Università della Svizzera italiana

Institute of Computing CI

High-Performance Computing **2022**

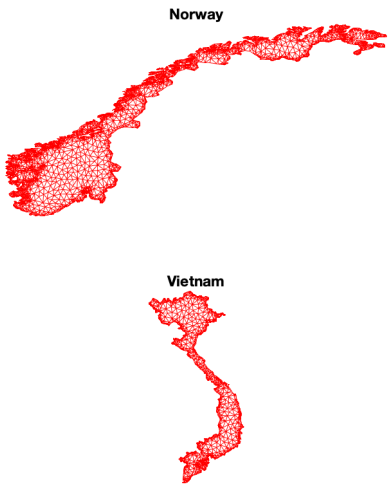
Student: Anthony Bugatto Solution for Project 6

Discussed with: Riccardo Giacometti and Qianbo Zang Due

date: 07.12.2022, 23:59

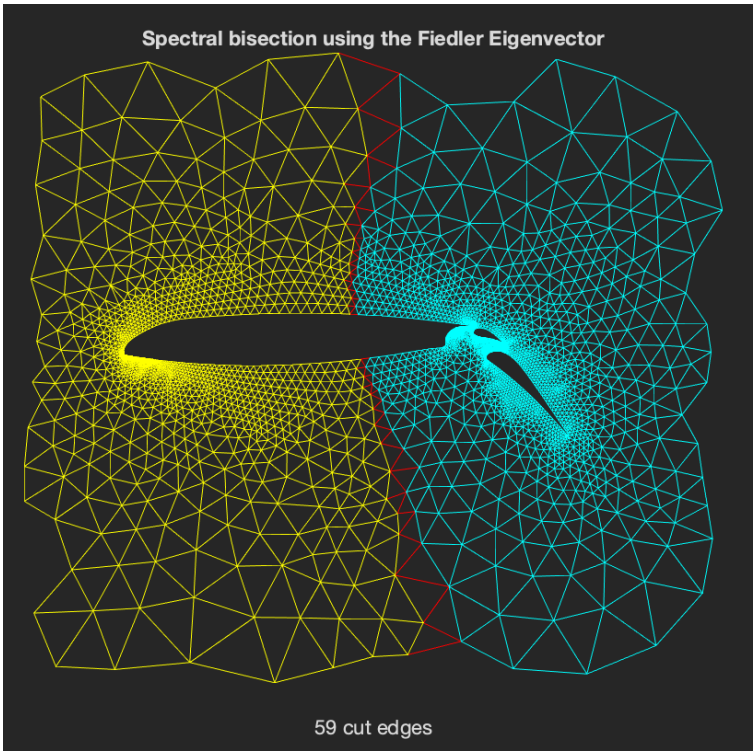
1. Task: Install METIS 5.0.2, and the corresponding Matlab mex interface

2. Task: Construct adjacency matrices from connectivity data [10 points]



3. Task: Implement various graph partitioning algorithms [25 points]

The output of the bisections looks exactly as intended, with the spectral method seeming to perform slightly better in general but not always. Different methods of implementing the spectral method were tried, sich as using different configurations of the Fiedler vector, but ultimately the median method was chosen as it exactly reproduced the airfoil partition in the project specification.


Spectral bisection using the Fiedler Eigenvector
59 cut edges

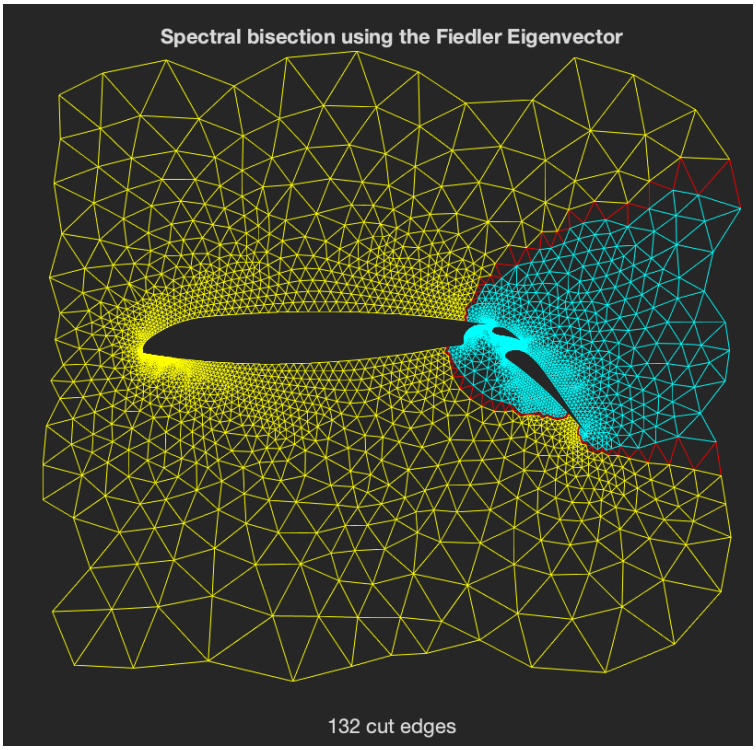
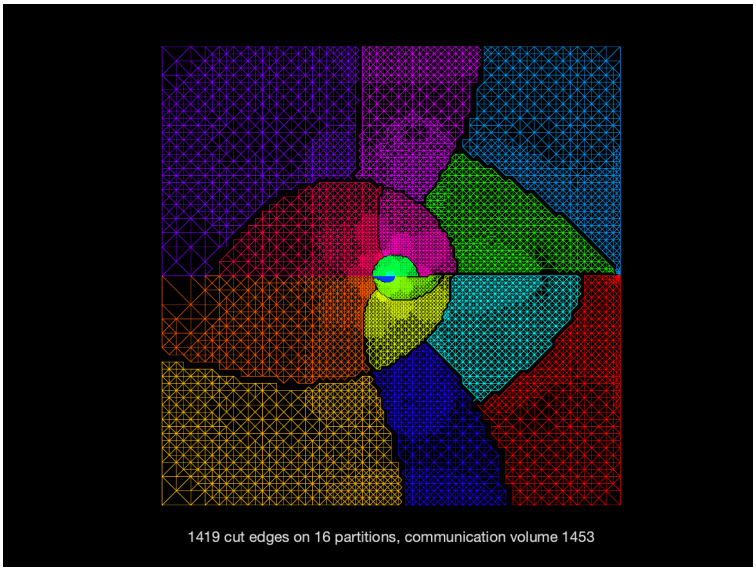

Spectral bisection using the Fiedler Eigenvector
132 cut edges

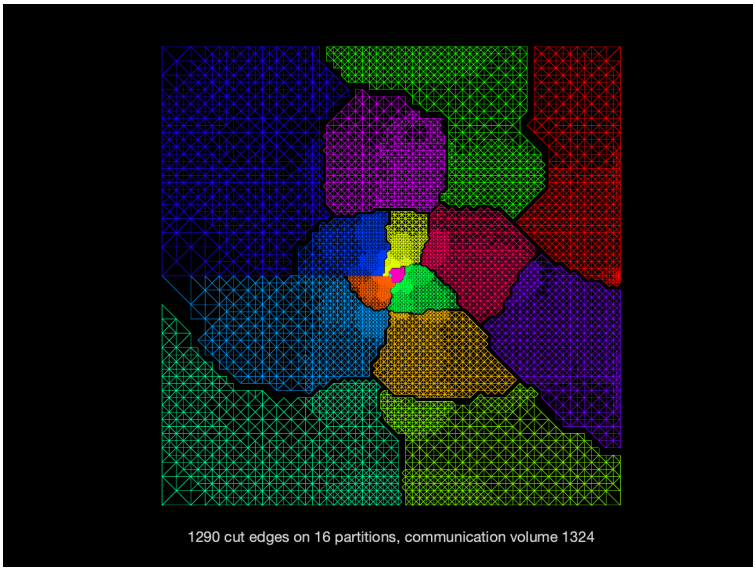
Table 1: Bisection results

Mesh	Coordinate	Metis 5.0.2	Spectral	Inertial
mesh1e1	18	17	18	20
mesh2e1	37	37	39	47
mesh3e1	19	19	22	19
mesh3em5	19	19	142	19
airfoil1	94	77	132	93
netz4504_dual	25	23	23	27
stufe	16	16	16	16
3elt	172	124	117	257
barth4	206	97	127	208
ukerbe1	32	27	28	28
crack	353	201	233	384

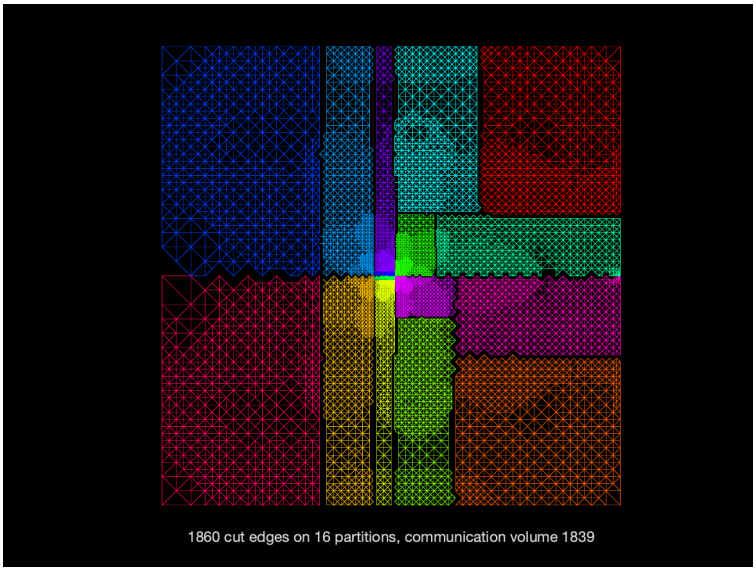
4. Task: Recursively bisecting meshes [15 points]

The results mainly follow from the singular version, with the latter two seeming to give better cuts in general. Interestingly when using the eig function, there was an initial error for non-singularity, which shouldn't be possible in a Laplacian matrix. Probably due to some numerical instability, the problem was solved by using 'smallestreal' in the eig function.

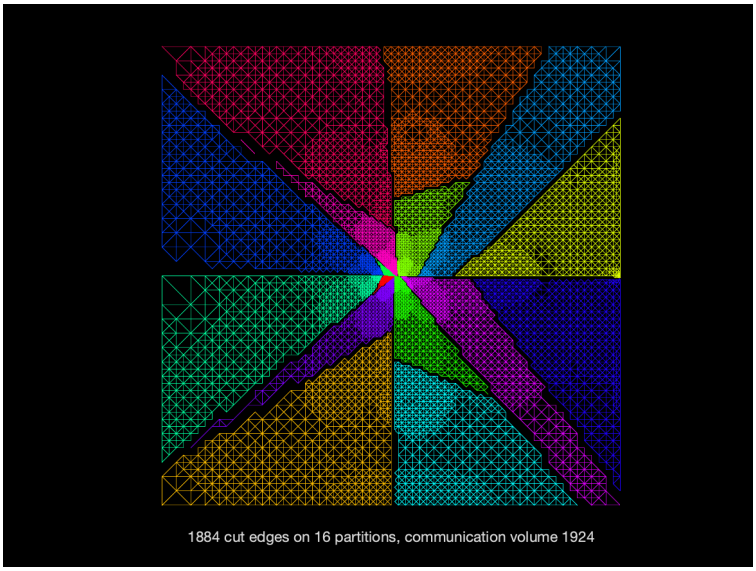




1290 cut edges on 16 partitions, communication volume 1324



1860 cut edges on 16 partitions, communication volume 1839

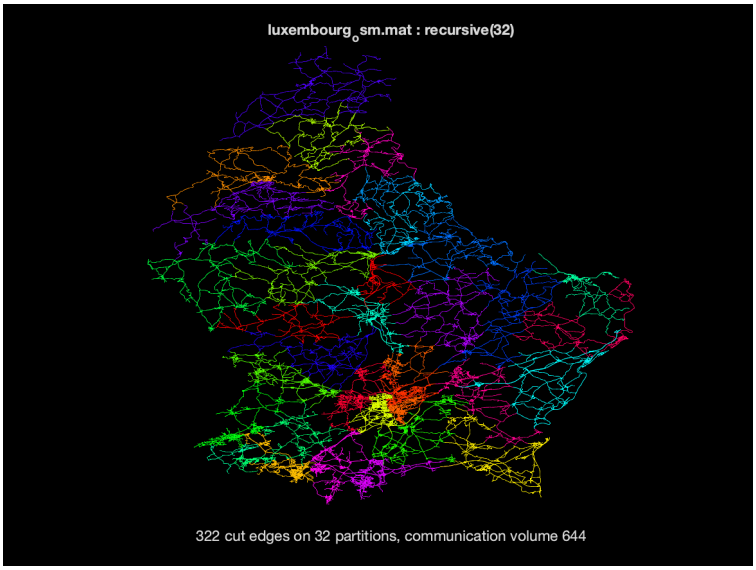


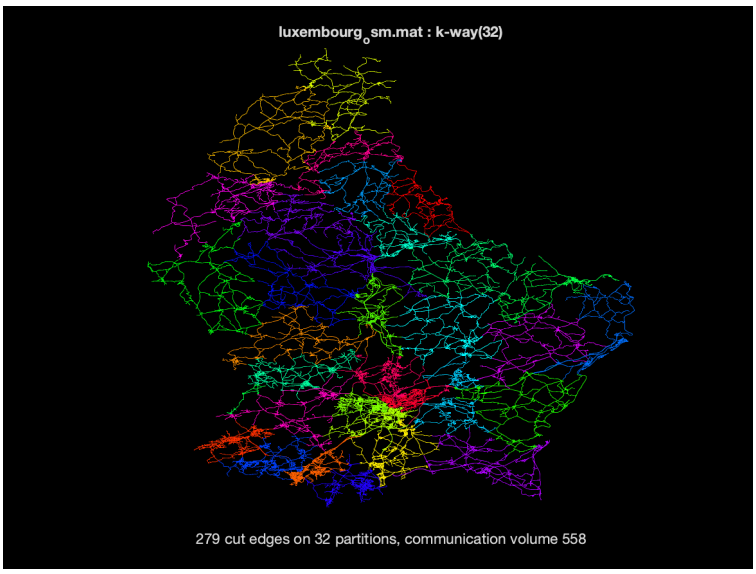
1884 cut edges on 16 partitions, communication volume 1924

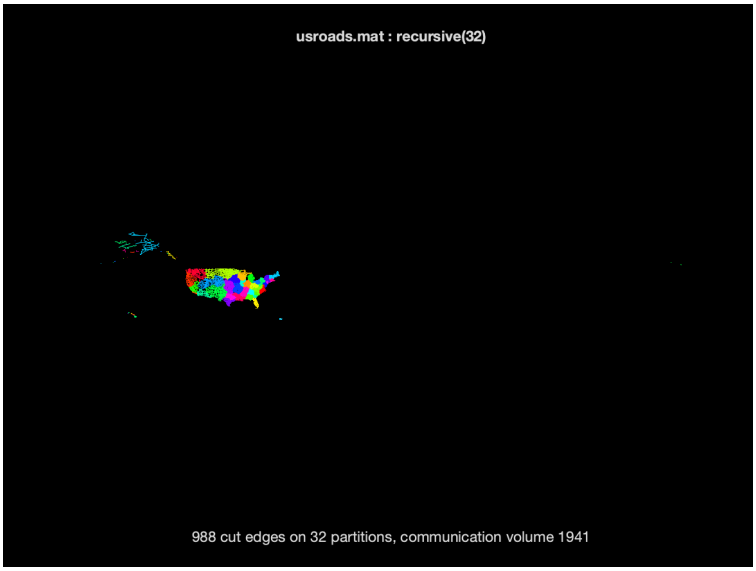
Bisection	Spectral		Metis 5.0.2		Coordinate		Inertial	
Partitions	8	16	8	16	8	16	8	16
mesh1e1.mat mesh1e1.mat	58	58	55	55	63	63	77	77
mesh2e1.mat mesh2e1.mat	173	267	131	207	134	231	193	292
mesh3e1.mat mesh3e1.mat	75	127	75	117	75	122	75	122
mesh3em5.mat mesh3em5.mat	290	311	75	117	75	122	75	122
airfoil1.mat airfoil1.mat	397	631	320	563	516	819	672	1081
netz4504_dual.mat ...netz4504_dual.mat ...	111	185	110	161	127	198	165	269
stufe.mat .....stufe.mat	128	243	107	194	123	227	324	609
3elt.mat 3elt.mat	469	752	395	651	733	1168	814	1230
barth4.mat barth4.mat	549	835	405	689	875	1306	974	1491
ukerbe1.mat ukerbe1.mat	126	236	128	224	225	374	339	499
crack.mat .....crack.mat	883	1419	784	1290	1343	1860	1351	1884

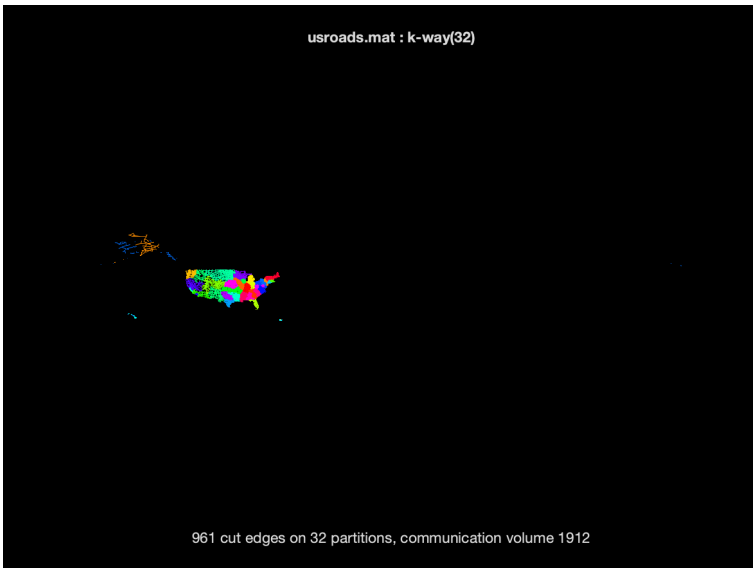
5. Task: Comparing recursive bisection to direct k-way partitioning [10 points]

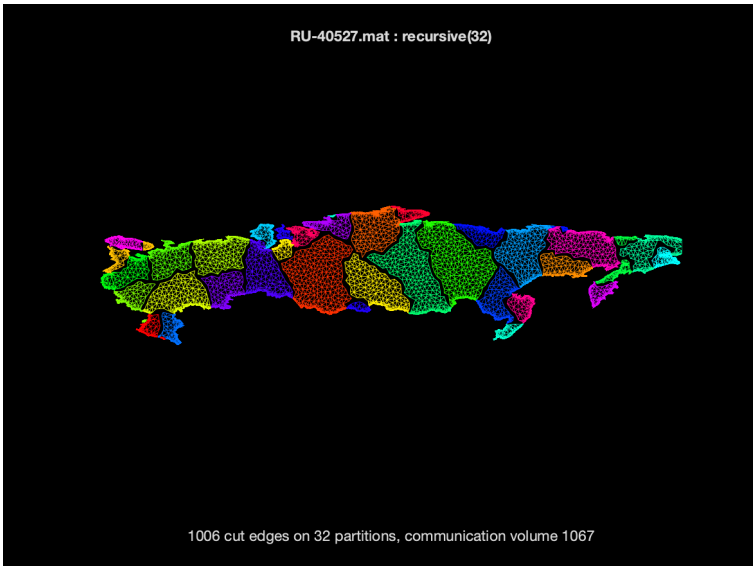
From the data below it can be seen that the k-way partitions seem to yield a slightly lower number of edgecuts, but visually look practically the same as the recursive partitions.

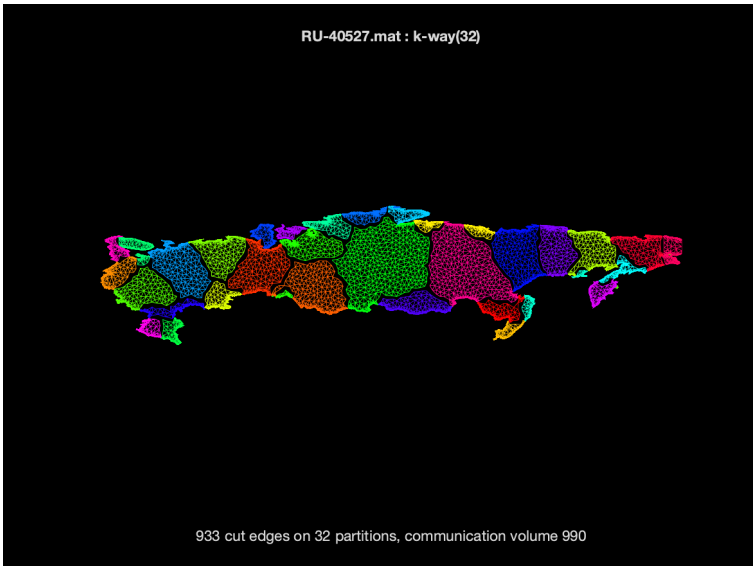



luxembourg_sm.mat : k-way(32)
279 cut edges on 32 partitions, communication volume 558


usroads.mat : recursive(32)
988 cut edges on 32 partitions, communication volume 1941


usroads.mat : k-way(32)
961 cut edges on 32 partitions, communication volume 1912

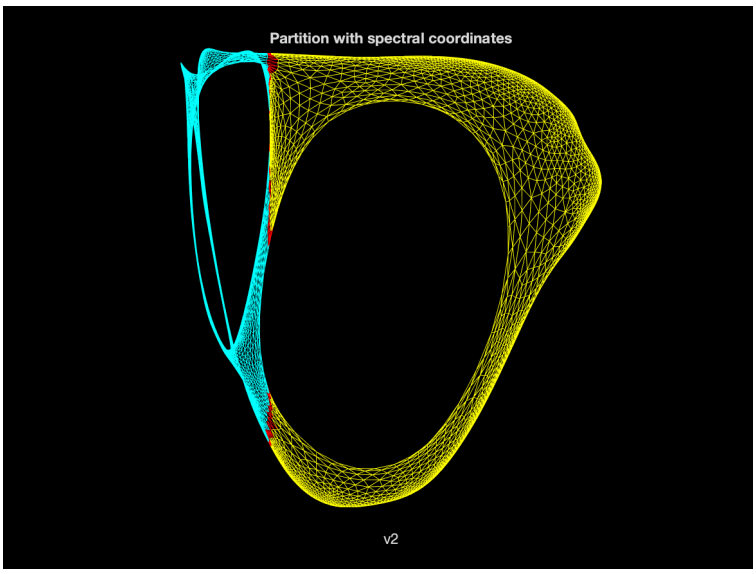


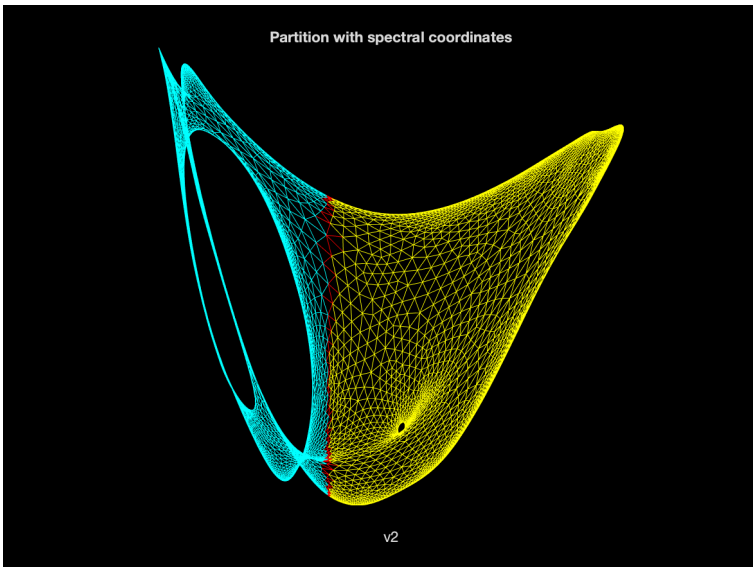


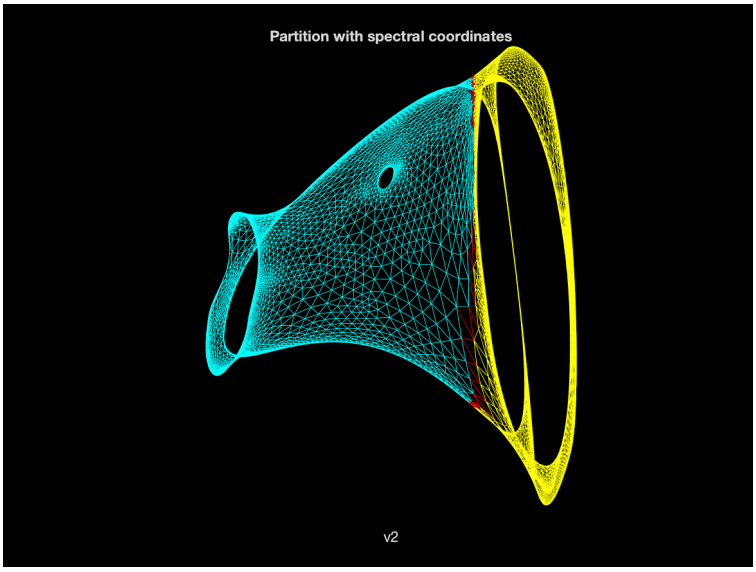
luxembourg_osm.mat . . .	197		322	170		279	
usroads.mat . . .	607	988	579	961			
GR-3117.mat . . .	297	509	278	471			
CH-4468.mat . . .	730	1089	673	1042			
VN-4031.mat . . .	245	445	245	411			
NO-9935.mat . . .	284	470	255	439			
RU-40527.mat . . .	616	1006	551	933			

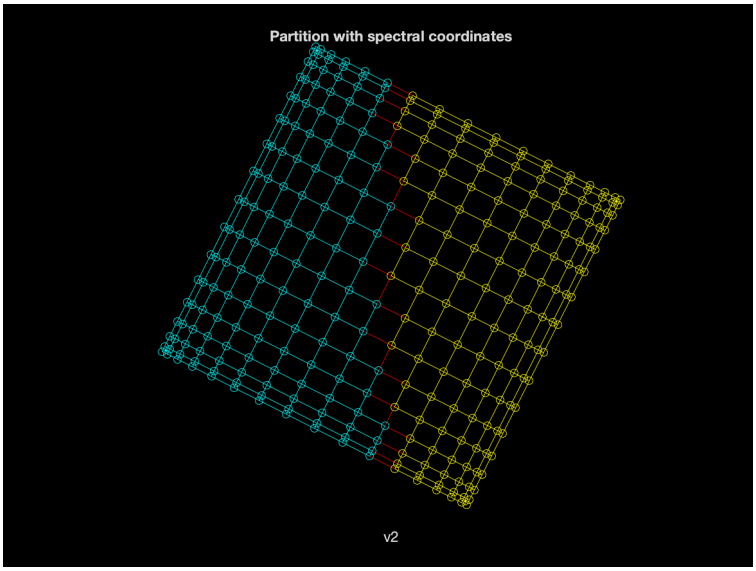
6. Task: Utilizing graph eigenvectors [25 points]

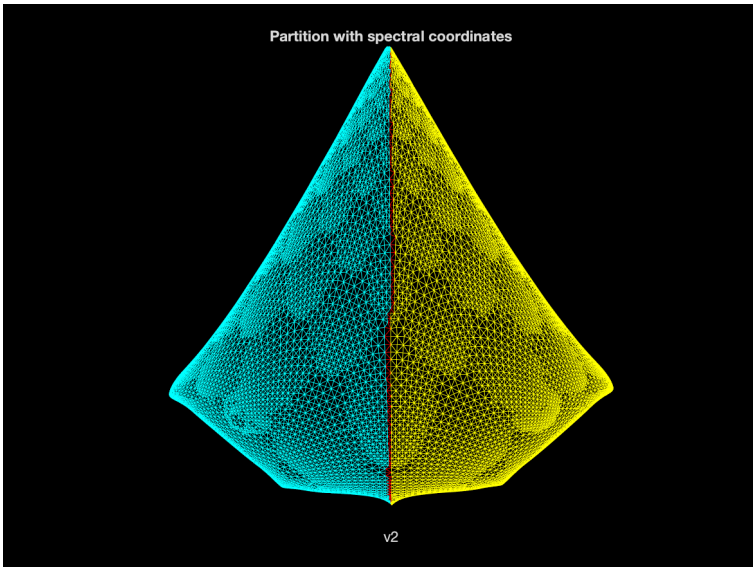
Below we can see the eigenvalue coordinate plots for the: airfoil, 3elt, barth, mesh3, and crack meshes.






Partition with spectral coordinates
v2


Partition with spectral coordinates
v2


Partition with spectral coordinates
v2