Data partitioning strategies for 3D tomographic imaging

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3D imaging
Tomography
Helical CT
Forward projection
Backprojection
Definition

A partitioning $\Pi_V$ of a set $V$ is a collection of subsets $V_i \subset V$:

$$\Pi_V = \{V_1, \ldots, V_p\},$$

such that

1. $V_i \neq \emptyset$ (non-empty),
2. $\bigcup_i V_i = V$ (complete),
3. $i \neq j \implies V_i \cap V_j = \emptyset$ (mutually disjoint).
Partitionings of graphs

- **Graph**: partition vertices while minimizing the *edge cut*
- An edge is *cut* if it is between two different parts
- All parts should be roughly the same size
Partitionings of sparse matrices

- **Sparse matrix**: partition nonzeros while minimizing the *net cut*
- The *nets* are the rows and columns
- The net cut is the number of additional parts in a net
Projection matrix

\[ \begin{bmatrix}
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9
\end{bmatrix} \]
• **Tomography**: partition 3D volume while minimizing the *line cut*

• The line cut is the number of additional parts a line crosses
Algorithm
Partitioning results
Results & Reference

- Communication reduced by between 60% and 90%
- Each GPU guaranteed to perform the same amount of work

A geometric partitioning method for distributed tomographic reconstruction.
doi:10.1016/j.parco.2018.12.007
3D image reconstruction involves large data sets. Because lines couple opposite sides of 3D volume, it is not easy to parallelize. Using ideas from computational geometry, we are able to scale our algorithms beyond what was possible before.

Thank you for your attention!