Molecular BioSystems

A new multi-scale method to reveal hierarchical modular structures in biological networks†

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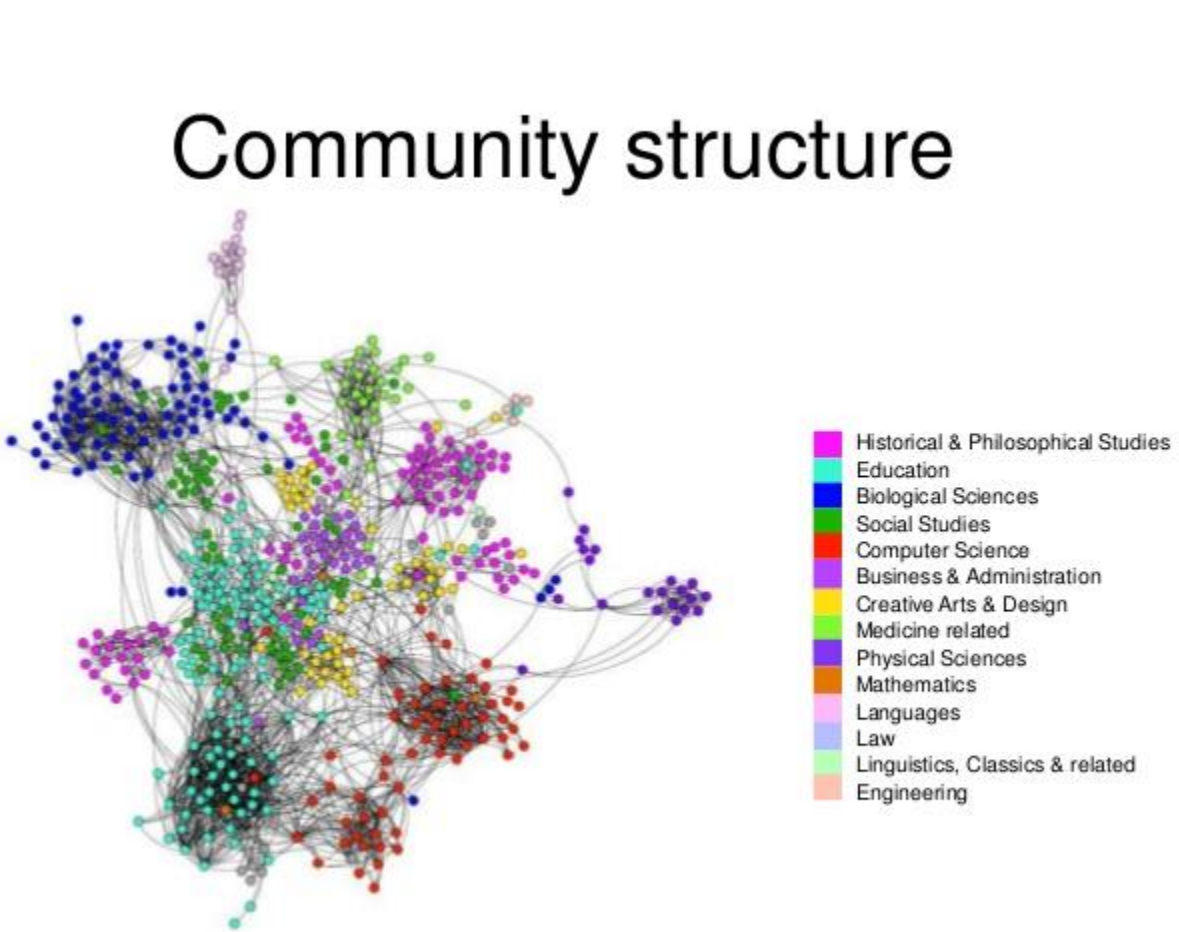
BACKGROUND

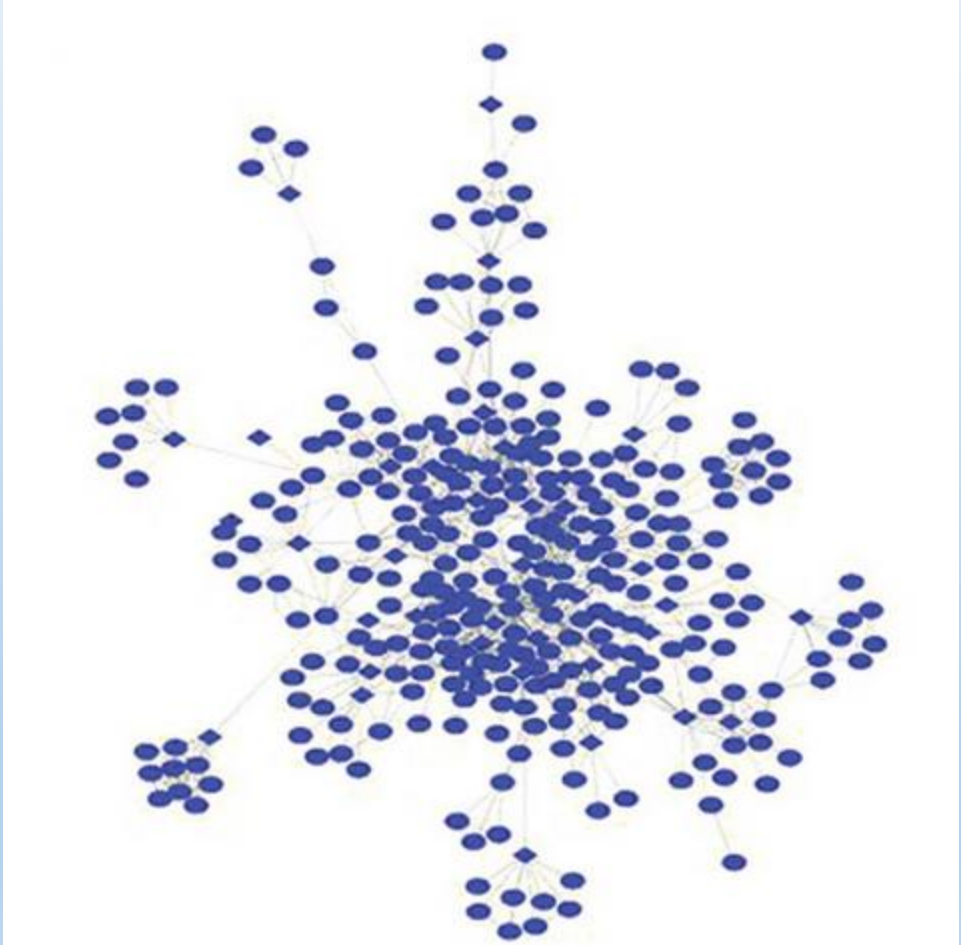
Modular Structure



- Modularity
  - the fraction of the edges that fall within the given groups minus the expected fraction if edges were distributed at random

Biological network

- Incompleteness and Noise
- usually static and mixed
- Hierarchical Structure
- Inconsistency
  - small modules are tree-like and the density of modules increases with the size of the community



Data Sample

```
*Vertices 334
1 "YOR261C"
2 "YPR103W"
3 "YFR004W"
4 "YFR052W"
5 "YDR356W"
6 "YPL255W"
7 "YLL004W"
8 "YPR162C"
9 "YOL038W"
10 "YMR314W"
11 "YER094C"
12 "YOR157C"
13 "YPL218W"
14 "YPR181C"
15 "YML085C"
16 "YNL223W"
17 "YDR013W"
18 "YJL072C"
19 "YBL050W"
20 "YPL232W"
```

```
333 "YOR265W"
334 "YML104C"
*Edges
1 2
3 4
5 6
7 8
3 9
3 10
11 12
13 14
15 16
17 18
19 20
21 22
23 24
25 26
27 28
22 29
30 31
32 14
```

METHODS

ISIM

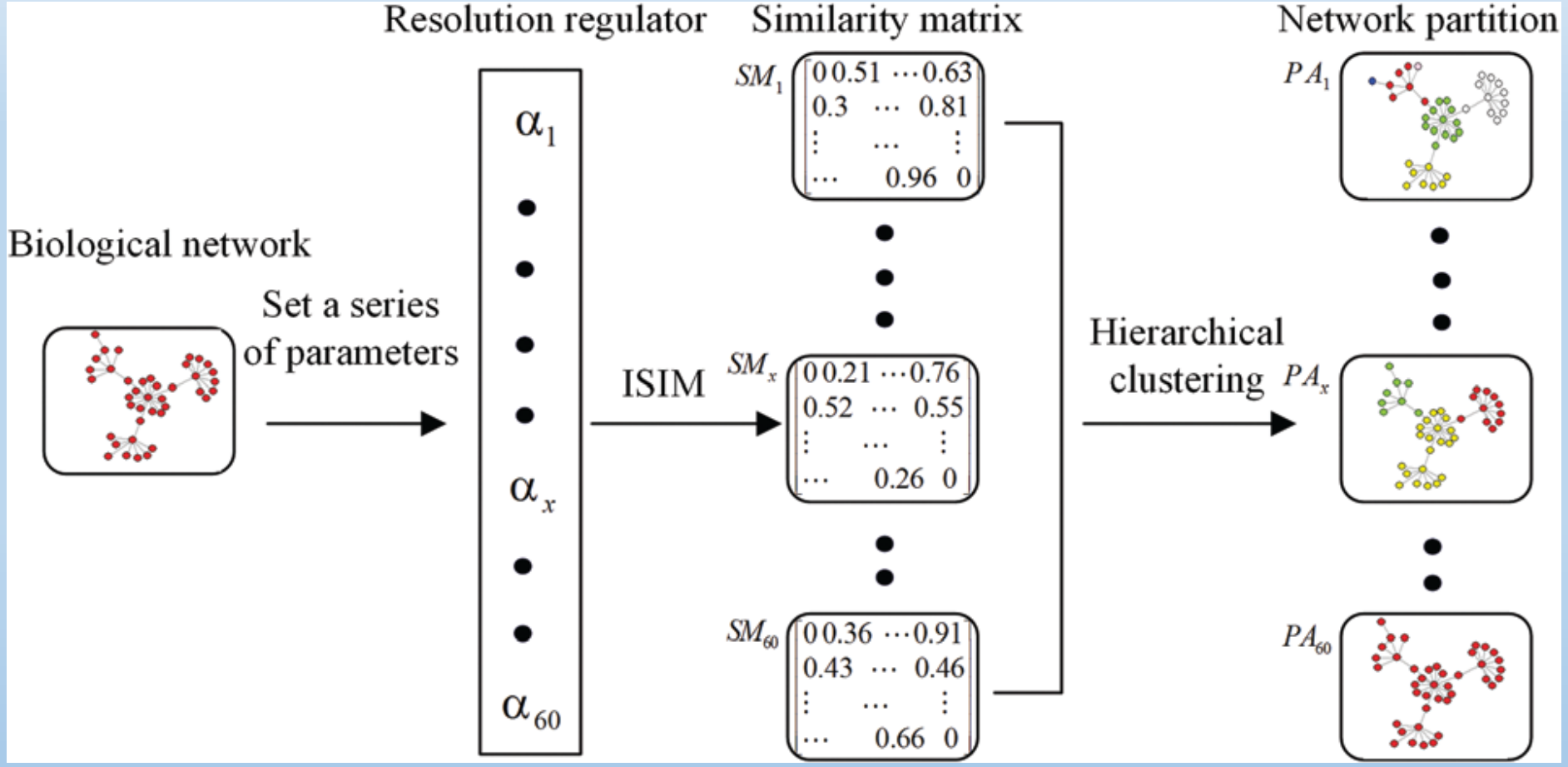
$$P_{ij}(t+1) = (1-\alpha)\frac{1}{\mathrm{SP}(i,j)} + \alpha \sum_{k=1}^{|U_i|} \frac{1}{d_i} P_{kj}(t)$$

$$P(t+1) = (1-\alpha)\mathrm{SPV} + \alpha \mathrm{WP}(t)$$

$$P = (1-\alpha)(I-\alpha W)^{-1}\mathrm{SPV}$$

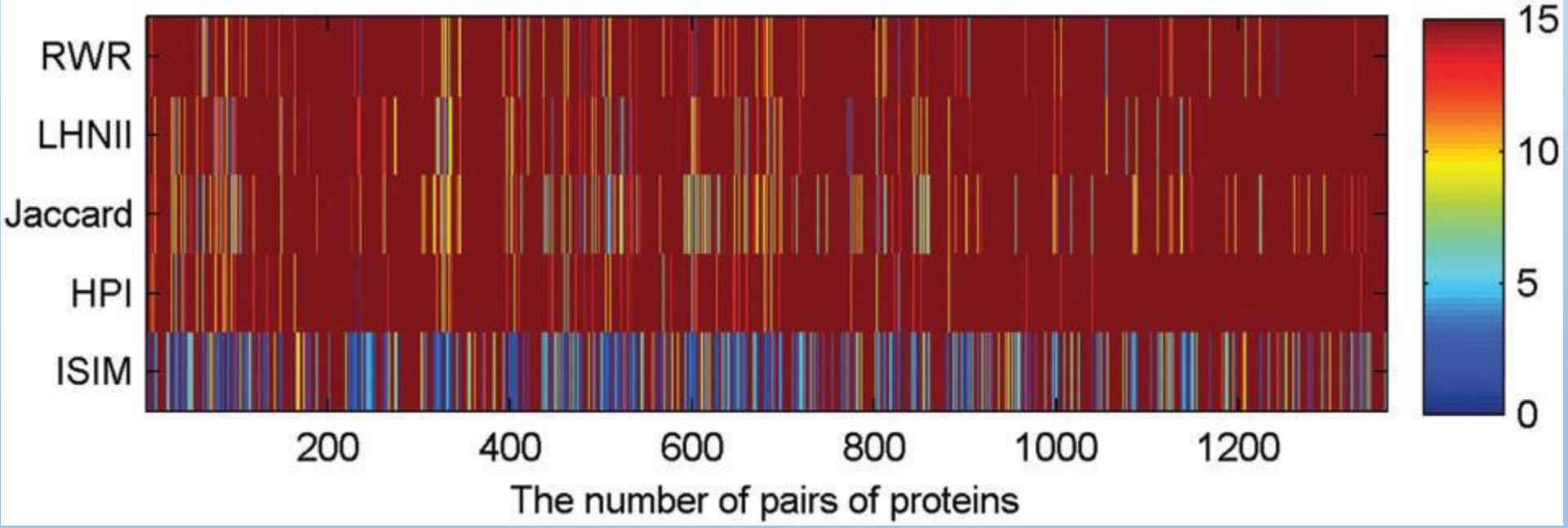
$$S_{ij} = \frac{P_{ij} + P_{ji}}{2}$$

ISIMB

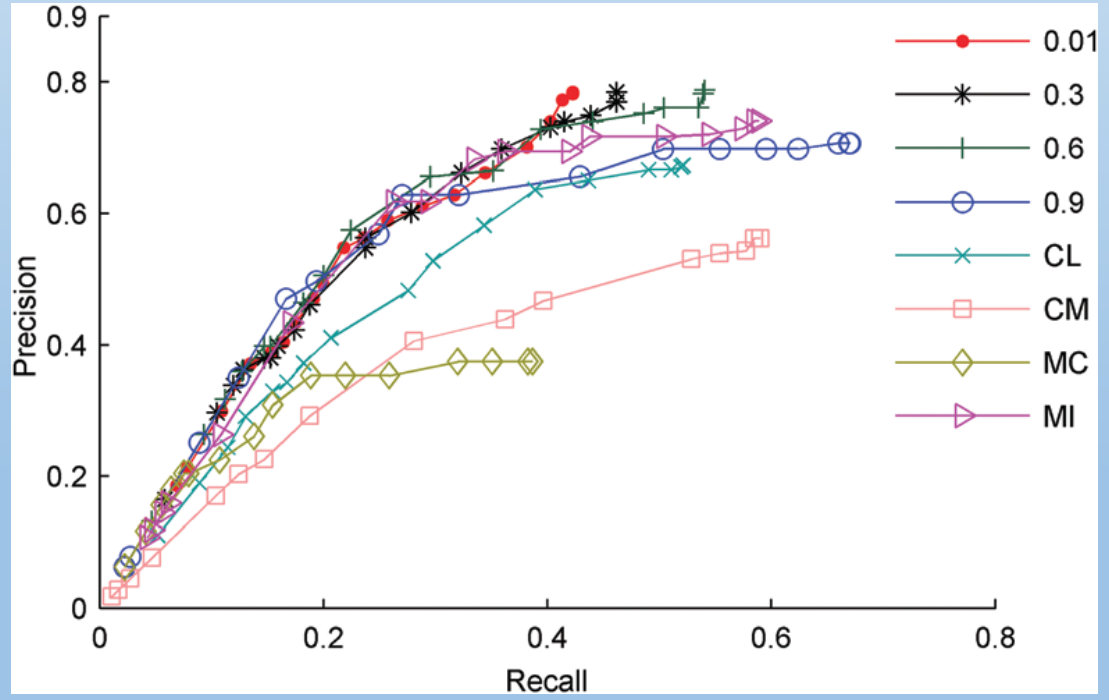

Resolution regulator
Similarity matrix
Network partition
Biological network
Set a series of parameters
ISIM
Hierarchical clustering
α_1
α_x
α_{60}
SM_1
SM_x
SM_{60}
PA_1
PA_x
PA_{60}

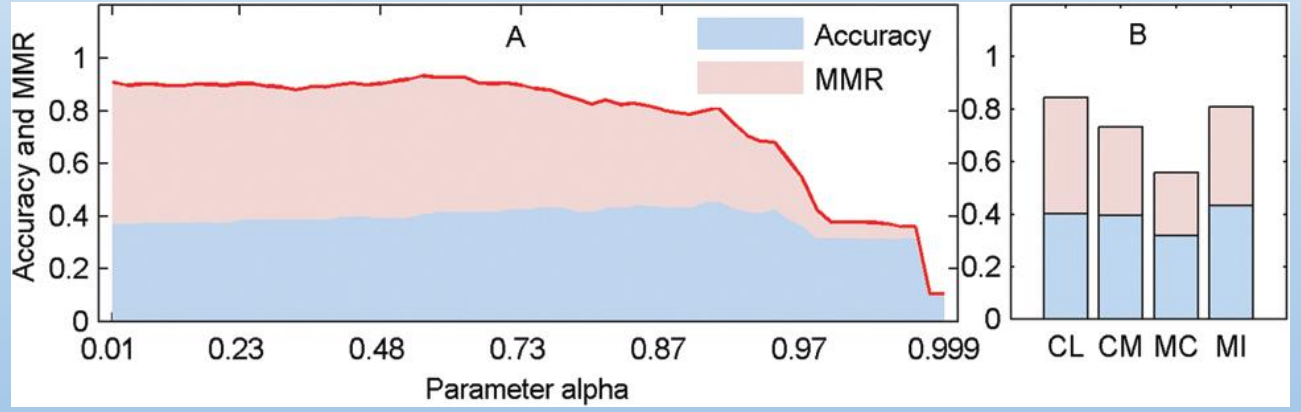
RESULTS

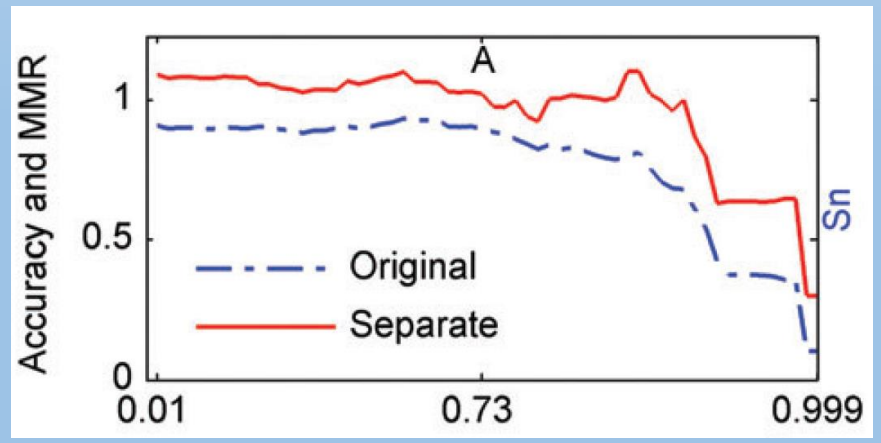
Robustness to biological network data quality



Detecting protein complexes in PPI networks







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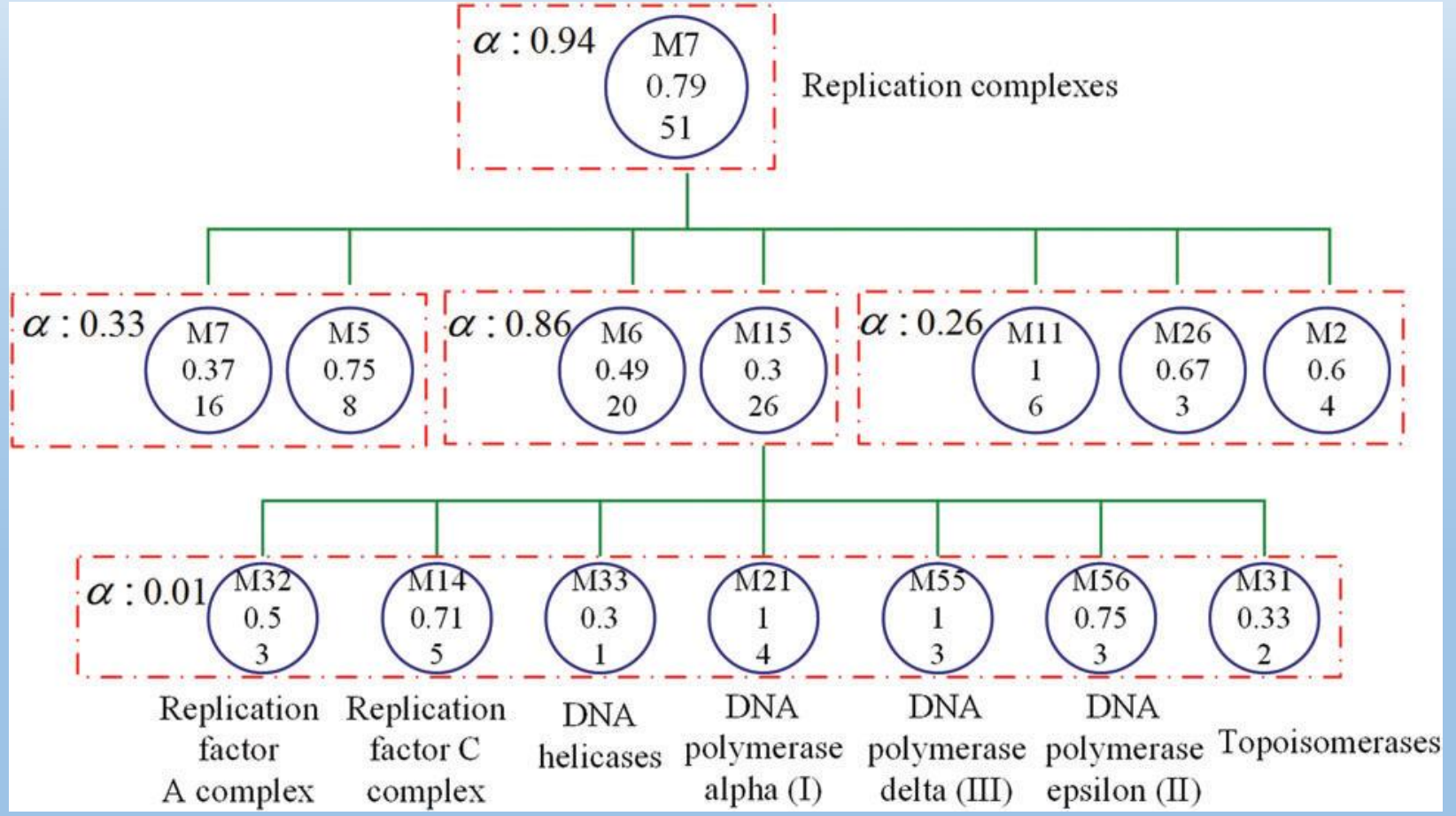
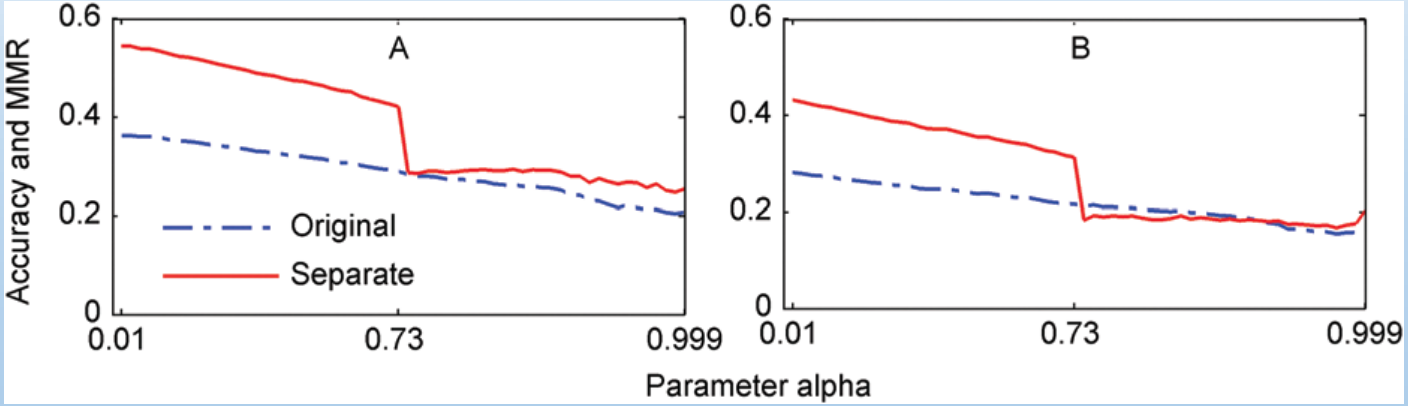


Detecting functional modules



physical PPI network

genetic interaction network

Network		Method				
		ISIMB	CMC	MCODE	ClusterONE	MINE
Physical	Accuracy	0.232	0.129	0.104	0.128	0.129
	MMR	0.256	0.161	0.064	0.191	0.134
Genetic	Accuracy	0.195	0.119	0.096	0.119	0.127
	MMR	0.182	0.115	0.06	0.132	0.093

ASSESSMENT

- ● Robustness
- ● Binding Hierarchical Structure to Multi-scale Method
- ◆ Convergence Dynamic Strategy to Static Model
- ◆Expression of Global Structure

- ■ Details
- ☐ Dense Network & Overlapping
- ☐ Evaluating Index

- ➢ Structural_ + Functional_

QUESTION(S)?