Università della Svizzera italiana

Institute of Computational Science ICS

Numerical Computing **2020**

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Solution for Project 3

Due date: Wednesday, 4 November 2020, 11:55 PM

Numerical Computing 2020 — Submission Instructions
(Please, notice that following instructions are mandatory: submissions that don't comply with, won't be considered)

- Assignments must be submitted to iCorsi (i.e. in electronic format).
- Provide both executable package and sources (e.g. C/C++ files, Matlab). If you are using libraries, please add them in the file. Sources must be organized in directories called:
  Project_number_lastname_firstname
  and the file must be called:
  project_number_lastname_firstname.zip
  project_number_lastname_firstname.pdf
- The TAs will grade your project by reviewing your project write-up, and looking at the implementation you attempted, and benchmarking your code's performance.
- You are allowed to discuss all questions with anyone you like; however: (i) your submission must list anyone you discussed problems with and (ii) you must write up your submission independently.

1. Install METIS 5.0.2, and the corresponding Matlab mex interface

For this project I had some problems regarding the fact that I still didn't receive my MacBook. I had to run Matlab on a Linux virtual machine that my old pc had some problems running. For this reason I was not able to complete it in time.

2. Implement various graph partitioning algorithms *(60 Points)*

Table 1: Bisection results

Mesh	Coordinate	Metis 5.0.2	Spectral	Inertial
grid5rect(10,100)	10	10	10	20
grid5rect(100,10)	10	10	10	20
grid5recRotate(100,10,-45)	18	10	10	100
gridt(40)	58	60	58	66
grid9(30)	88	93	93	133
Smallmesh	25	12	12	33
Tapir	55	23	18	53
Eppstein	42	41	45	58

We can see that Metis and Spectral bisection are almost always the best choice. Obviously it isn't a suprise to see the Metis software in the top because it uses the technique of swapping pairs of vertices that result in the largest decrease in the size of the edge-cut. The Inertial method tries to find a partition that goes through the center of gravity of the points; being a geometrical approach, this method may not work well with more artificial and less connected graphs. The Spectral Bisection algorithm uses the Laplacian matrix to represent graph connectivity, the second eigenvector gives a graph bisection. This method doesn't use geometric information and operates on a representation of the graph; this makes the decision about the vertices to partition based on the whole graph. For this global approach this method works better that the Inertial method.

3. Visualize the Fiedler eigenvector *(10 Points)*

4. Recursively bisecting meshes *(20 Points)*

Table 2: Edge-cut results for recursive bi-partitioning.

Case	Spectral	Metis 5.0.2	Coordinate	Inertial
mesh3e1				
airfoil1				
3elt				
barth4				
crack				

5. Compare recursive bisection to direct k-way partitioning *(10 Points)*

Table 3: Comparing the number of cut edges for recursive bisection and direct multiway partitioning in Metis 5.0.2.

Partitions	crack	airfoil1
16		
32		