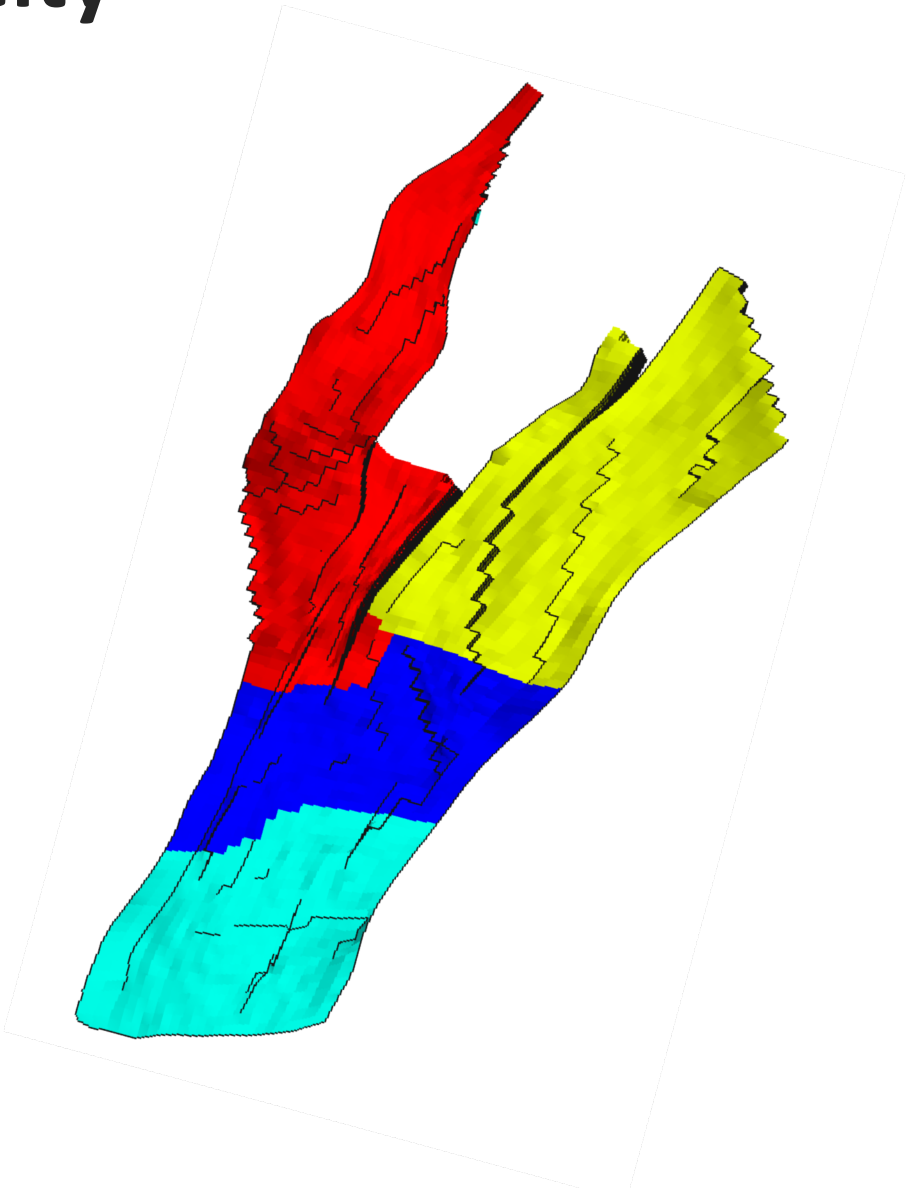
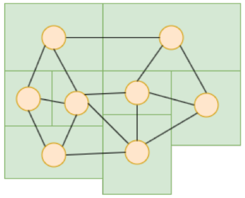
Mesh partitioning in presence of strong coefficient heterogeneity



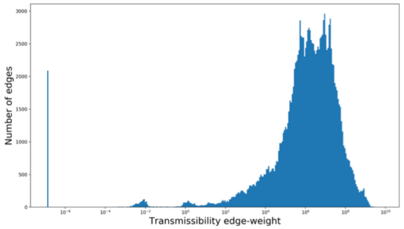
Andreas Thune

24. January 2019

This presentation focuses on mesh-partitioning in OPM’s Flow reservoir simulator.

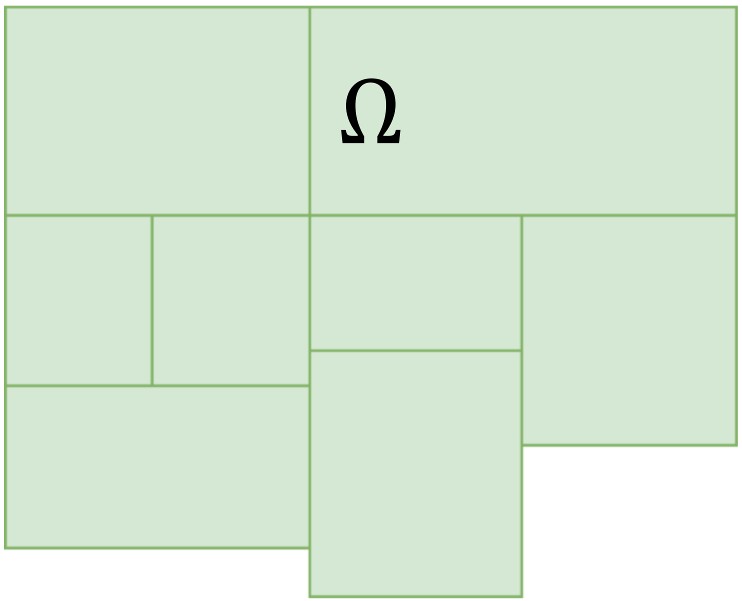


Domain decomposition and weighted graph partitioning schemes.



Experiments on alternative strategies.

The current domain decomposition strategy of Flow uses an edge-weighted graph partitioning scheme.



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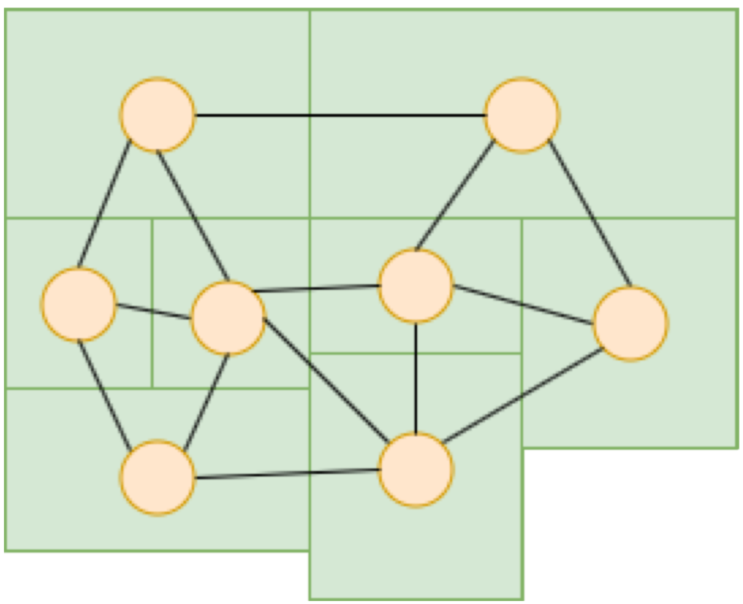
$$\Omega \rightarrow G = (V, E)$$



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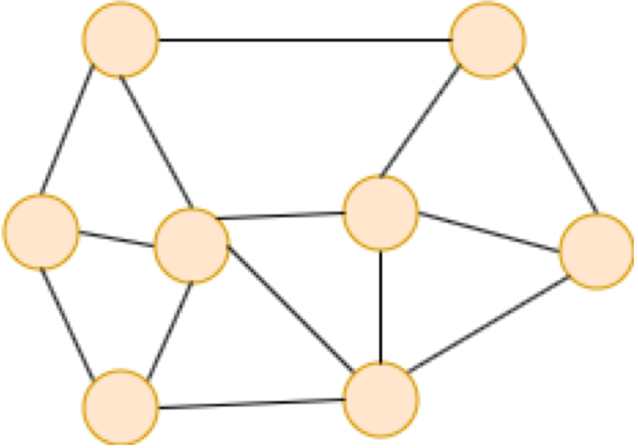
Graph partitioning problem:

$$min_{\mathcal{C}} \sum_{e \in \mathcal{C}} 1$$

$$|G_1| \approx |G_2|.$$



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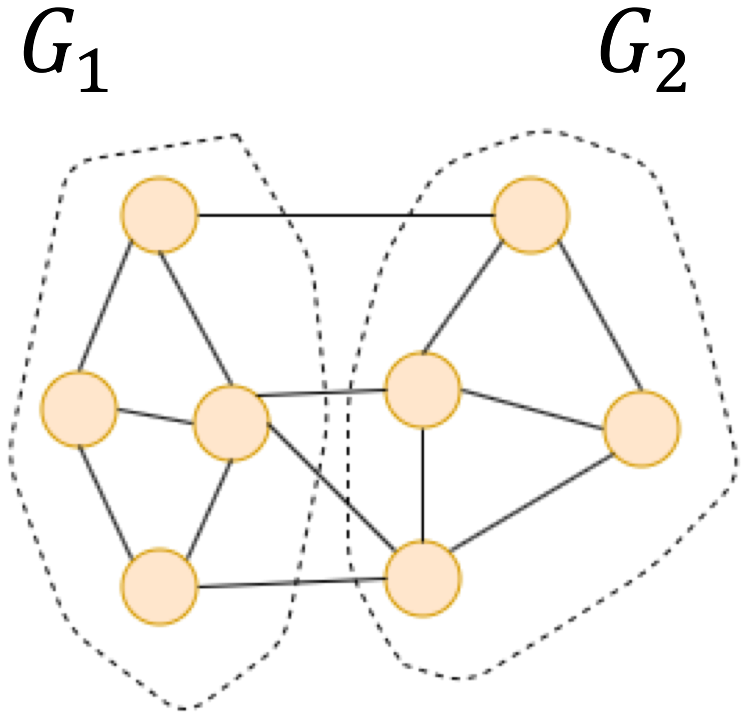

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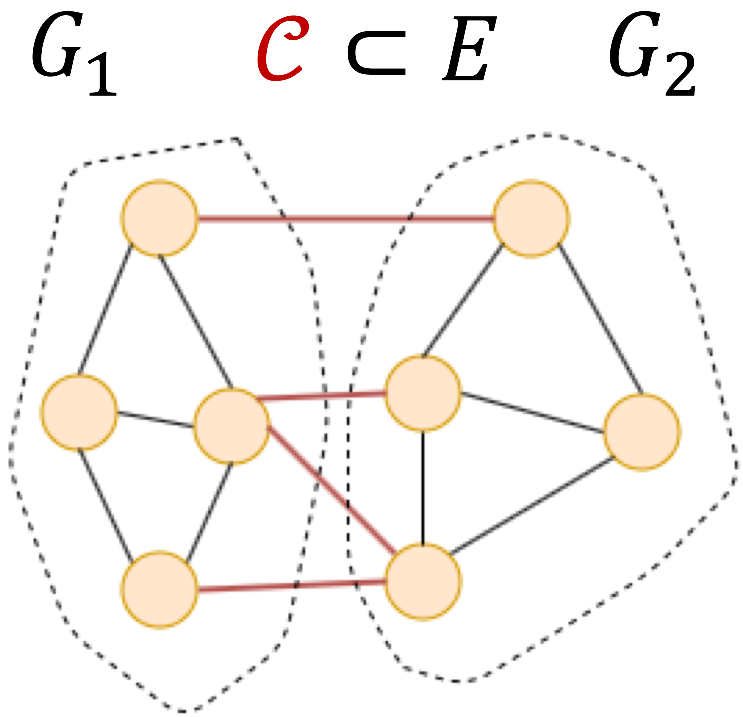

Edge cut:

$$J(\mathcal{C}) = \sum_{e \in \mathcal{C}} 1$$

$J(\mathcal{C})$ approximates the communication cost.

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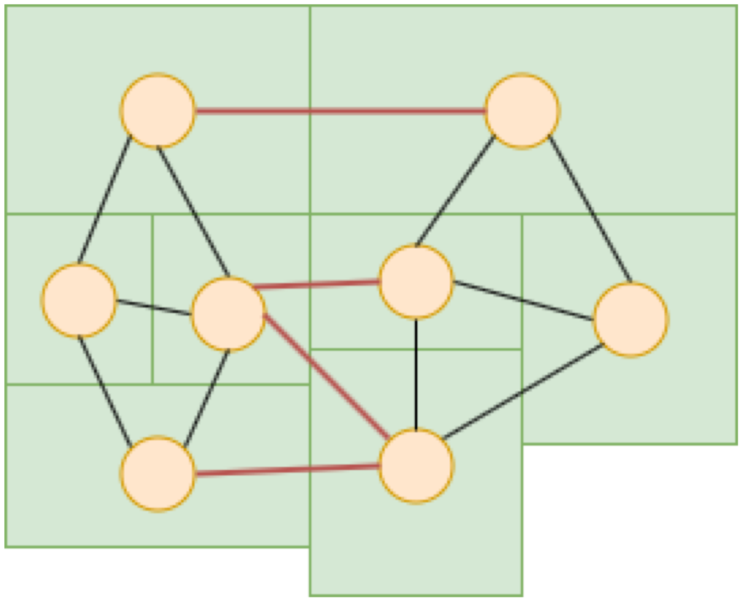

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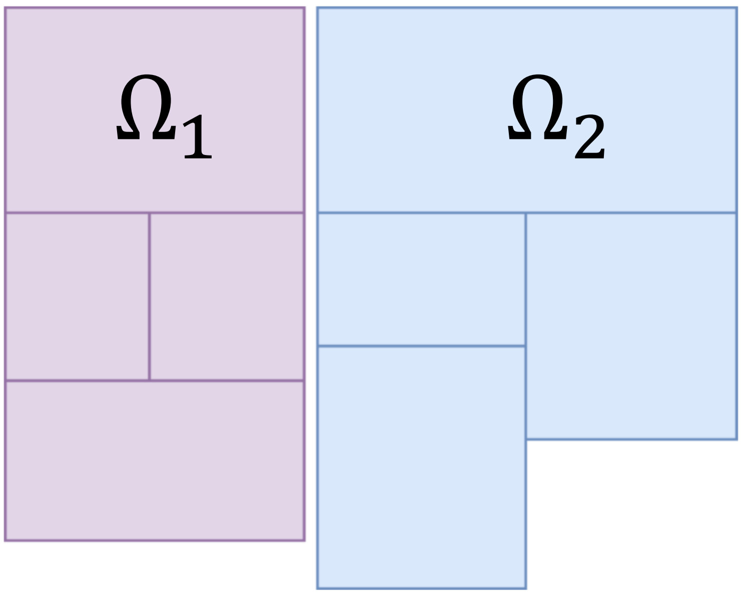
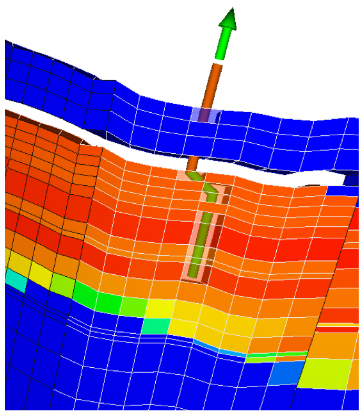
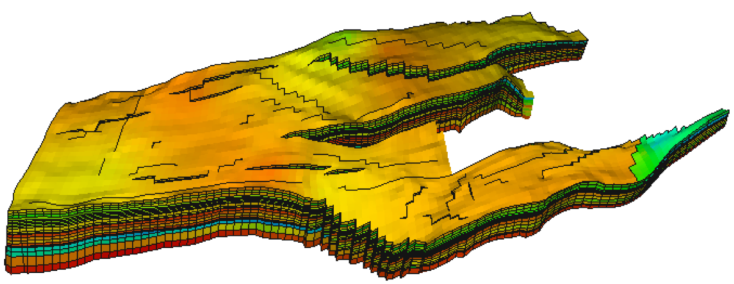
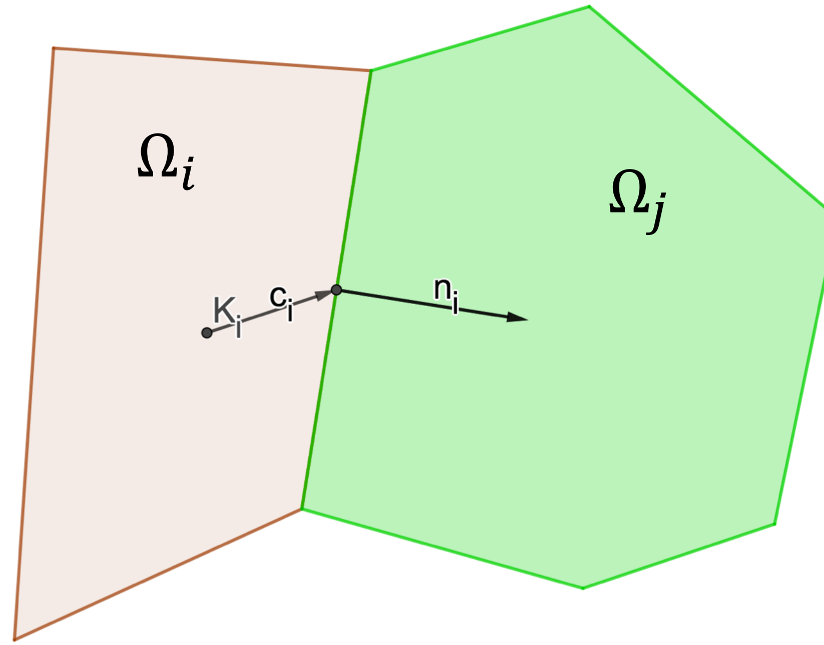


Heterogenous geological properties of the reservoir and wells motivates edge-weights in the partitioning scheme.







Transmissibility:

$$T_{ij} = \left(\frac{1}{t_i} + \frac{1}{t_j}\right)^{-1} \qquad t_i = \frac{\vec{c}_i K_i \, \vec{n}_i}{||\vec{c}_i||^2}$$

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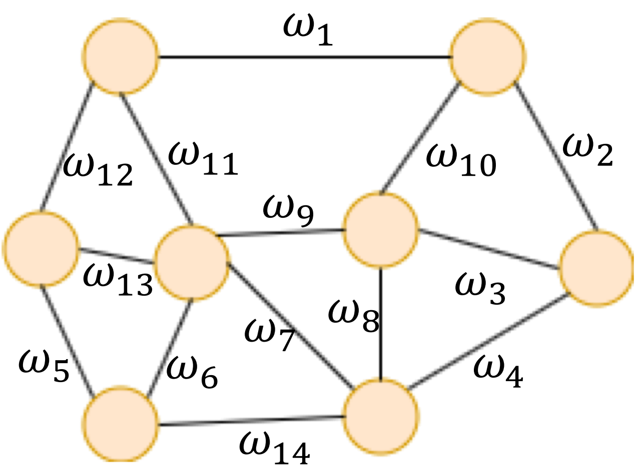


Weighted Edge cut:

$$J(\mathcal{C}) = \sum_{e \in \mathcal{C}} \omega_e$$

A weighting strategy based on cell-face transmissibility yield very heterogenous edge-weights.

Transmissibility weights:

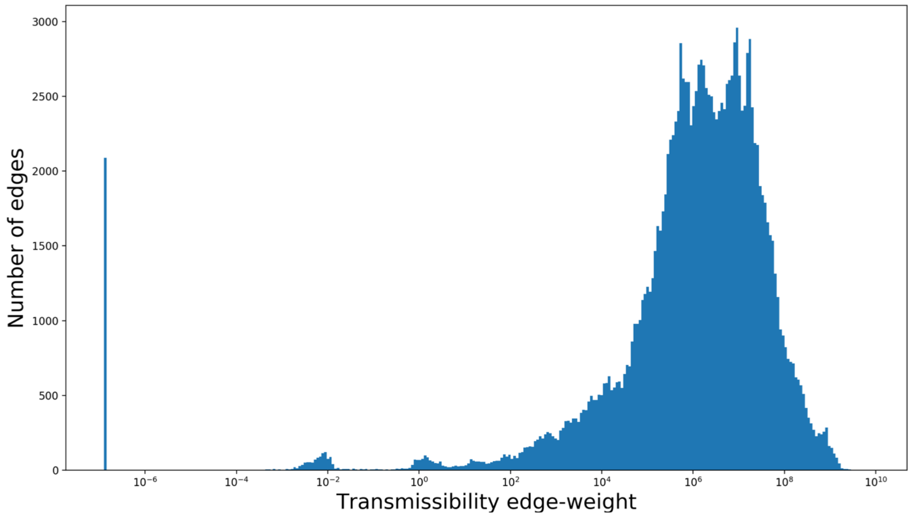
$$\omega_e = T_e$$

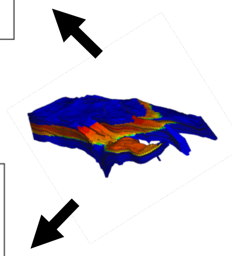
Logarithmic weights:

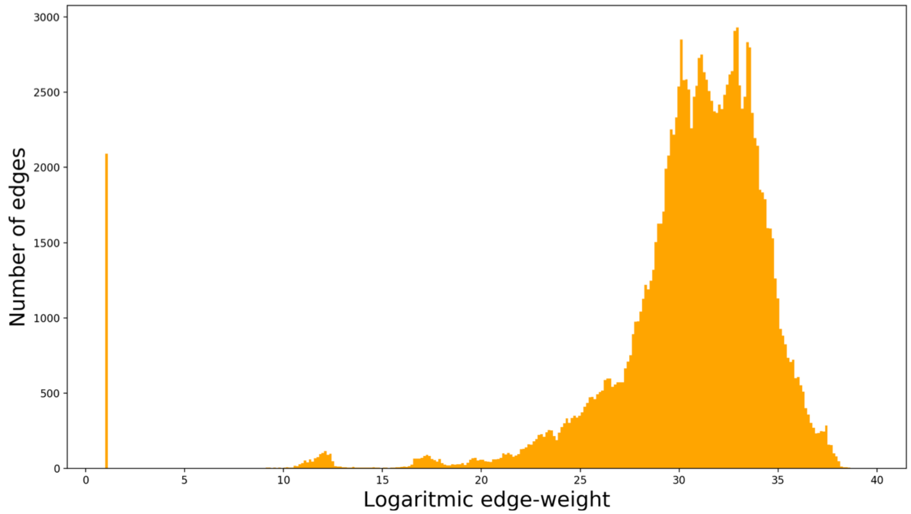
$$\omega_e = \log T_e$$

Uniform weights:

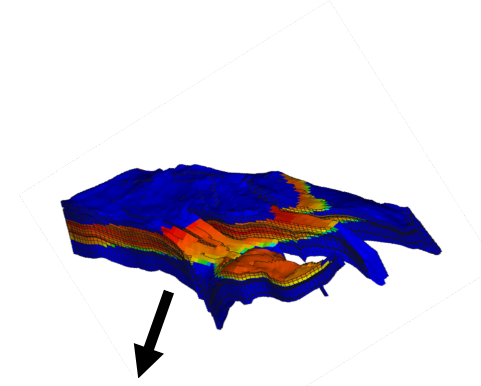
$$\omega_e = 1$$

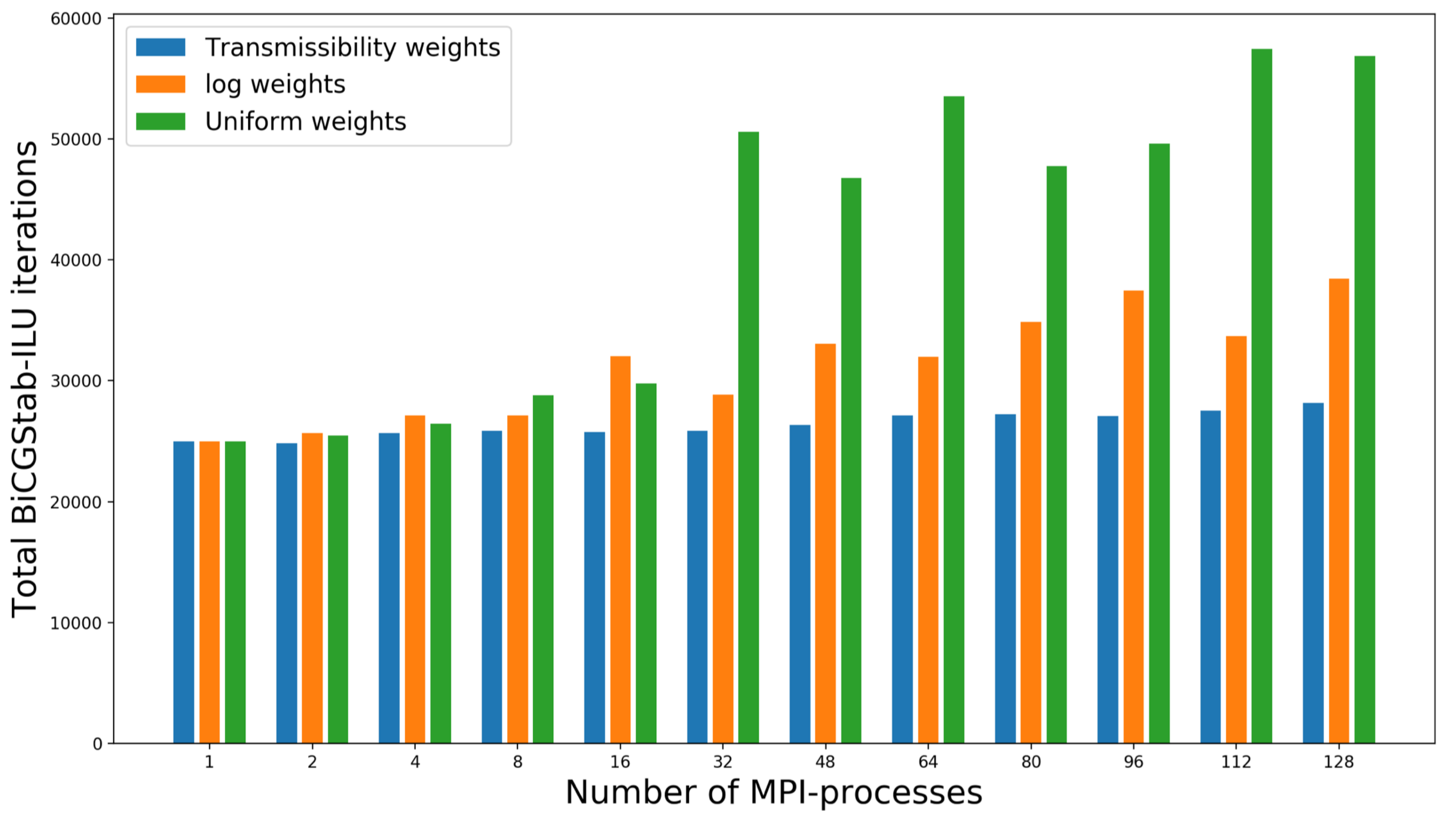




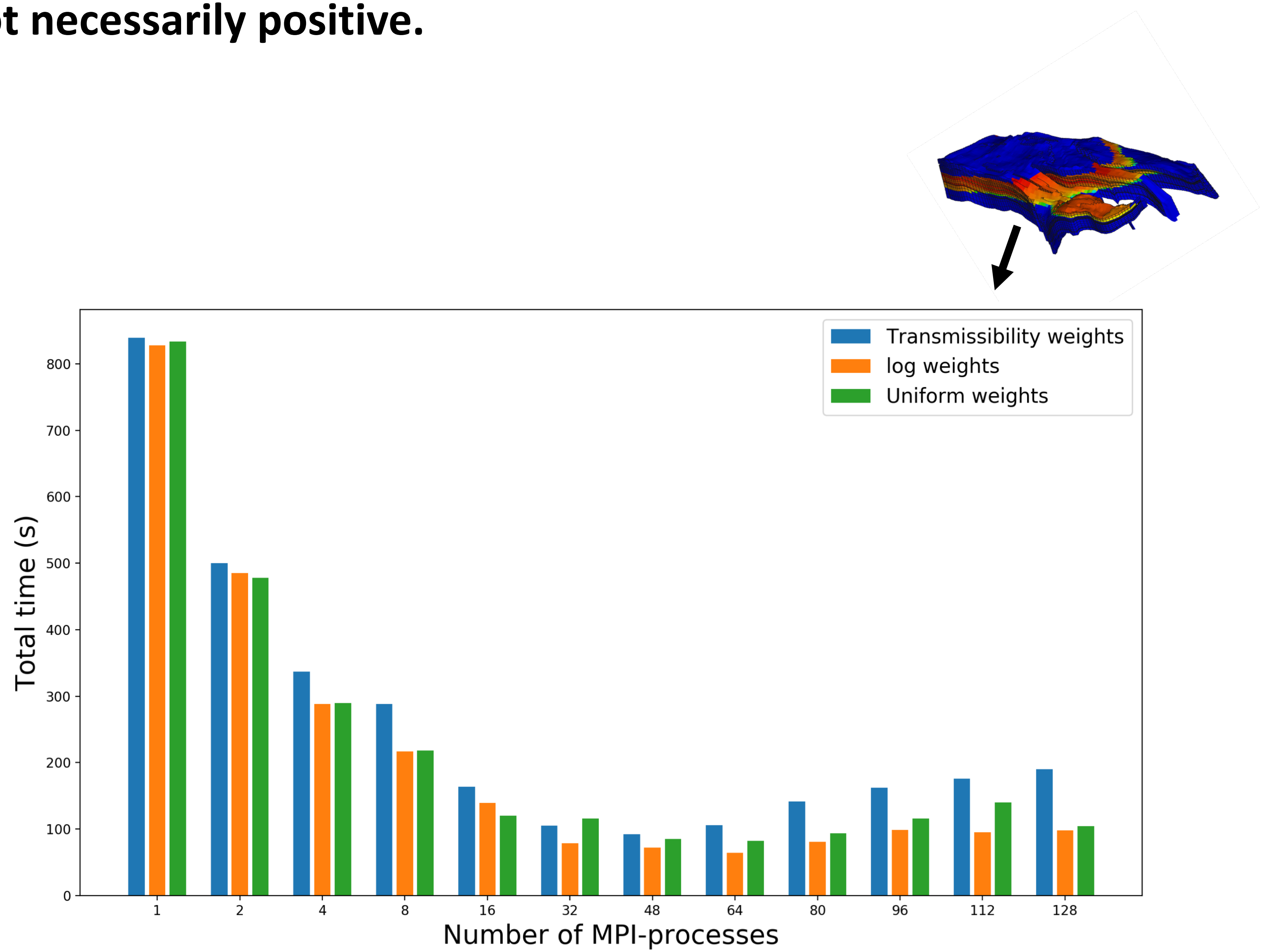


The edge-weights have a positive impact on the numerical effectiveness of the simulator.

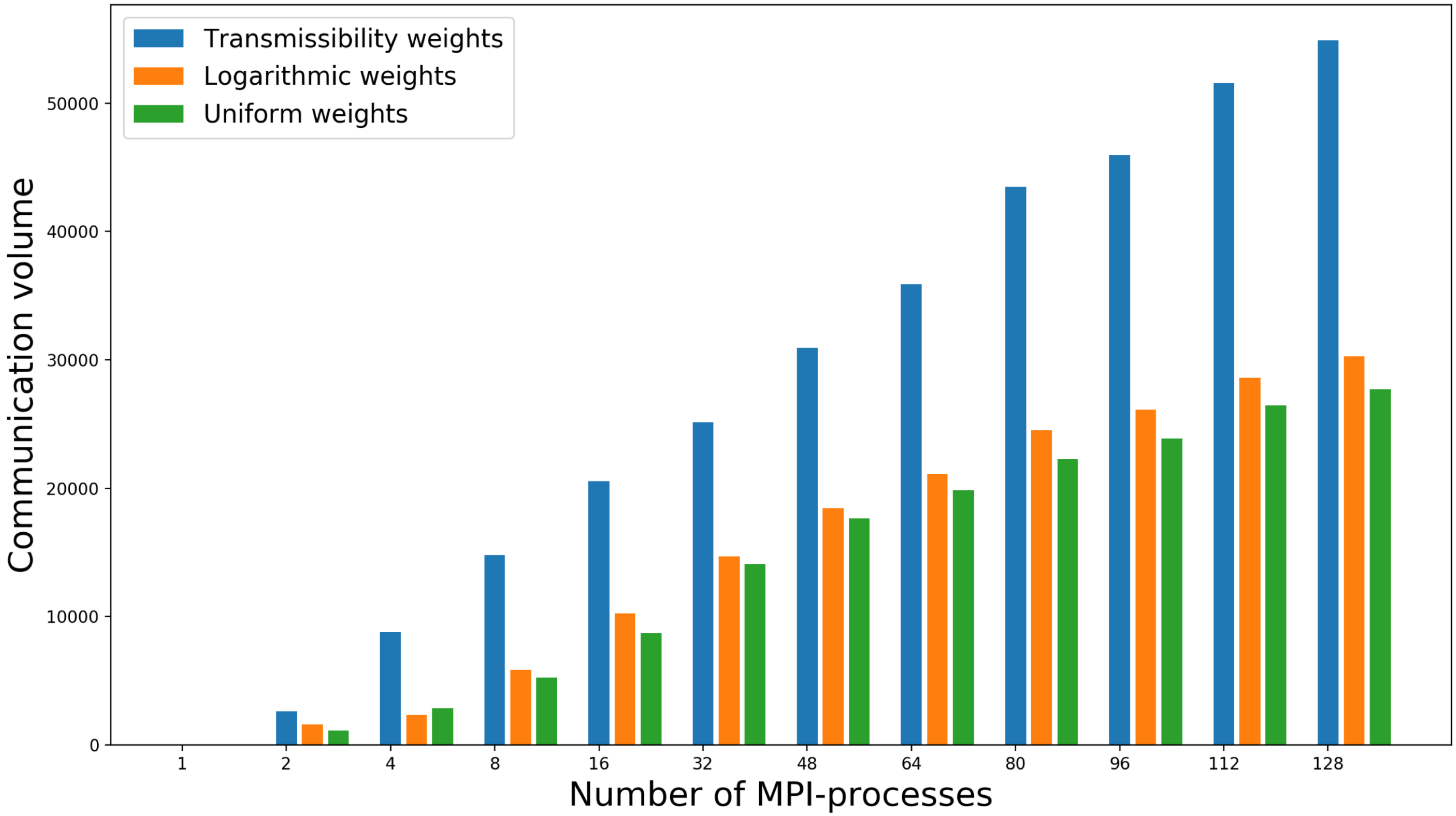




When considering overall performance the impact of edge-weights are not necessarily positive.

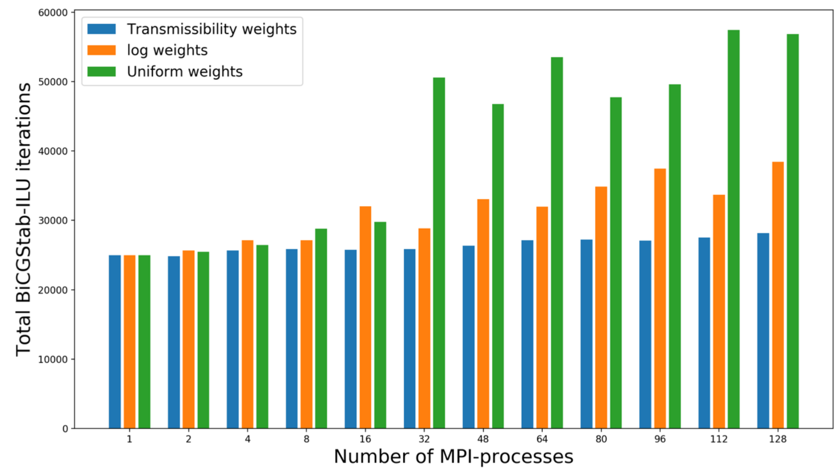


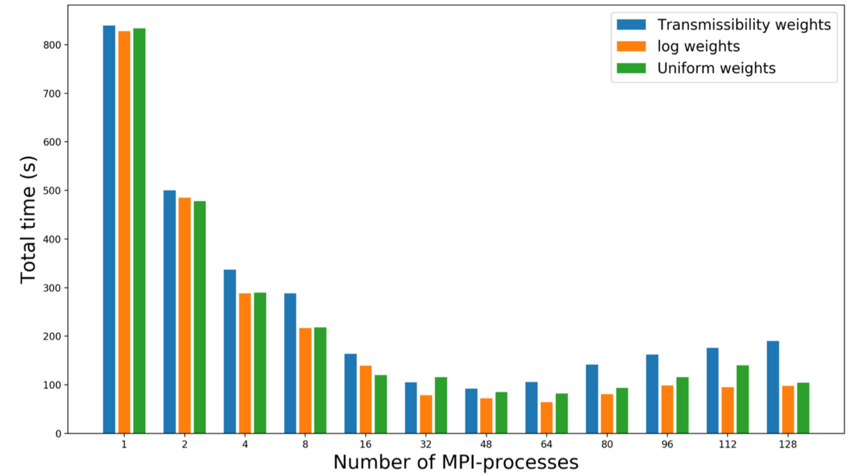
Transmissibility edge-weights results in higher communication volume than logarithmic and uniform edge-weights.



In summary, mesh partitioning greatly effects the parallel performance for problems with heterogeneity.

Including edge-weights in the graph partitioning scheme impacts the numerical performance and the parallel efficiency of Flow.





Questions?