

# GEOGRAPHER

MACSy

HU Berlin · Institut für Informatik · Modellierung und Analyse komplexer Systeme

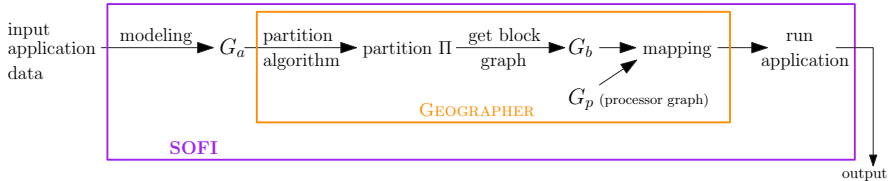


# What is GEOGRAPHER?

## A tool for partitioning graphs, meshes and points sets.

- Algorithms **to partition point sets**: *k*-means, Space Filling Curves (SFC), MultiSection.
- Improve a partitioned mesh by applying a **local refinement** approach combined with a **multilevel coarsening** scheme.
- Improve the load balance of an partitioned mesh by doing **repartition**.
- Given information about the physical network, **map** blocks to processors.

# Part of the *WAVE* toolbox



## Fraunhofer Scai - Lama

A framework for developing hardware-independent, high performance code.

GEOGRAPHER's and SOFI's implementations use Lama mainly for operations on distributed data (like DenseVector and CSRsparseMatrix) that may involve communications between processors and linear algebra operations etc.

# High level view

1. Input  $G_a$ , a mesh, i.e., an embedded graph in 2 or 3 dimensions.
  - Read  $G_a$  from two provided files: one for the graph and one for the coordinates, see at [FileIO](#) class.
  - Another option is to create uniform meshes, see at [MeshGenerator](#) class.
2. At first, vertices are distributed among PEs using a BlockDistribution. To increase locality, vertices are redistributed based on their Hilbert index, see [HilbertCurve](#) class.
3. Partition the points (using only the geometric information) using [KMeans](#) or [MultiSection](#).
4. Further improve the cut of the partition by using [LocalRefinement](#) and [MultiLevel](#).
5. Different parameters can be controlled via the [Settings](#) struct. To measure the quality of the partition use [Metrics](#) struct.

# Using GEOGRAPHER as an executable

See the README file and the documentation about how to install GEOGRAPHER and the required libraries.

## Minimal example

```
mpirun -np k installation/path/Geographer --dimensions 2 --graphFile  
rotation-00000.graph --coordFile rotation-00000.graph.xyz
```

Partition the 2D mesh `rotation` into `k` blocks with a 3% imbalance.

More options:

- `numBlocks`: the number of desired blocks, default is `k`  
**warning**: local refinement works only when `numBlocks=k`.
- `epsilon`: desired imbalance, default is 3%
- `fileFormat`: to read different file formats, default is METIS

## More option to control the partitioner

- `outFile`: the name of the file to store metrics and the partition.
- `initialPartition`: choose the initial, geometric partition method between [geoSFC](#) for the Hilbert curve, [geoKmeans](#) for the balanced  $k$ -means, [geoHierKM](#) for a hierarchical version of  $k$ -means and [geoMS](#) for the MultiSection. See also [ITL:Tool](#); default is `geoKmeans`
- `multiLevelRounds`: number of rounds for multilevel scheme.
- `minBoorderNodes`: number of nodes considered in the local refinement, default 1.
- `minSamplingNodes`: starting sample size for  $k$ -means, default 100.
- `metricsDetail`: detail level of the metrics possible values: no, easy, all; default no.
- `noRefinement`: if true then no local refinement is done, default false.

More options can be found in class [Setting](#) of using the `--help` flag when calling the executable.

# Using GEOGRAPHER as a library

Main entry point is function:

```
static scai::lama::DenseVector<IndexType>
    ITI::ParcoRepart::partitionGraph(
    scai::lama::CSRSparseMatrix<ValueType>& graph,
    std::vector<DenseVector<ValueType>>& coordinates,
    std::vector<DenseVector<ValueType>>& nodeWeights,
    struct Settings settings,
    struct Metrics& metrics);
```

The input consists of the graph, the coordinates and the node weights and it is controlled by various parameters in the Settings struct. It returns a distributed dense vector with the block that every point is assigned to.

**warning:** input can be redistributed during the partitioning.

# Minimal example program

```
//read graph from file
scai::lama::CSRsparseMatrix<ValueType> graph =
    ITI::FileIO<IndexType, ValueType>::readGraph(file);
//read coordinates
std::vector<scai::lama::DenseVector<ValueType>> coords =
    ITI::FileIO<IndexType, ValueType>::readCoords(
        coordsFile, N, dims);

struct Settings settings;
//set different parameter values: settings.X= ... ;
//init metris
struct Metrics metrics(settings);

// get partition; use wrapper without node weights
scai::lama::DenseVector<IndexType> partition =
    ITI::ParcoRepart<IndexType, ValueType>::partitionGraph(
        graph, coords, settings, metrics);
```



# Using GEOGRAPHER as a library

TODO: includes and linking info