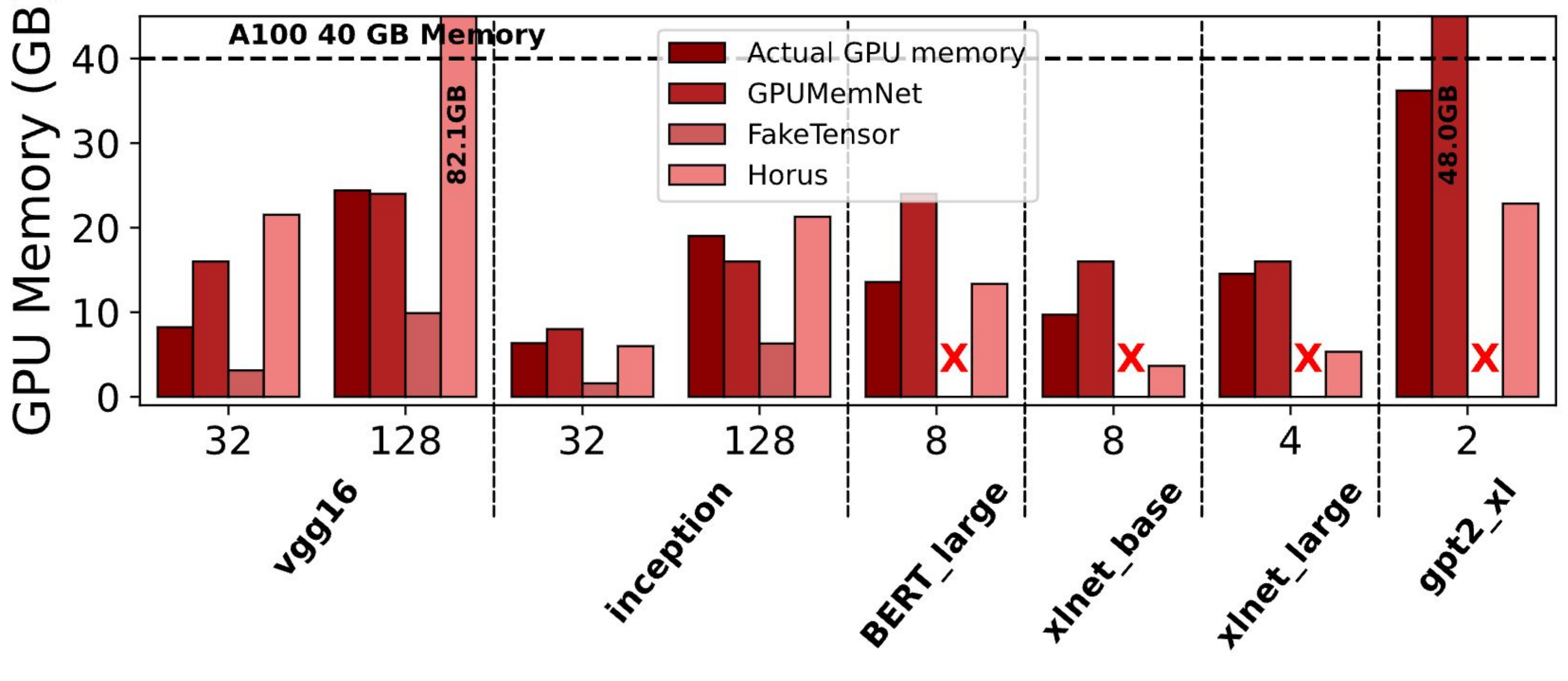
Trained MLPs & Evaluation

Dataset	Range	Accuracy	F1-Score
MLPs	2GB	0.97	0.96
	1GB	0.95	0.93
CNNs	8GB	0.83	0.83
Transformers	8GB	0.88	0.88



Batch Size, Workload (from top to bottom)

See the code on GitHub!

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