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Argonne NATIONAL LABORATORY

STATISTICAL PREDICTION OF LOSSY COMPRESSION RATIOS FOR 3D SCIENTIFIC DATA

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WHY USE COMPRESSION IN HPC?

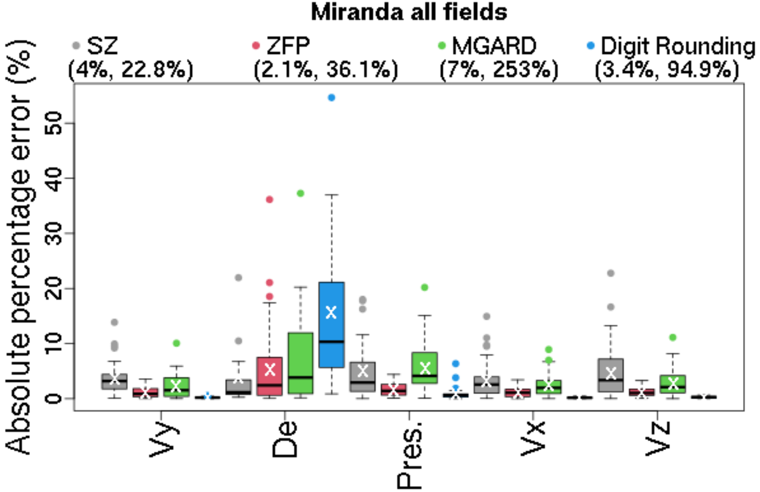
- HPC applications require lots of storage and memory throughput
- Compression allows for larger problem sizes to be ran while accelerating I/O time
- Checkpoint snapshots of an application's state

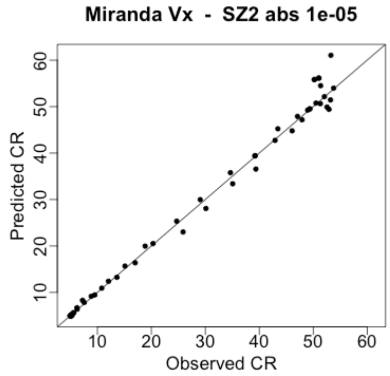
OUR PREVIOUS WORK

CR estimation for 2D datasets

- Statistical predictors with notions of correlation, entropy and lossyness
  - Truncated SVD
  - Quantized entropy

$$\log(\mathrm{CR}) = a + b \times \log(\text{q-ent}) + c \times \log\left(\frac{\text{SVD-trunc}}{\sigma}\right) + d \times \log(\text{q-ent}) \times \log\left(\frac{\text{SVD-trunc}}{\sigma}\right) + \epsilon, \quad (1)$$





EXTENSION TO 3D DATASETS

Completed this summer

- Extend statistical predictors to 3D
- Higher order SVD (HOSVD)

Algorithm 1 High-order SVD on tensor X of order N

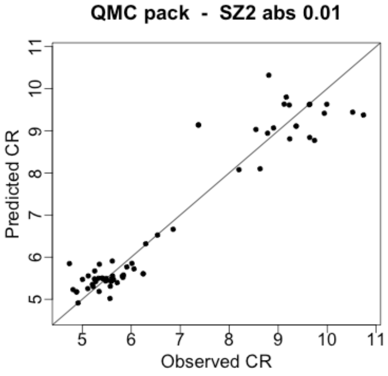
for $i = 1, ..., N$ **do**
  $X_{(i)} \leftarrow$ unfolding(X, mode=i)
  $X_{(i)} \leftarrow U^{(i)} D^{(i)} (V^{(i)})^T$
  $A^{(i)} \leftarrow$ left singular vectors $U^{(i)}$ of $X_{(i)}$
end for

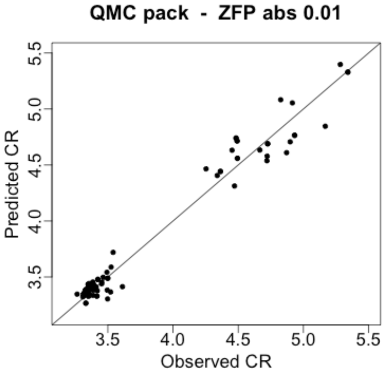
- Used the same regression model used for 2D datasets

RESULTS FOR 3D

- Comparable results to the 2D method counterpart

Compressor	MPE (median percentage error)	10% Quantile	90% Quantile
SZ2	4.5%	3.2%	5.7%
ZFP	1.7%	1.3%	3.5%
MGARD	0.6%	0.4%	1.3%
Bit Grooming	7.4%	5%	9.3%
TTHRESH	24.8	15.7%	27.7%





CONCLUSIONS

- Ability to predict CRs in 3D remains competitive with our method
- Flexible across compressors, error bounds, and datasets

CURRENT WORK

- Currently working on sampling-based approaches to reduce computational costs
  - Generate training samples from blocks of the data
  - Estimate CR using the samples and our predictors

QUESTIONS?

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