Multi-level Graph Drawing using Infomap Clustering

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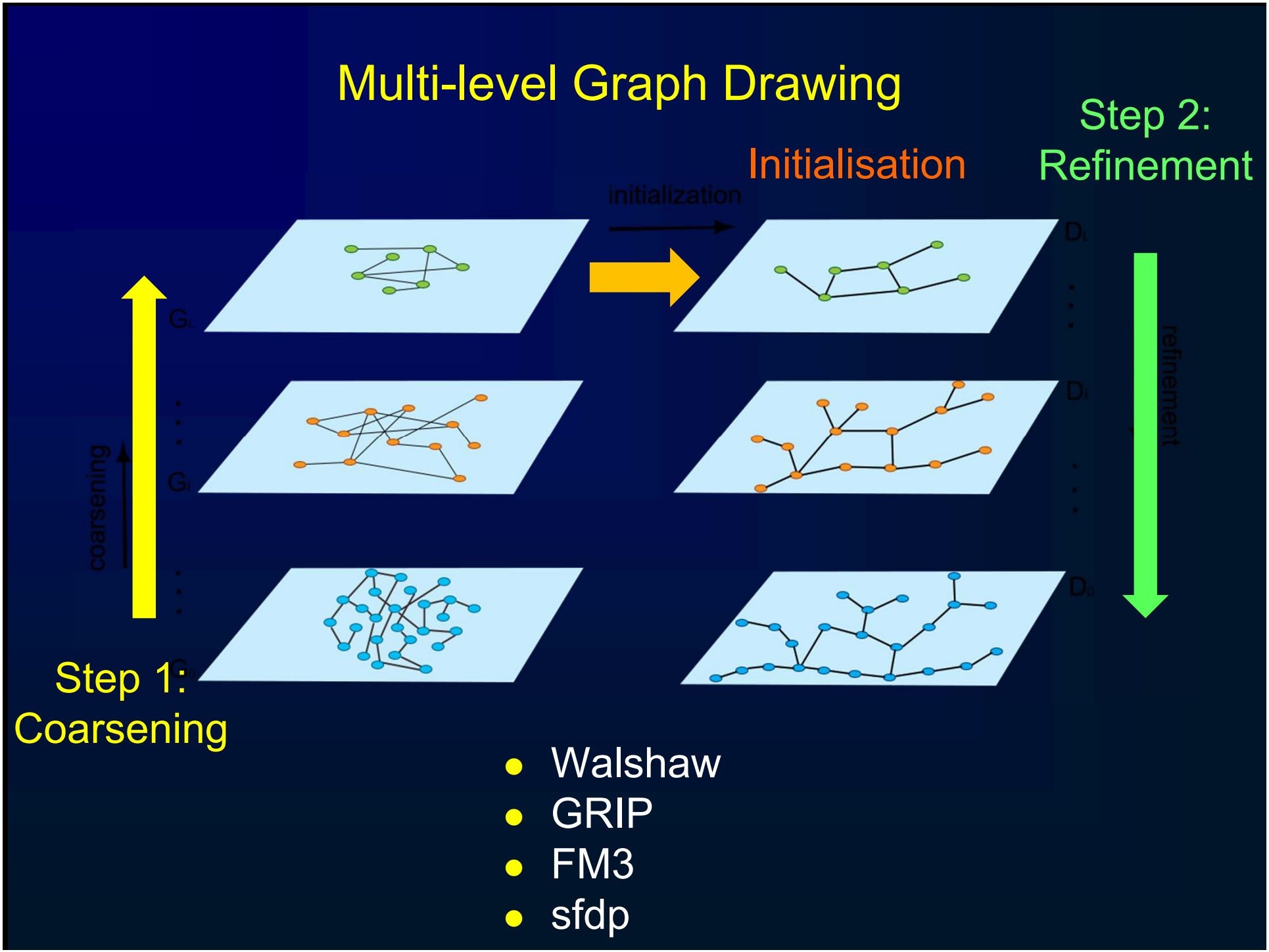
Multi-level Graph Drawing



- Walshaw
- GRIP
- FM3
- sfdp

Infomap Clustering

- computes clusters by translating a graph into a map, which decomposes the myriad nodes and links into modules that represent the graph
- compute the community structures that minimize the expected description length of a random walk trajectory
- The algorithm maximizes an objective function called the minimum description length
- in practice an approximation to the optimal solution can be found quickly, fast for large graphs

Infomap Multi-level Algorithm

1. Coarsening: Infomap Clustering

2. Initialisation
   - Circle Placement
   - Barycenter Placement
   - Zero Placement

3. Refinement
   - FR
   - FRG: Grid variant of FR
   - FME (Fast Multipole Embedded)

Experiment Design

Original layout

- FR
- FRG
- FME

Infomap Multi-level layout

- InfomapFR
- InfomapFRG
- InfomapFME

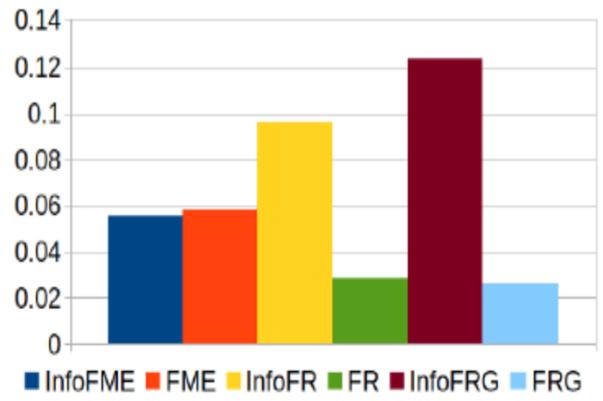
Comparison

- Runtime, Number of levels
- Quality Metrics: shape-based metrics, crossing, stress
- Visual comparison

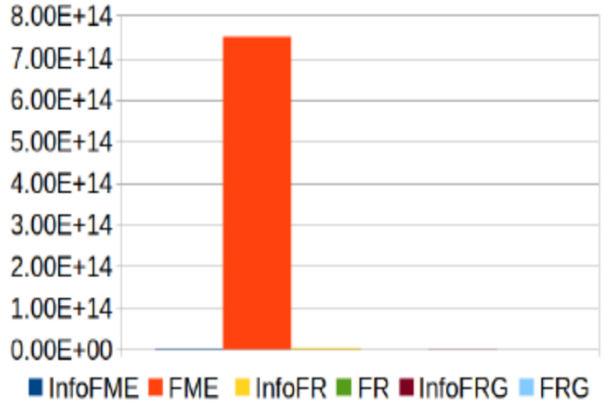
L (# of Level), Runtime

Graph G	$\|V_0\|$	$\|E_0\|$	D	L	Time	$\|V_1\|$	$\|E_1\|$	$\|V_2\|$	$\|E_2\|$	$\|V_3\|$	$\|E_3\|$
G_15_0	1785	20459	11.5	2	0.02	59	100	9	8		
nasa1824	1824	18692	10.3	2	0.02	53	217	5	7		
G_4_0	2075	4769	2.3	2	0.02	89	326	8	11		
yeastppi	2361	7182	3.0	2	0.04	302	1923	101	0		
soc_h	2426	11630	4.8	2	0.02	301	1088	149	1		
oflights	2939	15677	5.3	2	0.03	170	477	19	24		
ecolippi	3796	78120	20.6	2	0.03	245	2453	53	1		
facebook	4039	88234	21.9	2	0.02	93	272	7	11		
3elt	4720	13722	2.9	2	0.05	189	489	17	35		
USpowerGrid	4941	6594	1.3	2	0.18	489	963	44	104		
as19990606	5188	10974	2.1	2	0.17	368	2034	12	38		
commanche_dual	7920	19800	2.5	2	0.24	503	1365	34	71		
p2p-Gnutella05	8846	31839	3.6	2	0.20	830	18154	3	0		
astroph2001	16046	121251	7.6	3	0.61	1219	9333	395	68	369	0
condmat2001	16264	47594	2.9	3	1.33	1720	4574	798	774	726	0
crack-dual	20141	30043	1.5	3	1.16	1357	3633	84	216	10	18
bcsstk31	35588	608502	17.1	2	0.36	453	2295	25	44		
shock-9	36476	71290	2.0	3	1.17	1351	3852	74	191	8	14
del16	65536	196575	3.0	3	1.95	1981	5921	101	290	8	16

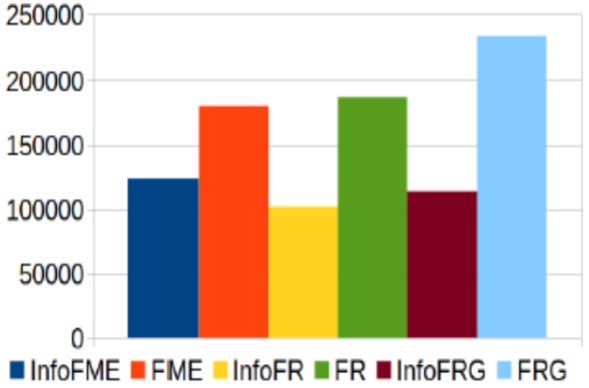
Comparison of Metrics



(a) Shape-based (larger, better)

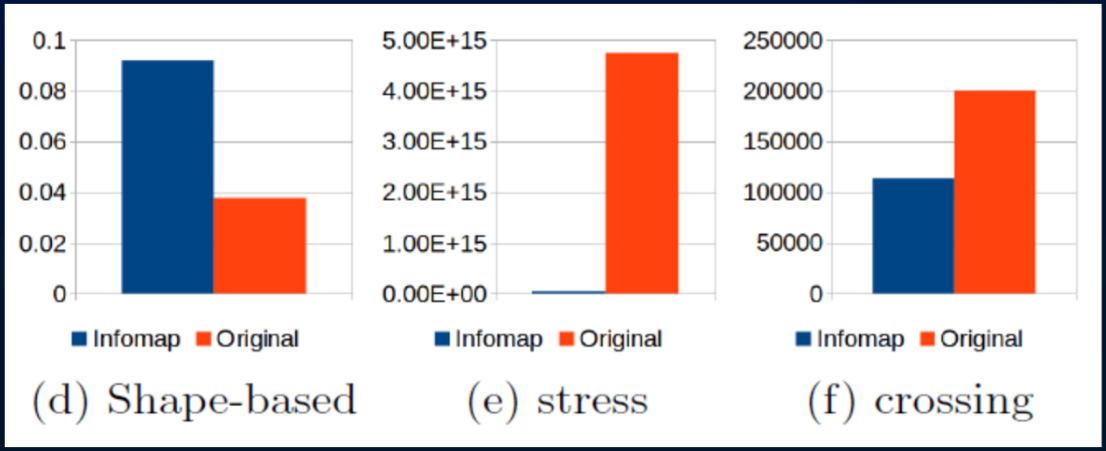


(b) stress (smaller, better)



(c) crossing (smaller, better)

Average Metrics

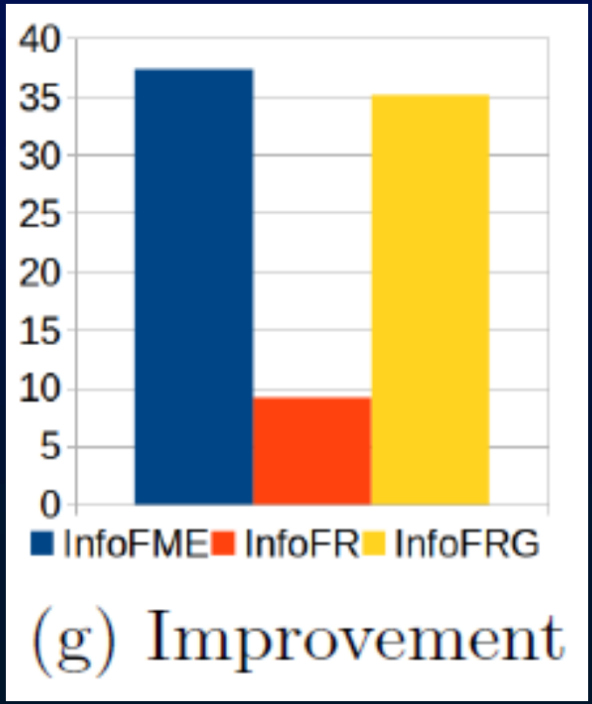


(d) Shape-based (e) stress (f) crossing

Shape-based Metrics

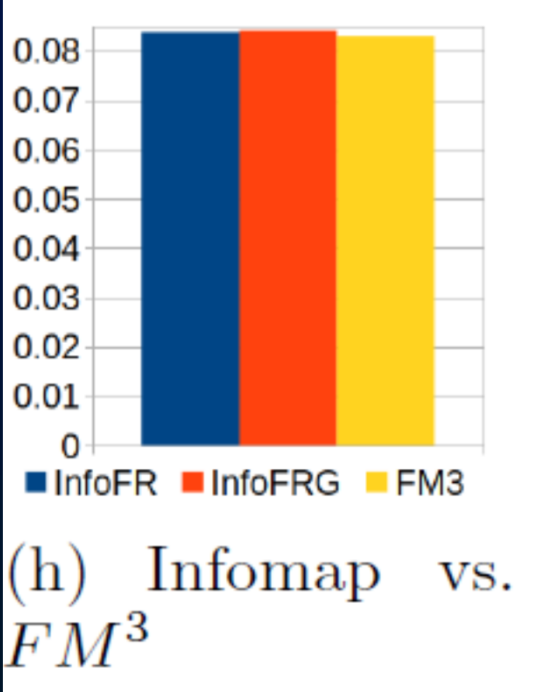
- Faithful metric for Large graph visualisation
- Similarity between original graph G and Proximity graph G' of drawing D(G)
- Proximity graph: Relative Neighborhood graph, Gabriel graph

Improvement



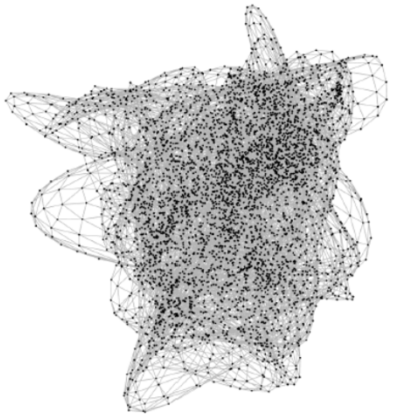
(g) Improvement

FM3 vs. Infomap

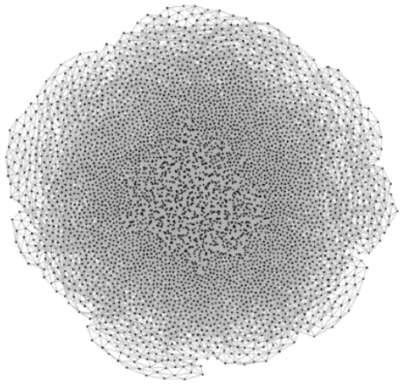


(h) Infomap vs. FM^3

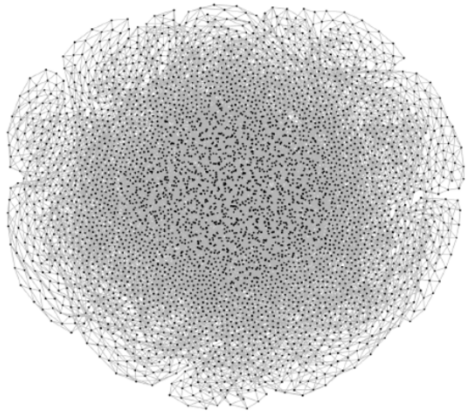
3elt



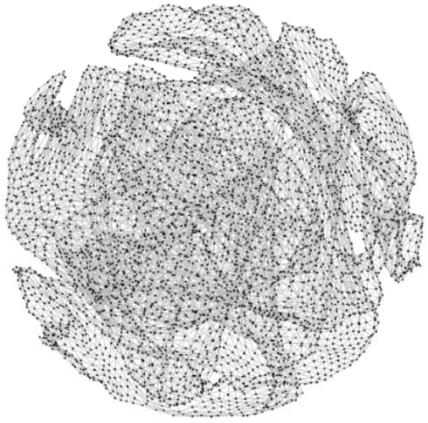
(a) FME



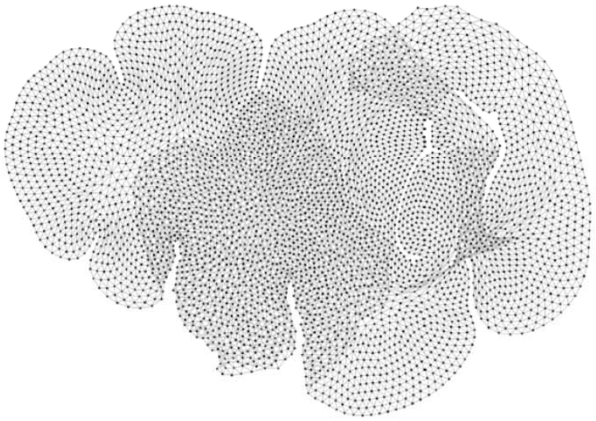
(b) FRG



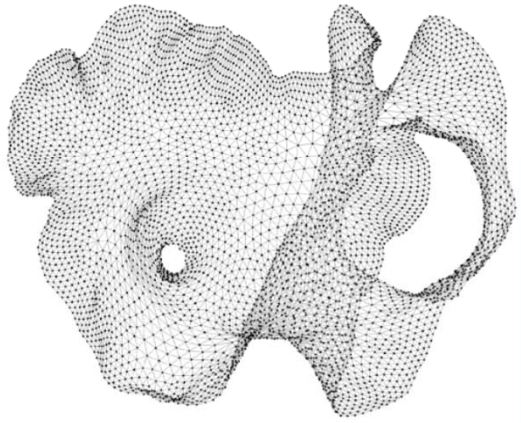
(c) FR



(d) Infomap FME

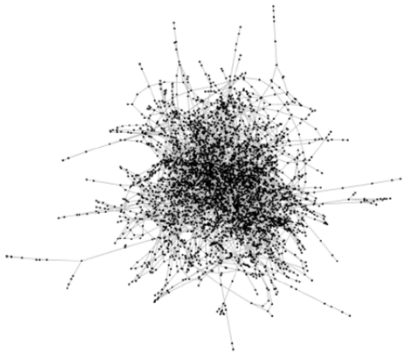


(e) Infomap FRG



(f) Infomap FR

USPowergrid



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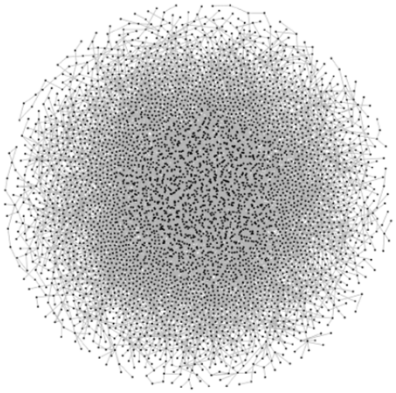
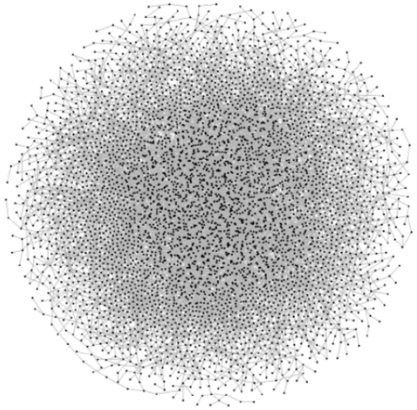


(b) FRG



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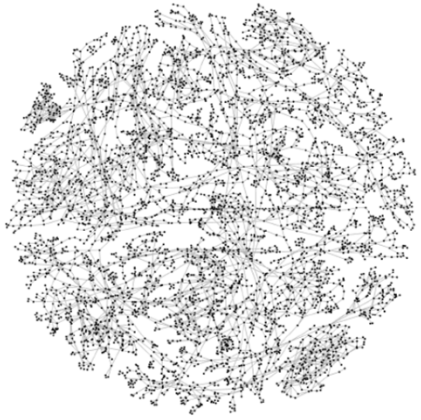

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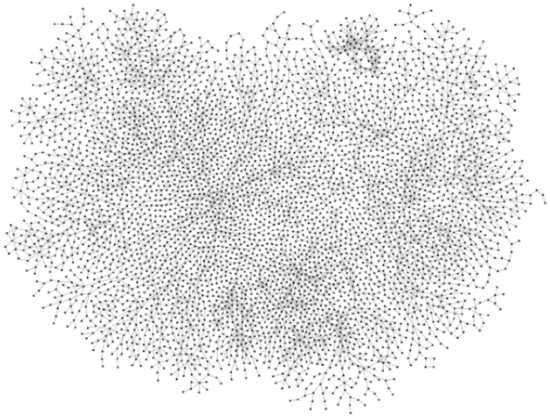

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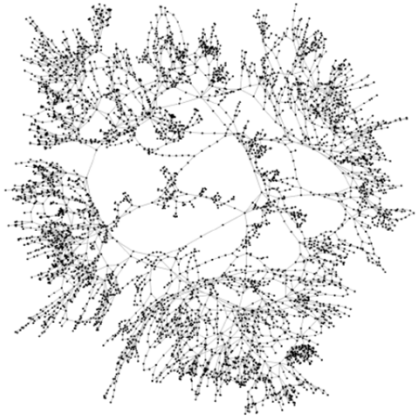
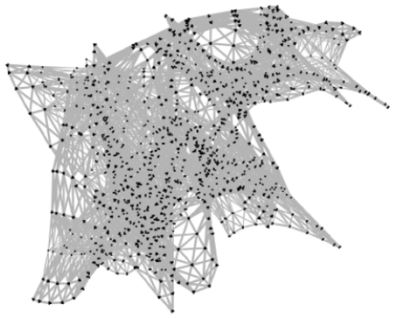
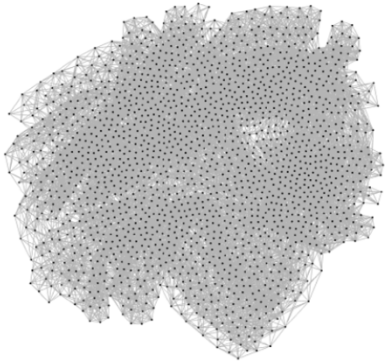


(f) Infomap FR

nasa1824



(a) FME



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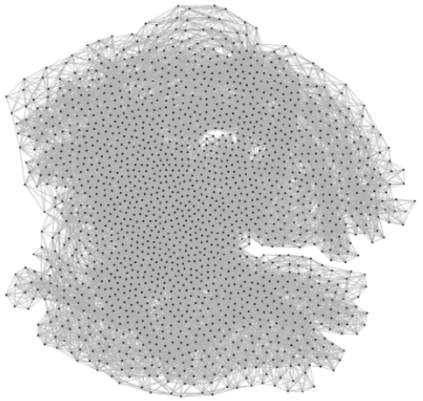

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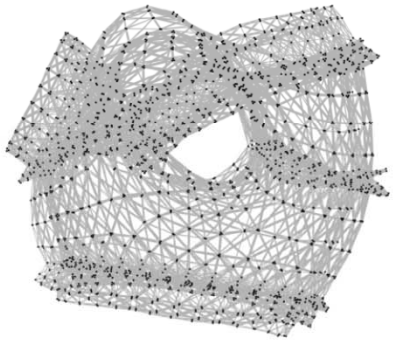

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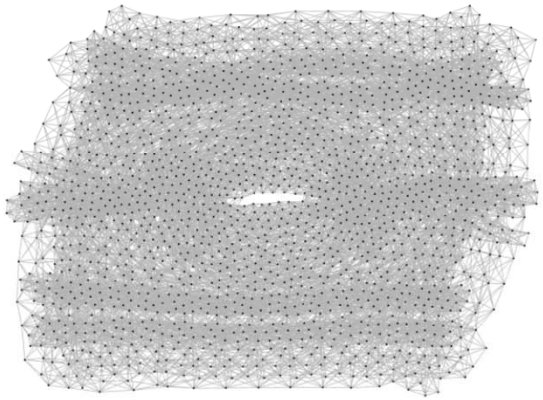

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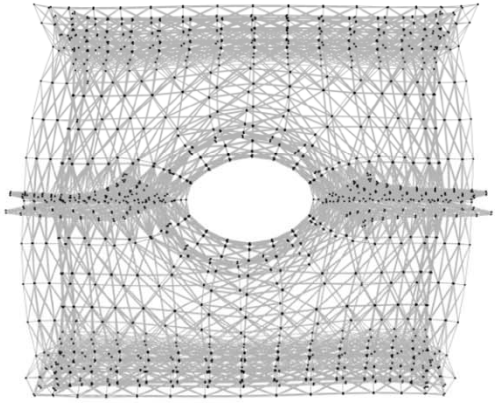
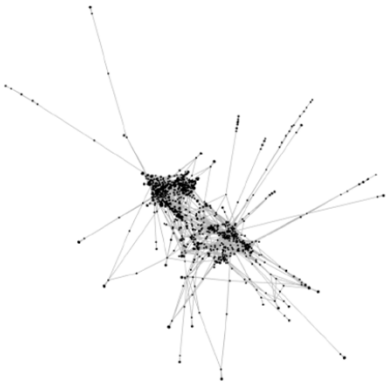
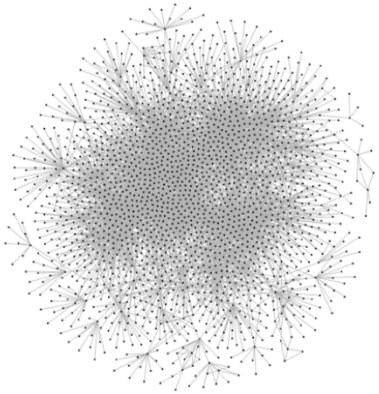


(f) Infomap FR

G_4_0



(a) FME



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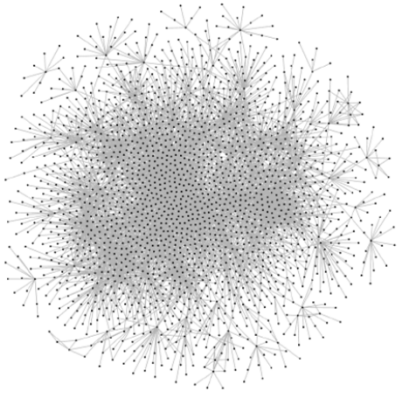
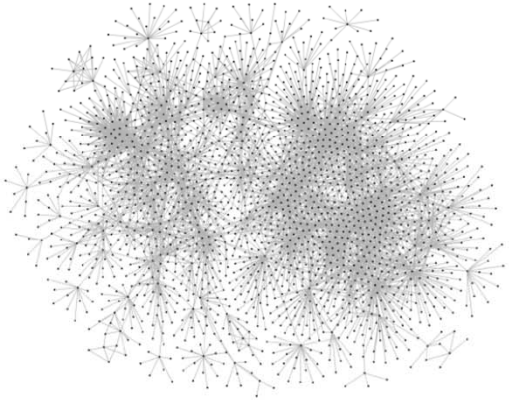


(c) FR

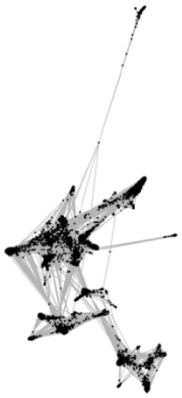
(d) Infomap FME



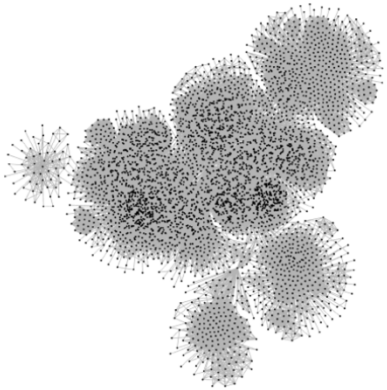
(e) Infomap FRG

(f) Infomap FR

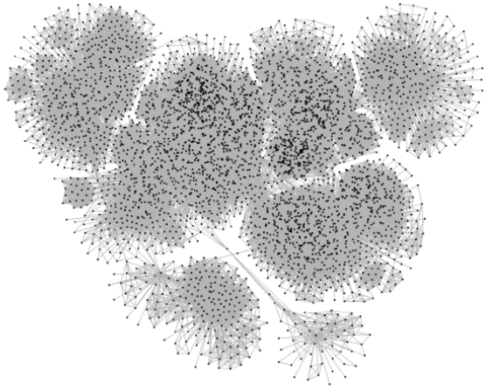
Facebook



(a) FME



(b) FRG



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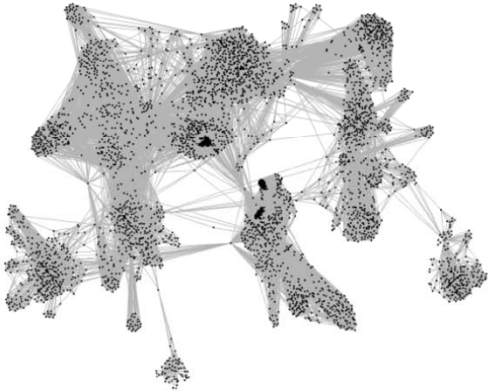
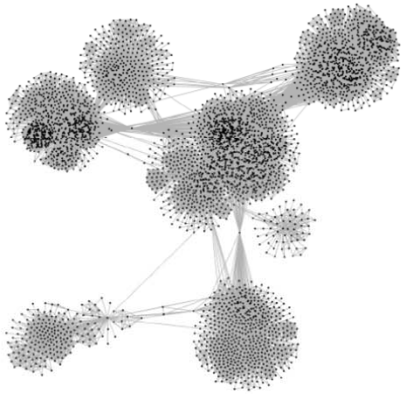


(d) Infomap FME



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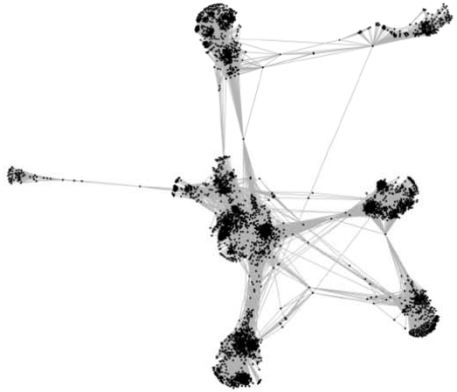
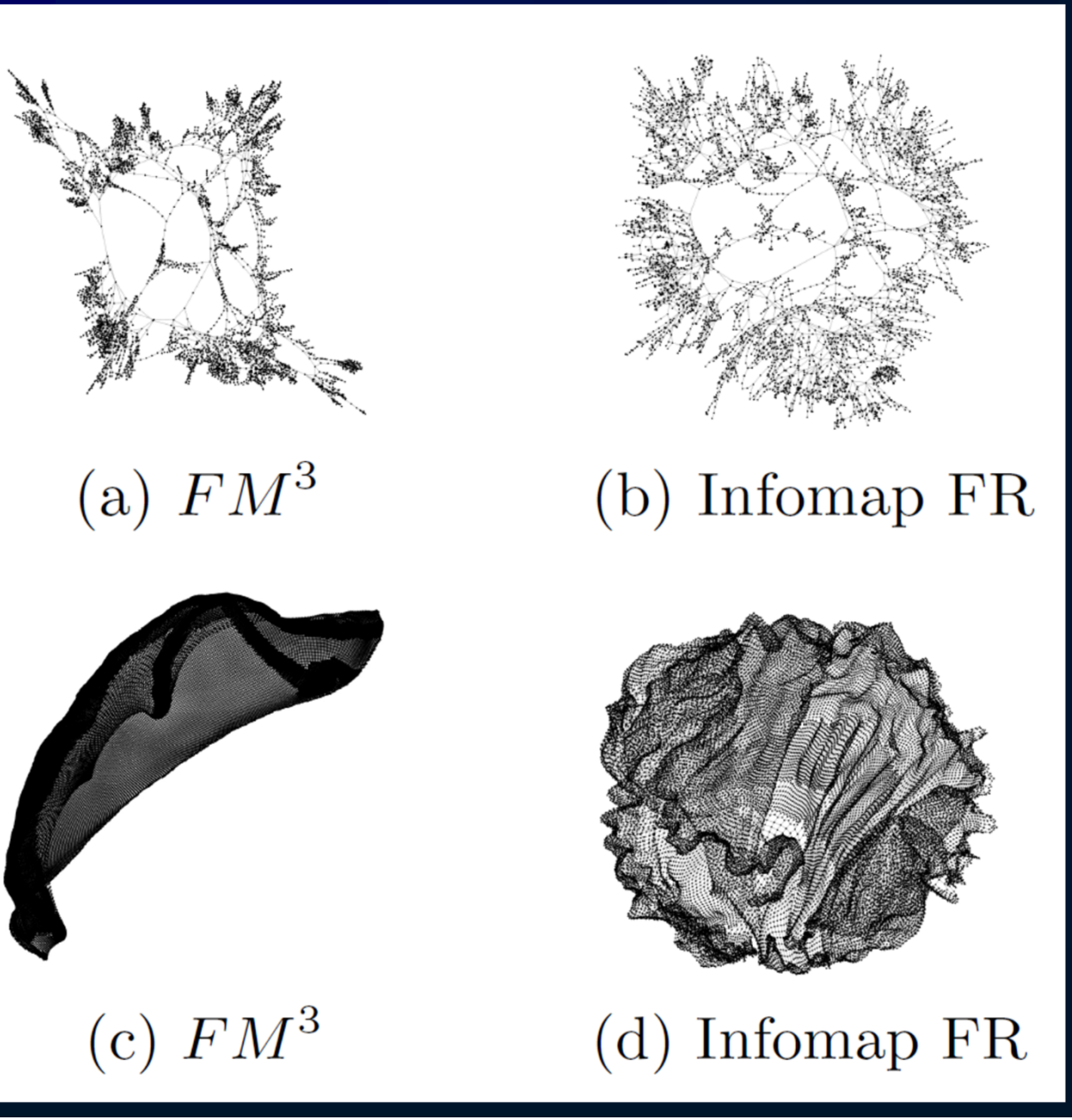


(f) Infomap FR

FM3 vs. InfomapFR



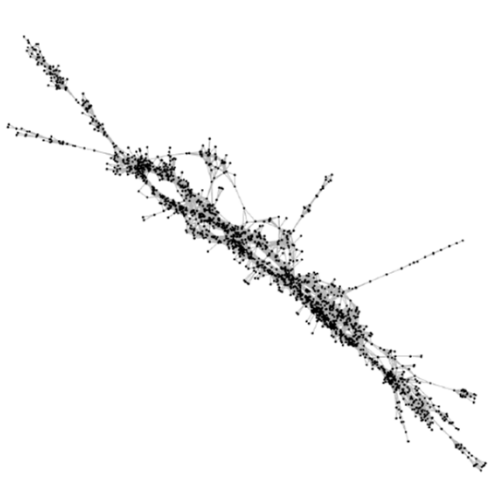
(a) FM^3

(b) Infomap FR

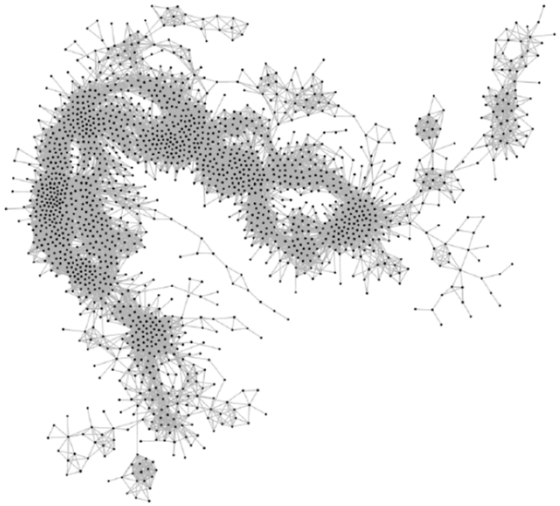
(c) FM^3

(d) Infomap FR

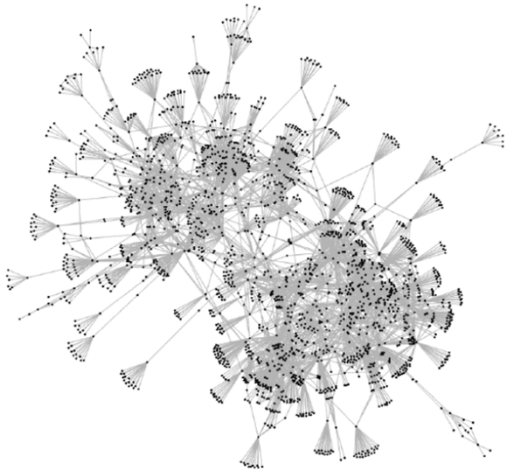
FM3 vs. InfomapFRG



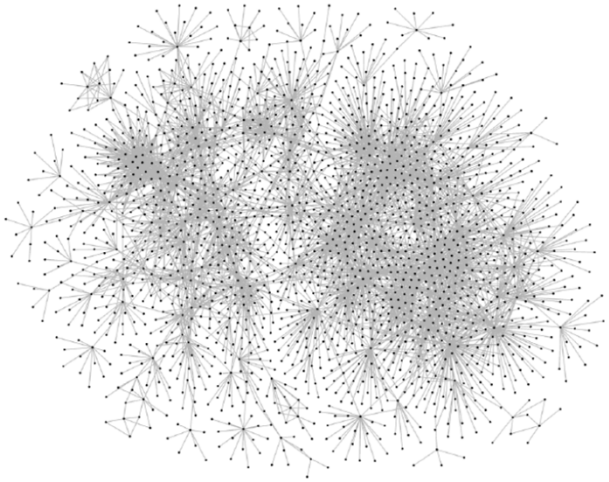
(a) FM^3



(b) Infomap FRG



(c) FM^3



(d) Infomap FRG

Summary

- Overall, Infomap based multi-level algorithm perform significantly better than original layout algorithms.
- Metric wise, InfomapFR layout and InfomapFRG layout perform the best.
- InfomapFME achieved significant improvement.
- InfomapFR and InfomapFRG perform similar to FM3.

Work in Progress

Comparison with other clustering methods

- Louvain, Label Propagation, Spectral clustering