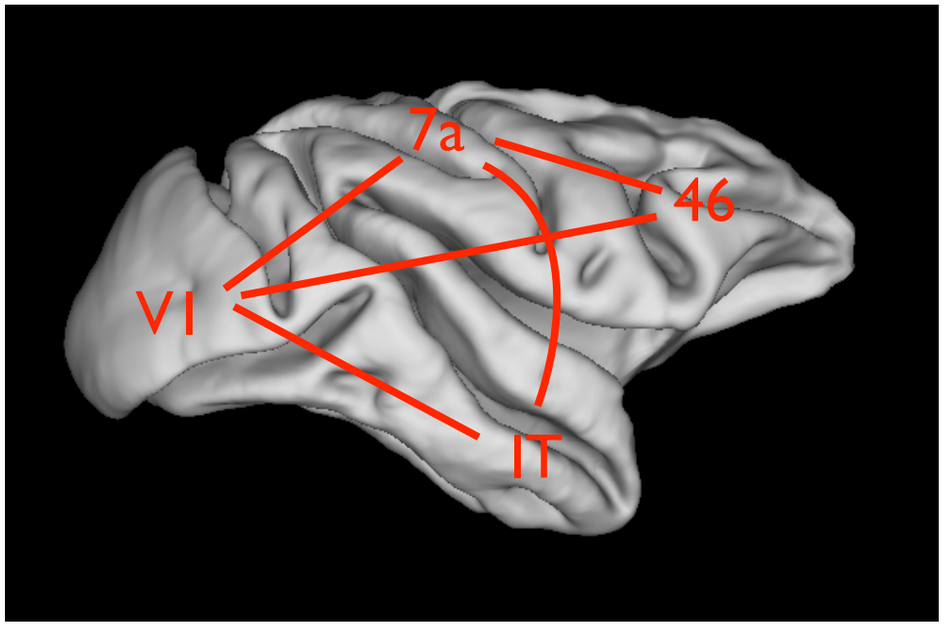
Old gets richer - A model for the development of hubs

Bioinformatics Group Meeting
Roman Bauer
Kaiser Lab
28. 01. 2014

Networks with Hubs



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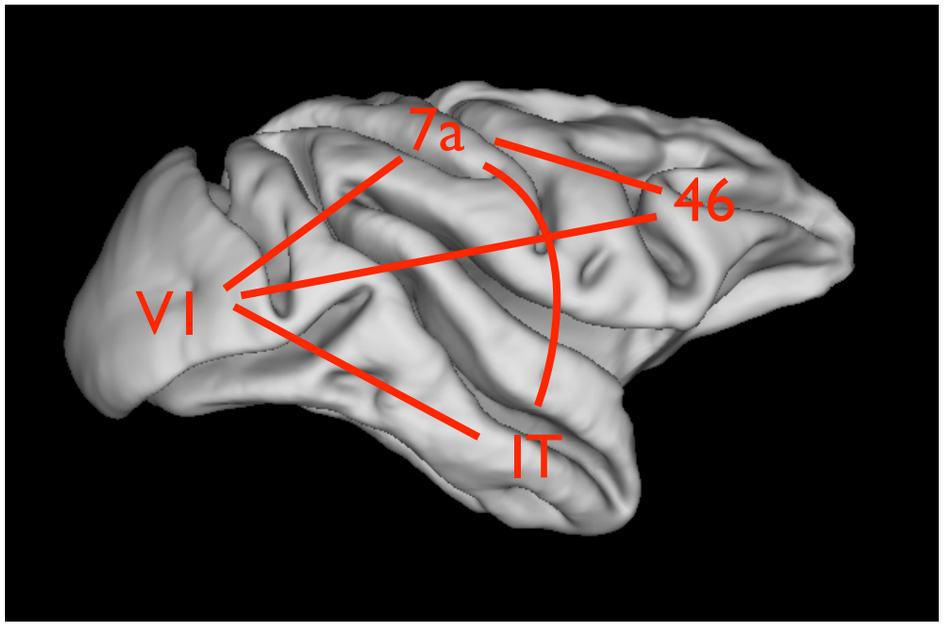

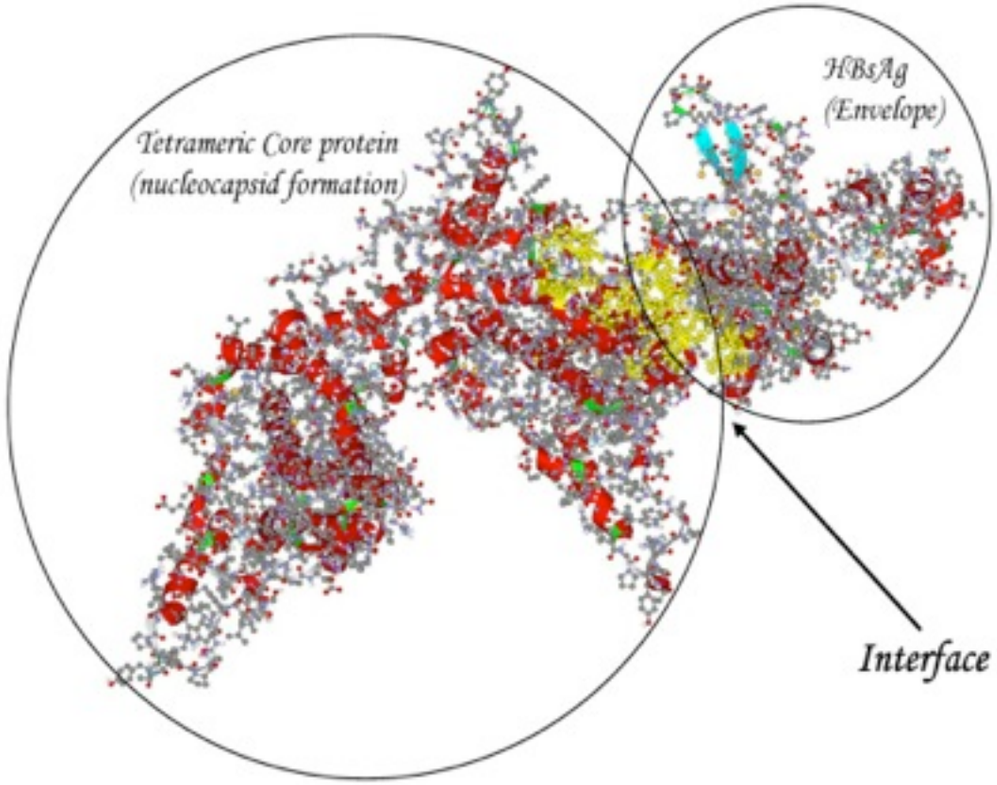

from van Hemert et al. 2008

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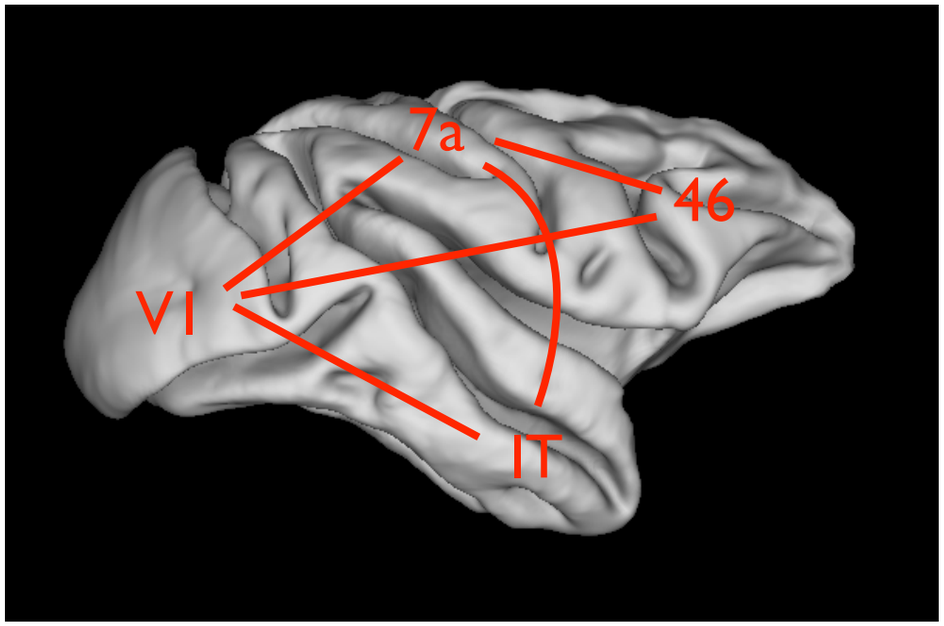

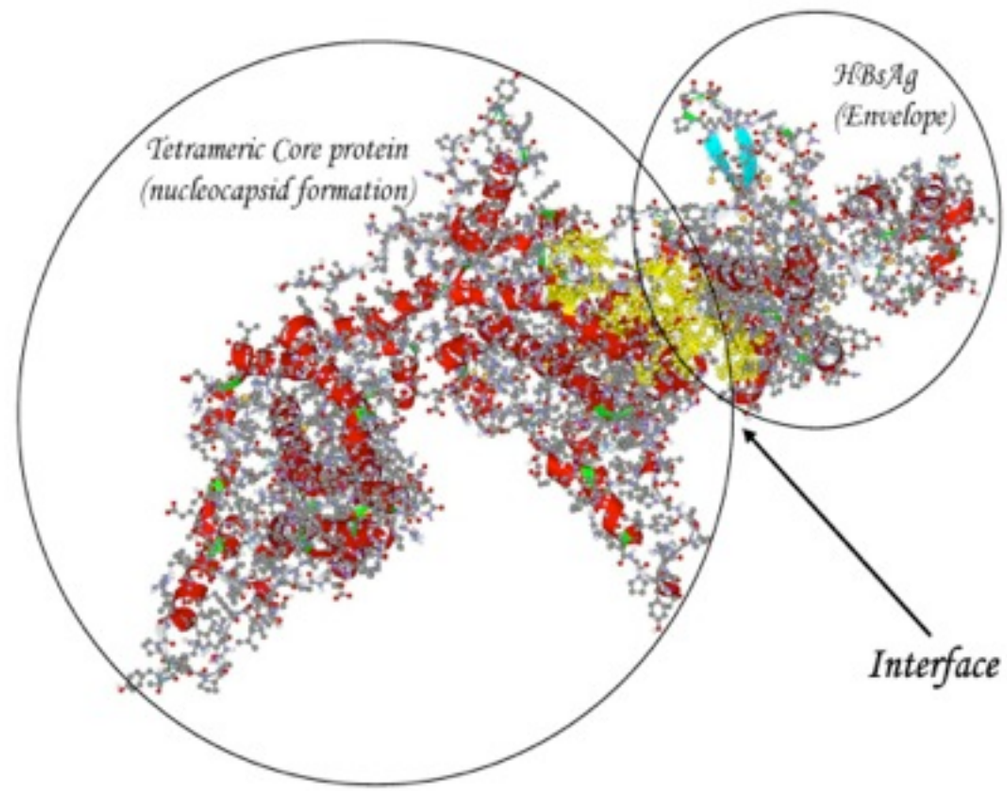

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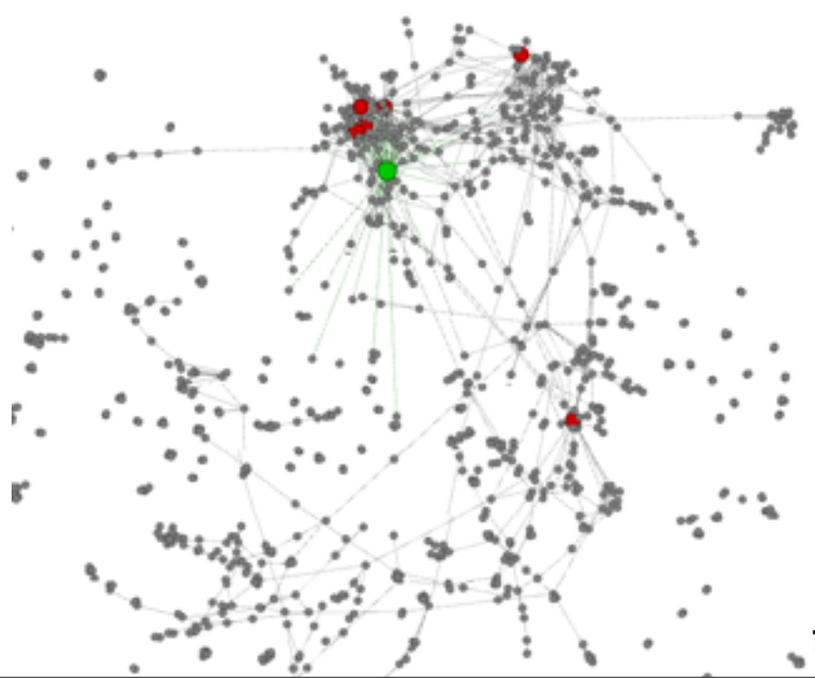
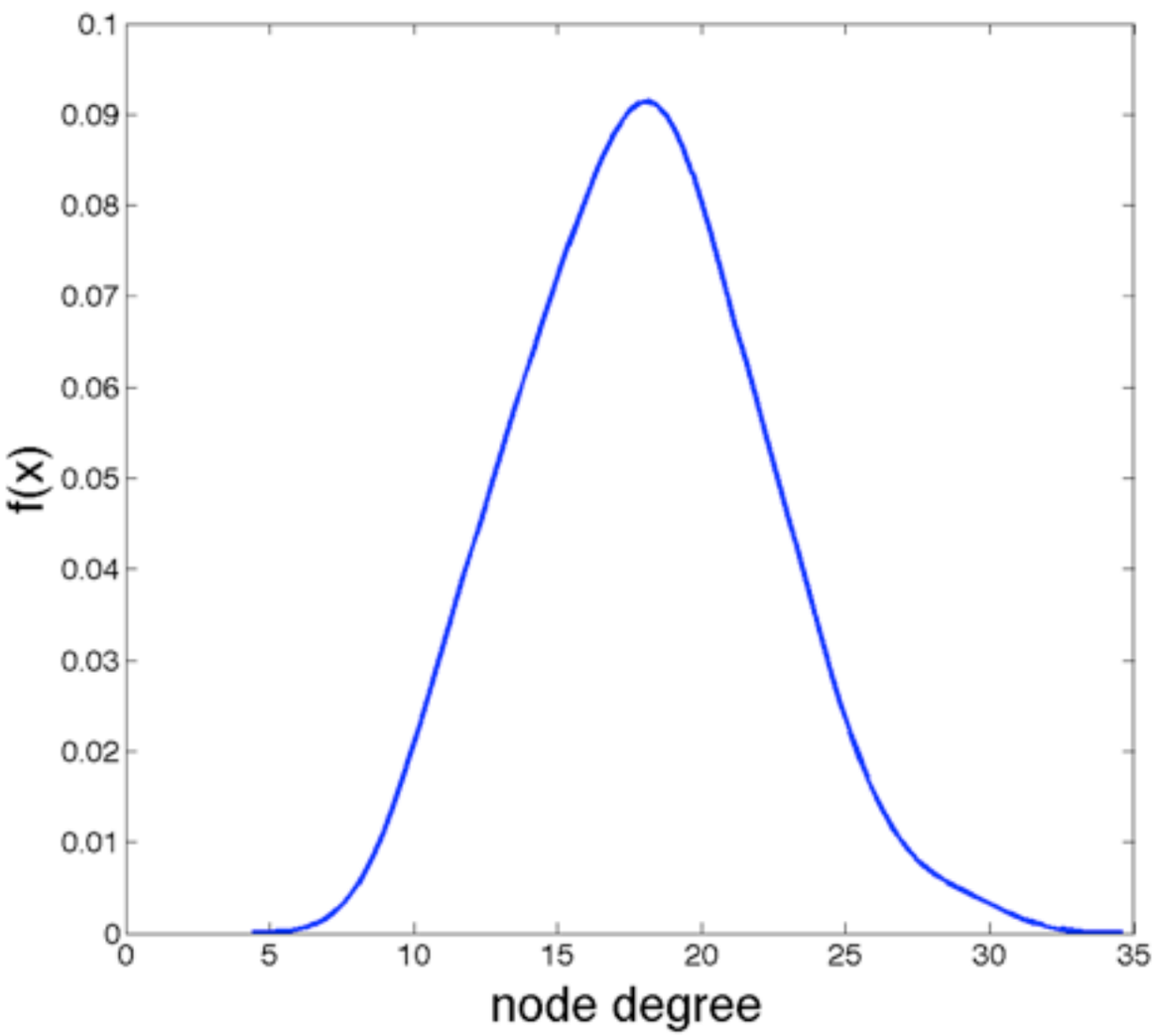


from http://www.eecs.wsu.edu/~yyao/DynamicGraph.html

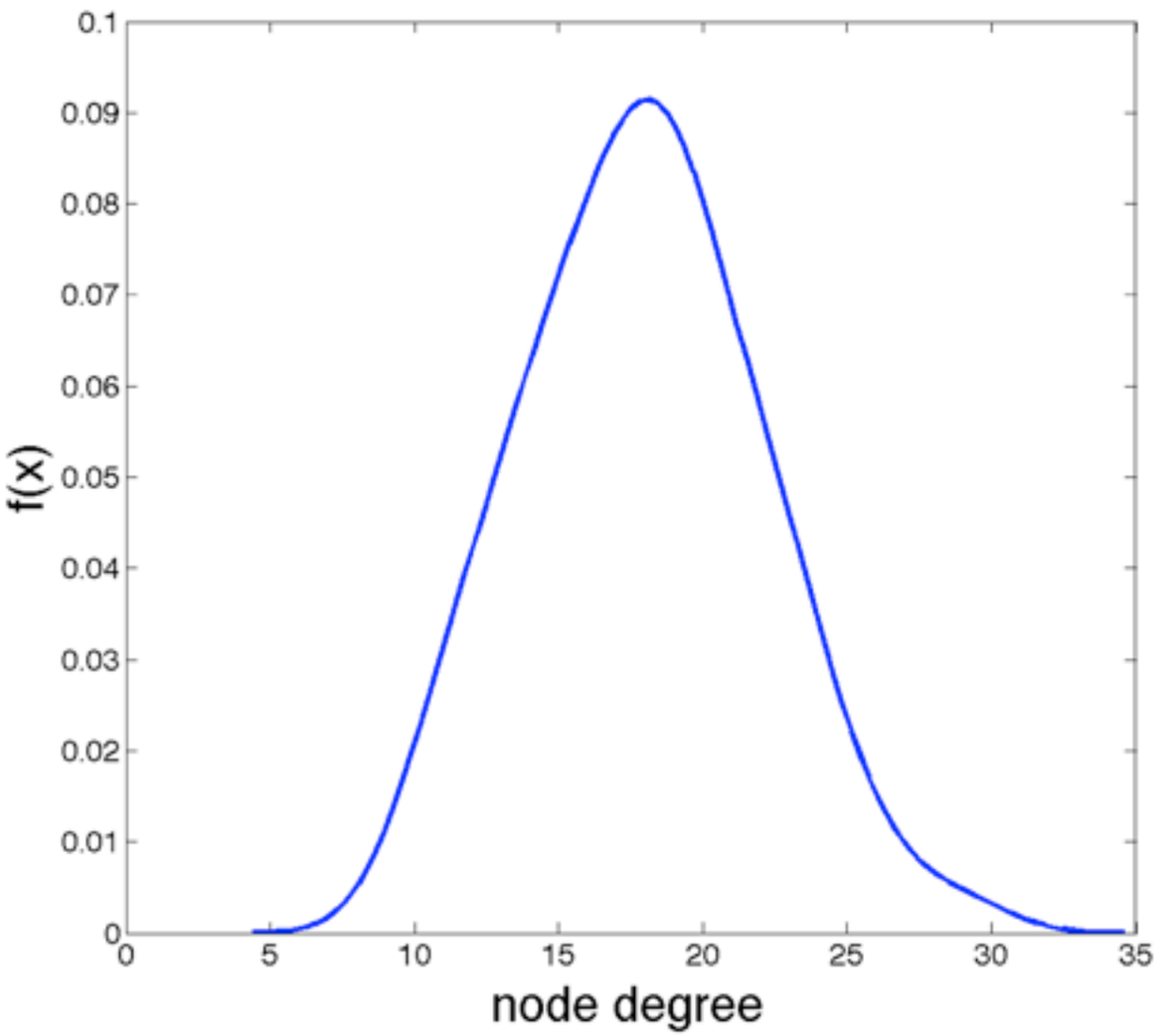
Degree Distribution

Random Network Growth

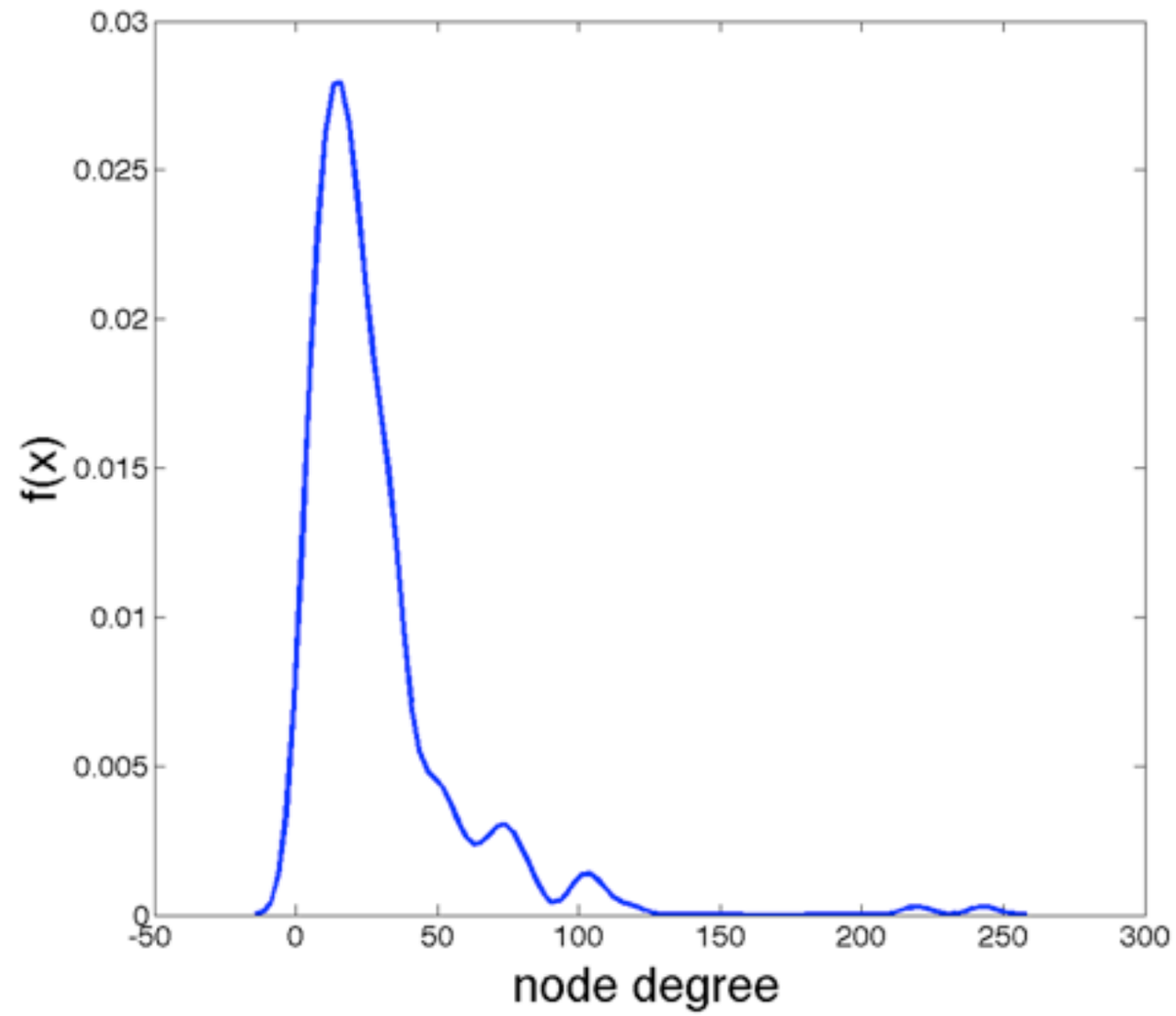


Degree Distribution

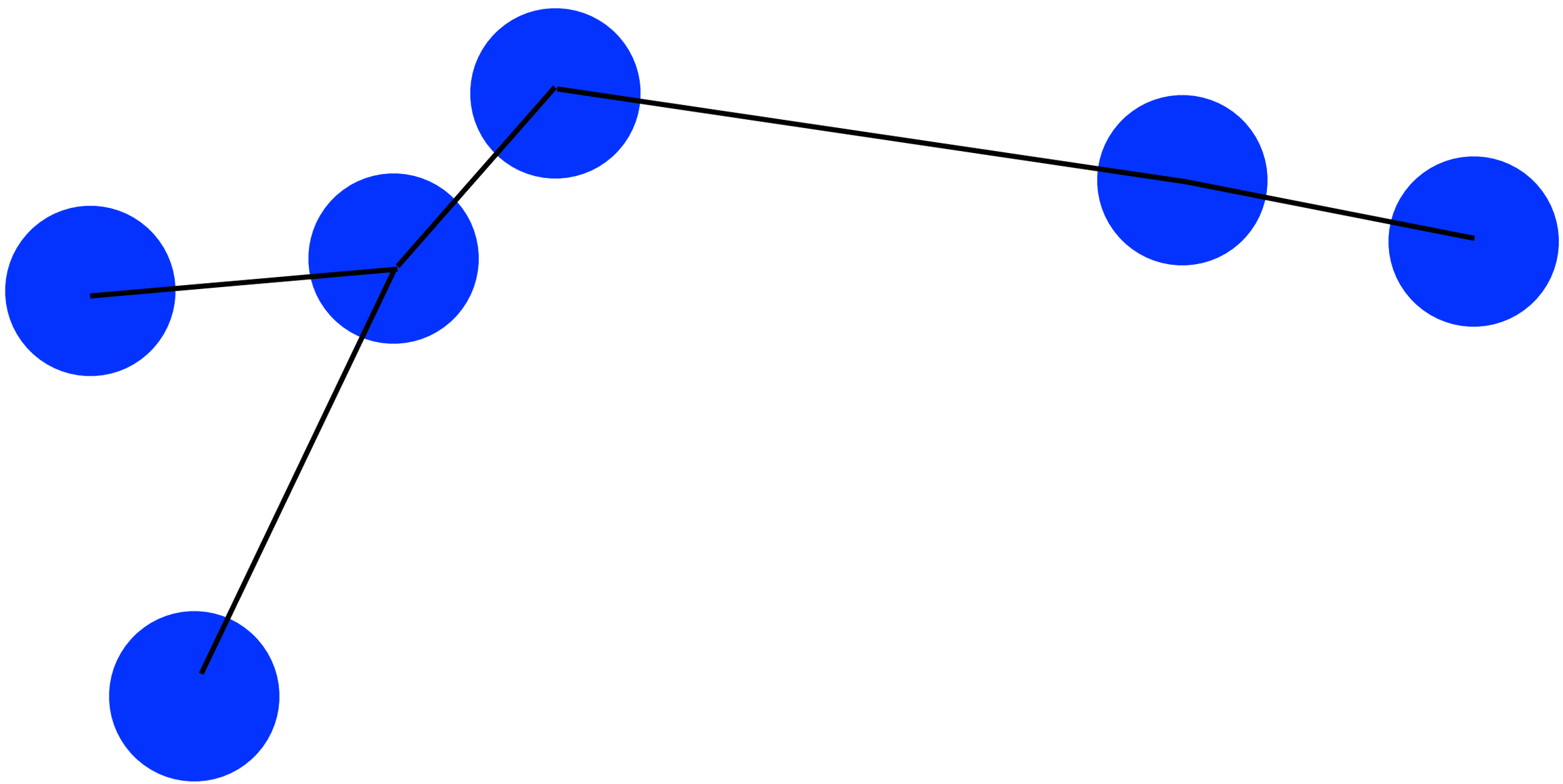
Random Network Growth



C. elegans



Modeling Development of Hubs



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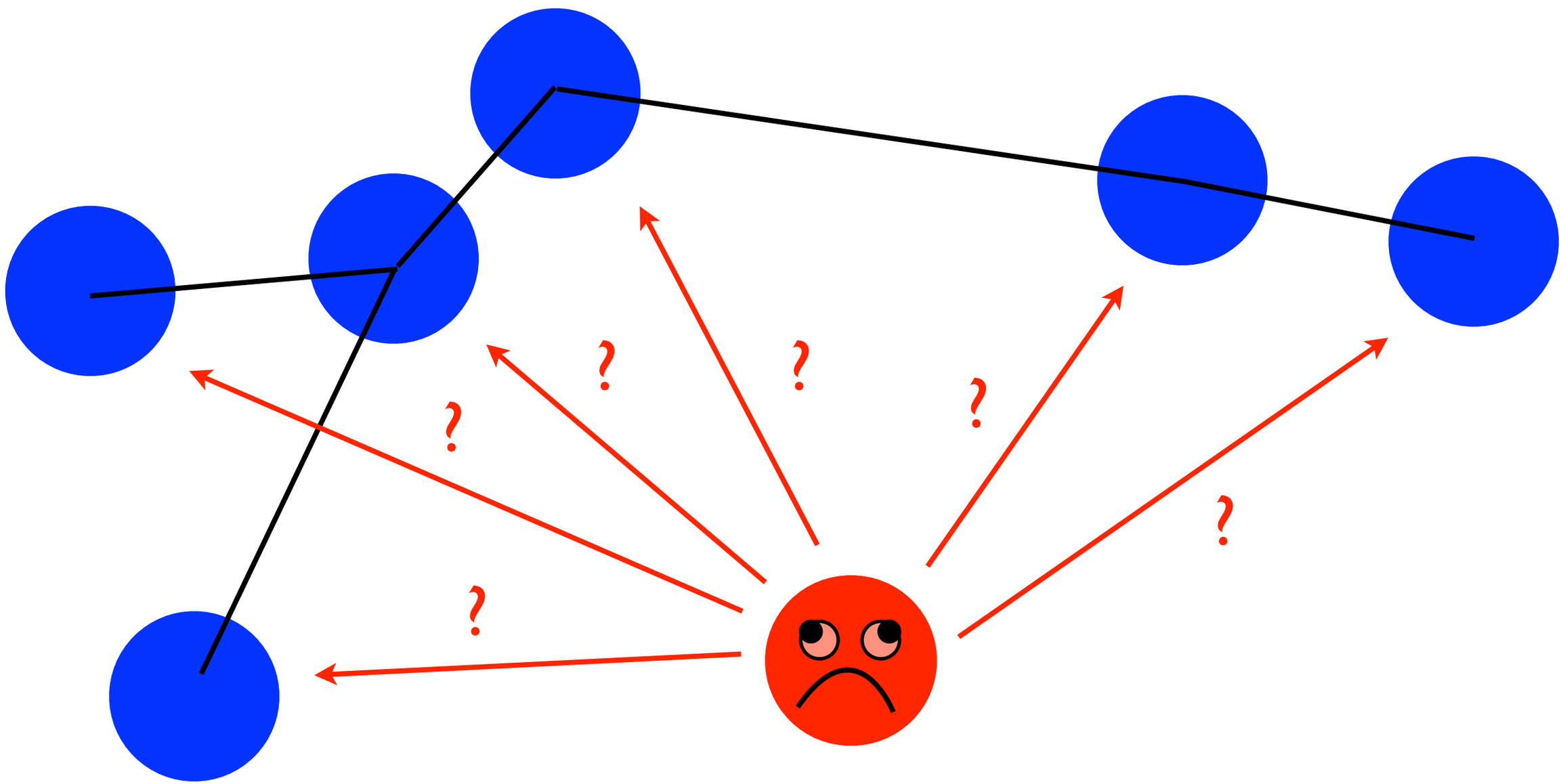
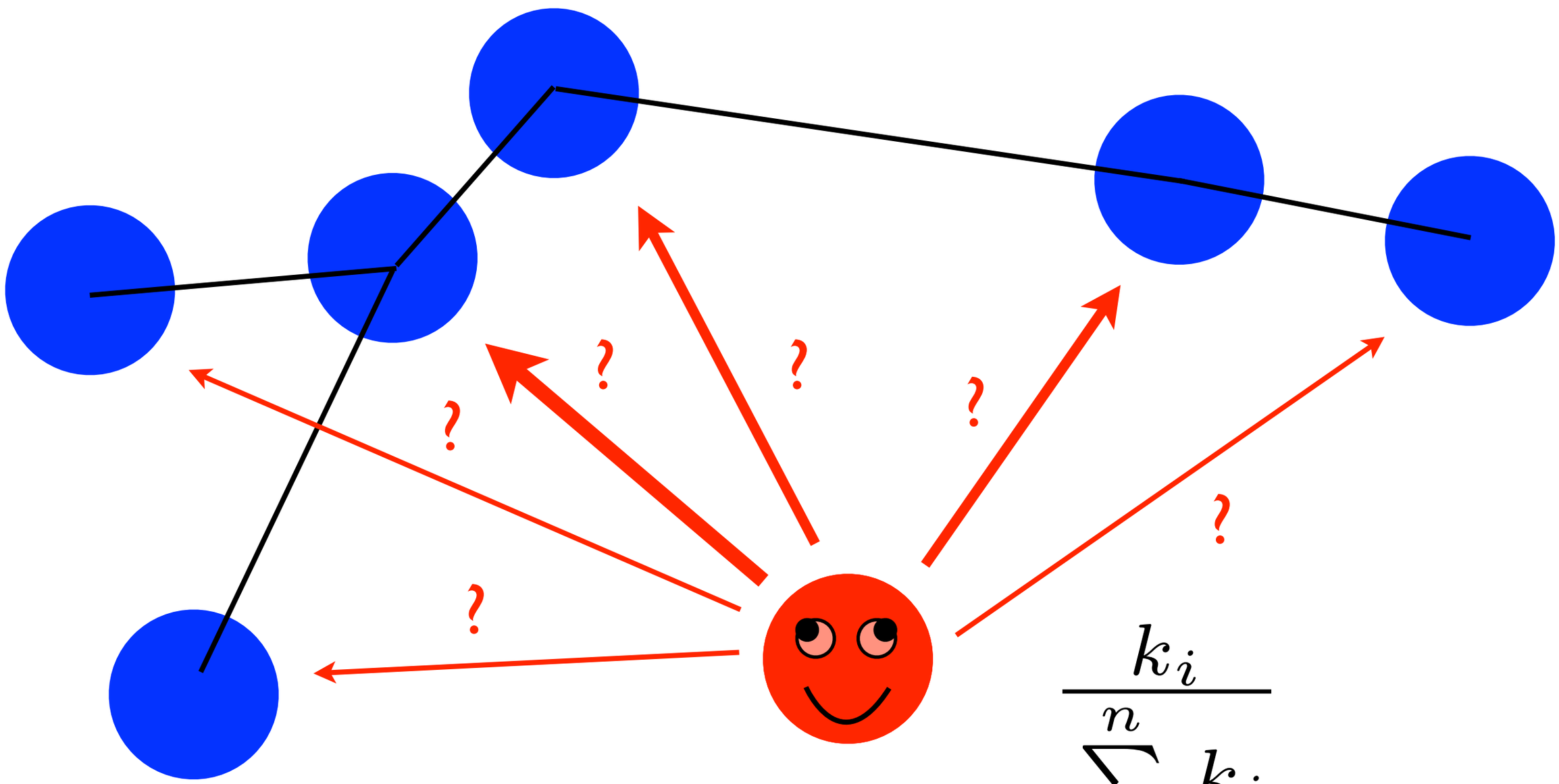
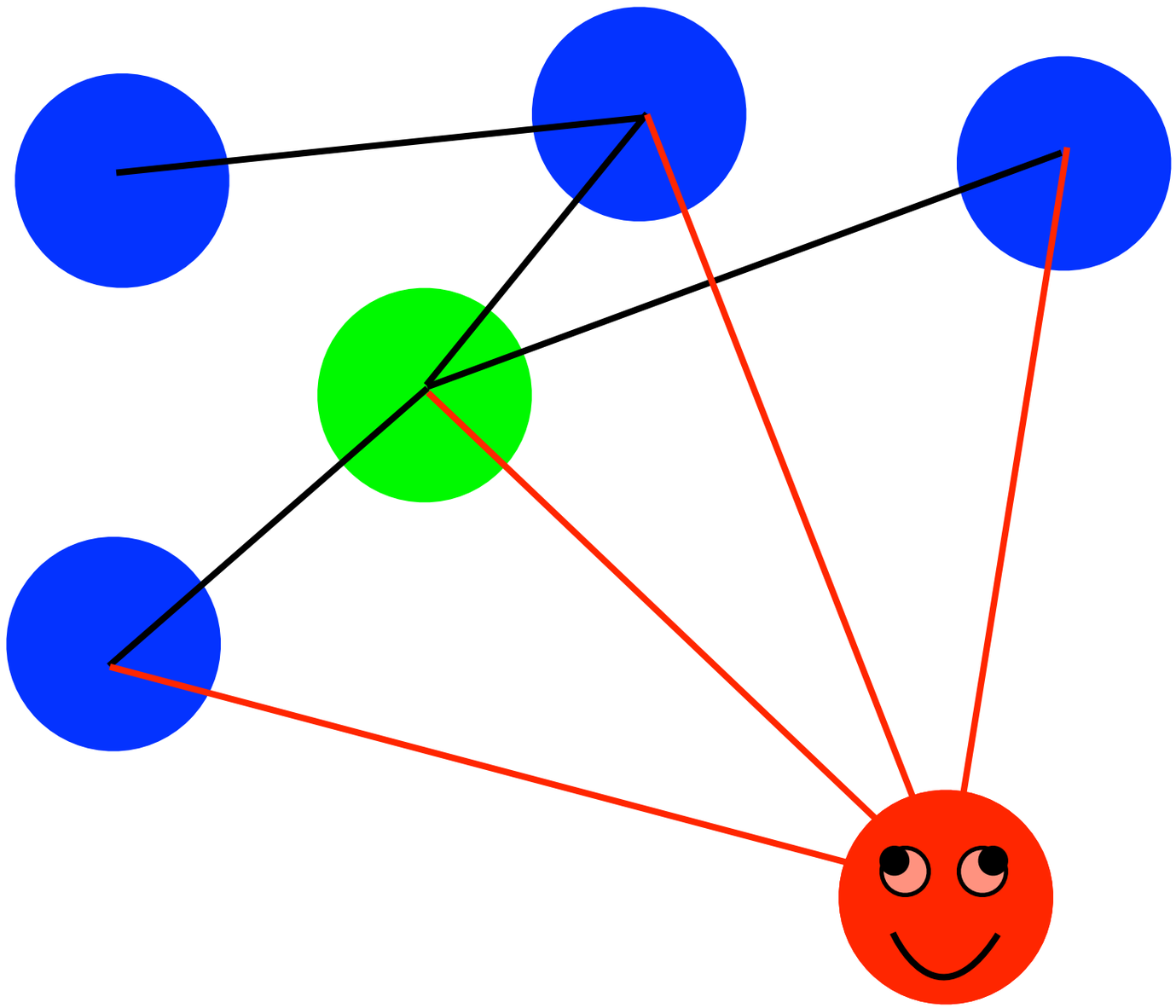


Preferential Attachment
(Barabasi & Albert, 1999)



$$\frac{k_i}{\sum_{i=1}^{n} k_i}$$

Duplication-Divergence
(Vazquez et al. 2001)



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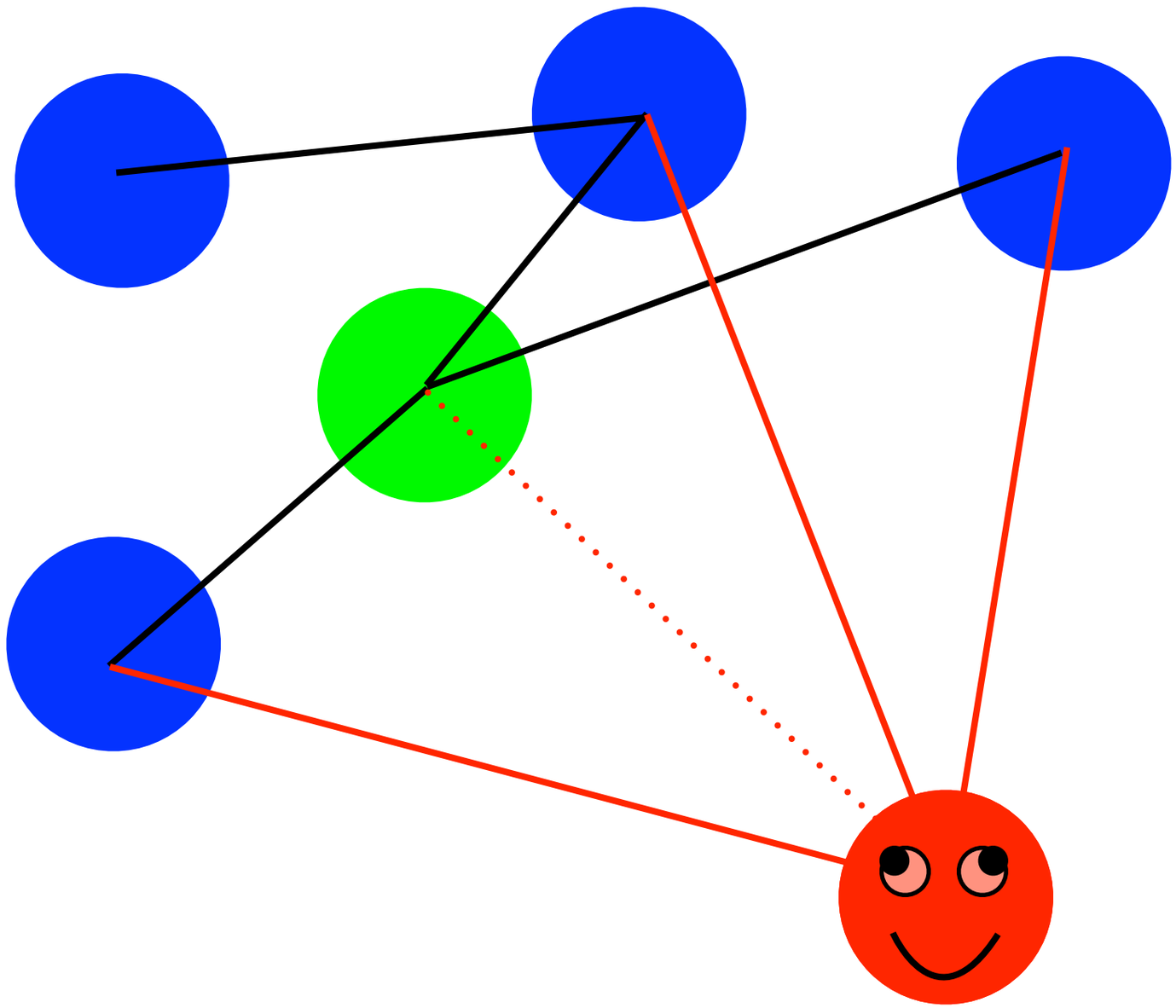

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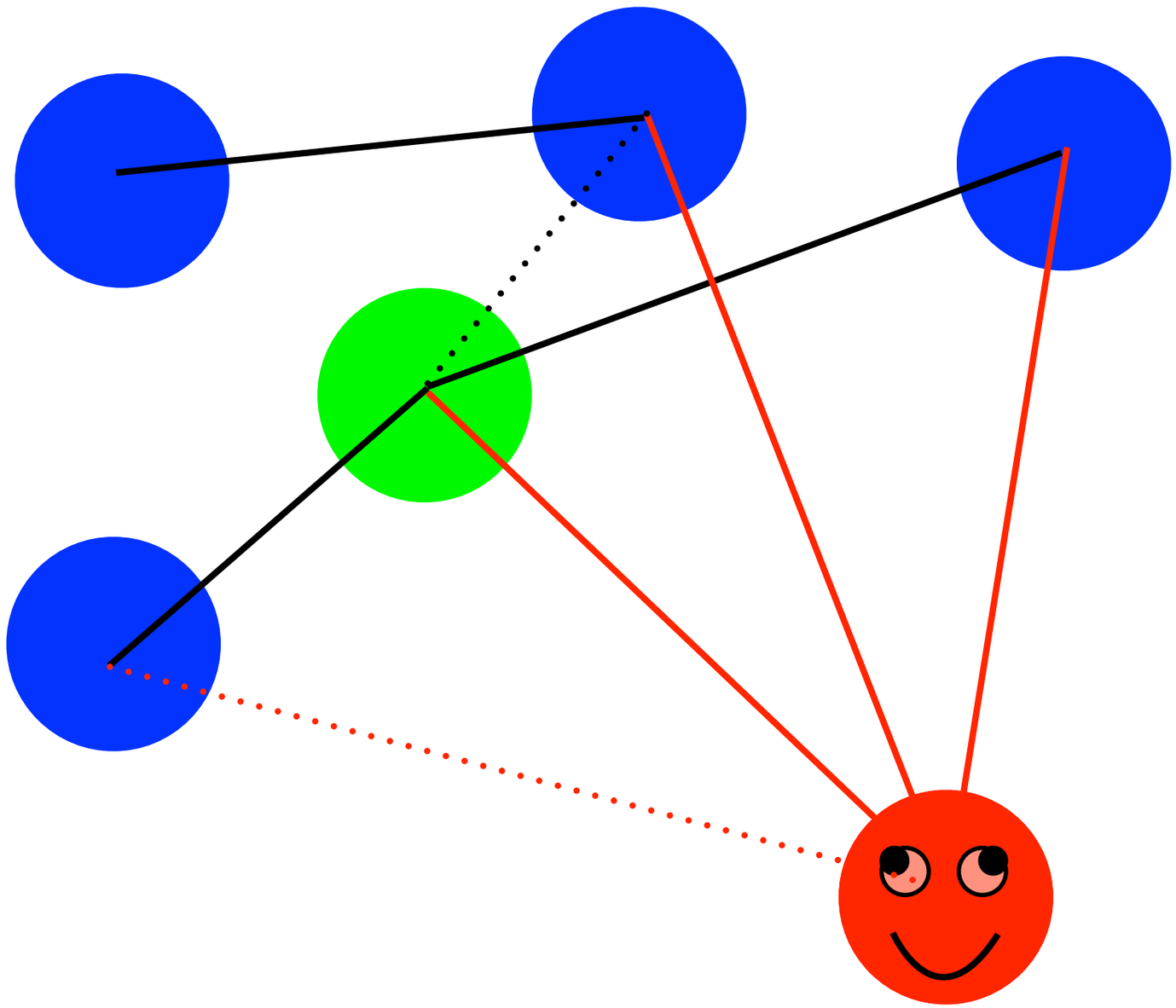
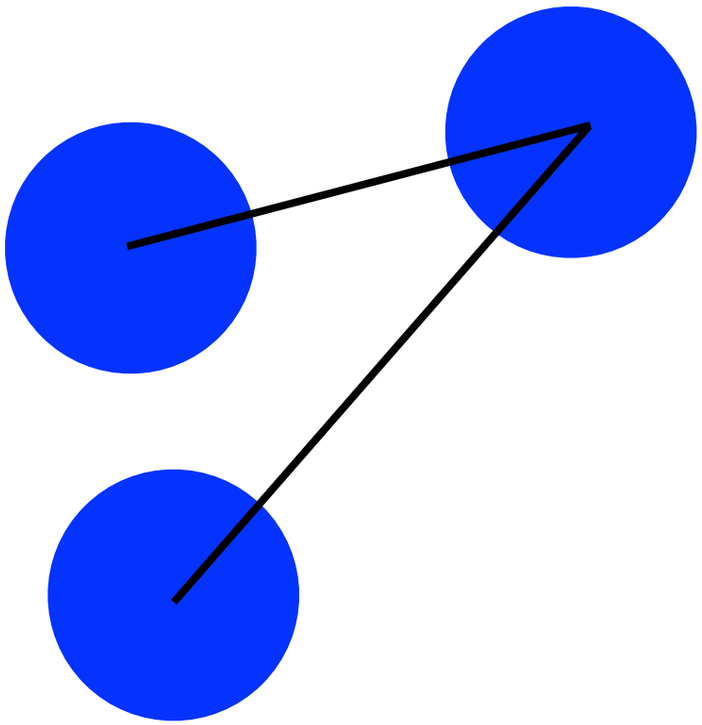


Nonlinear Growth



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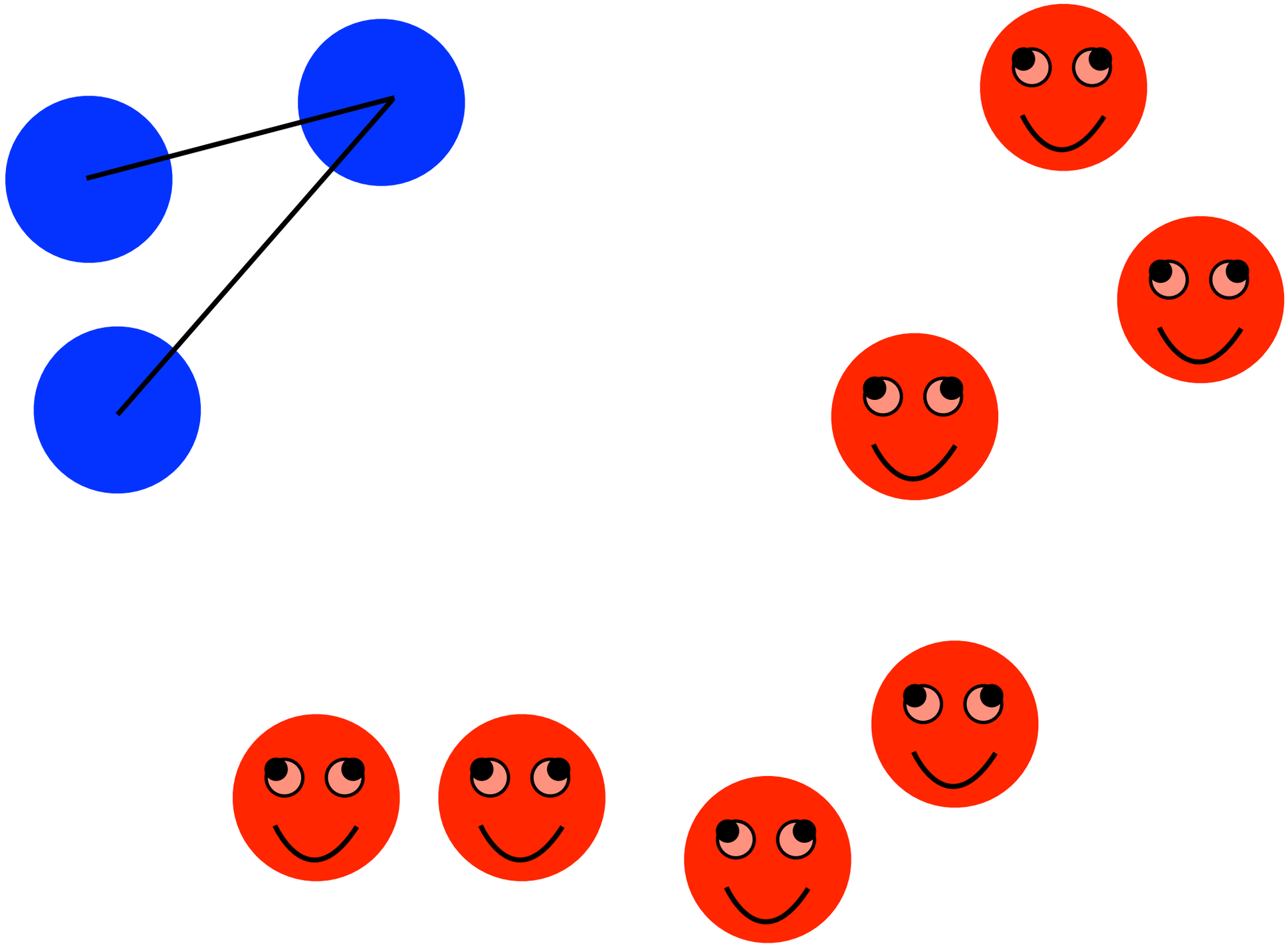

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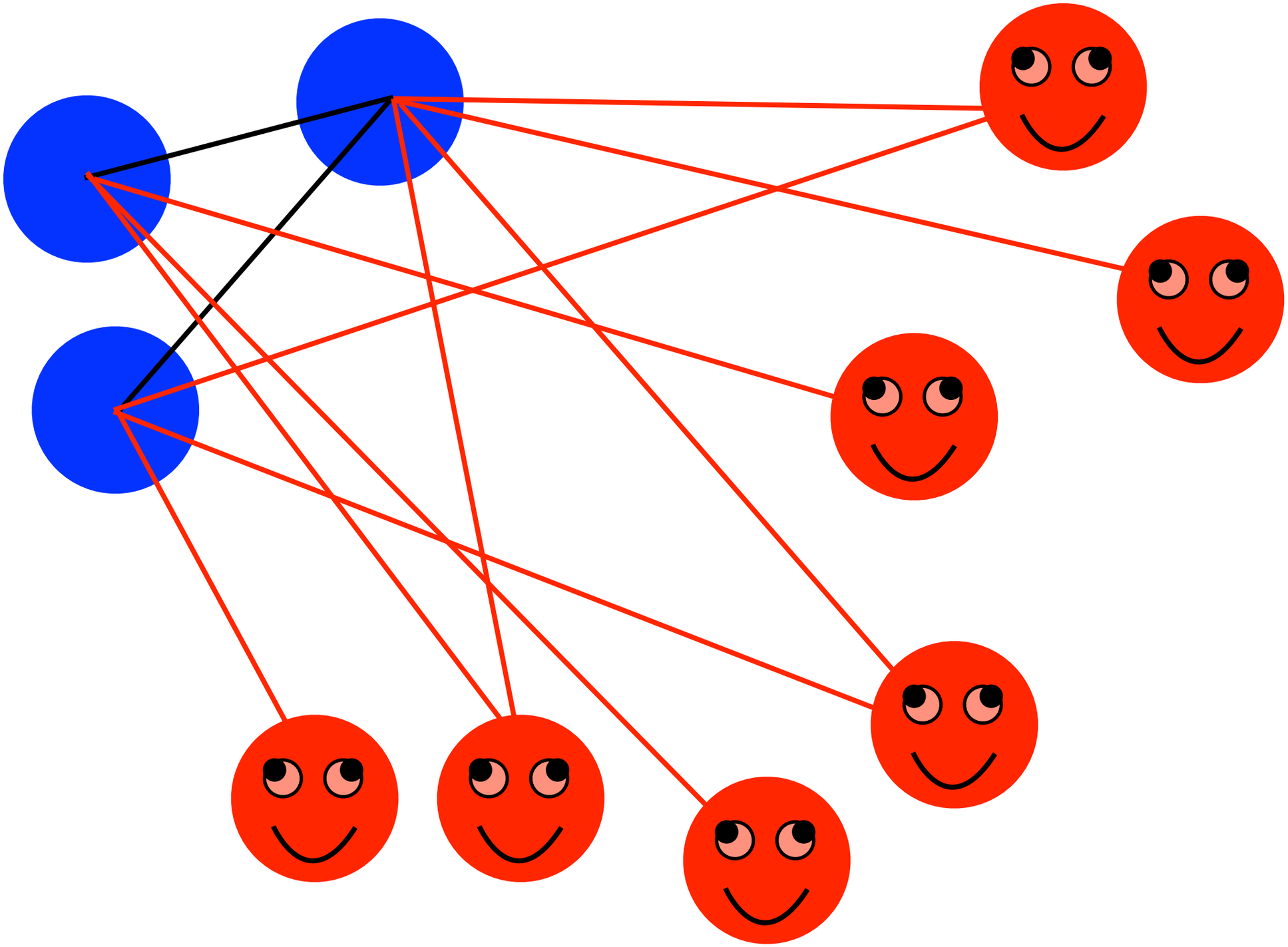
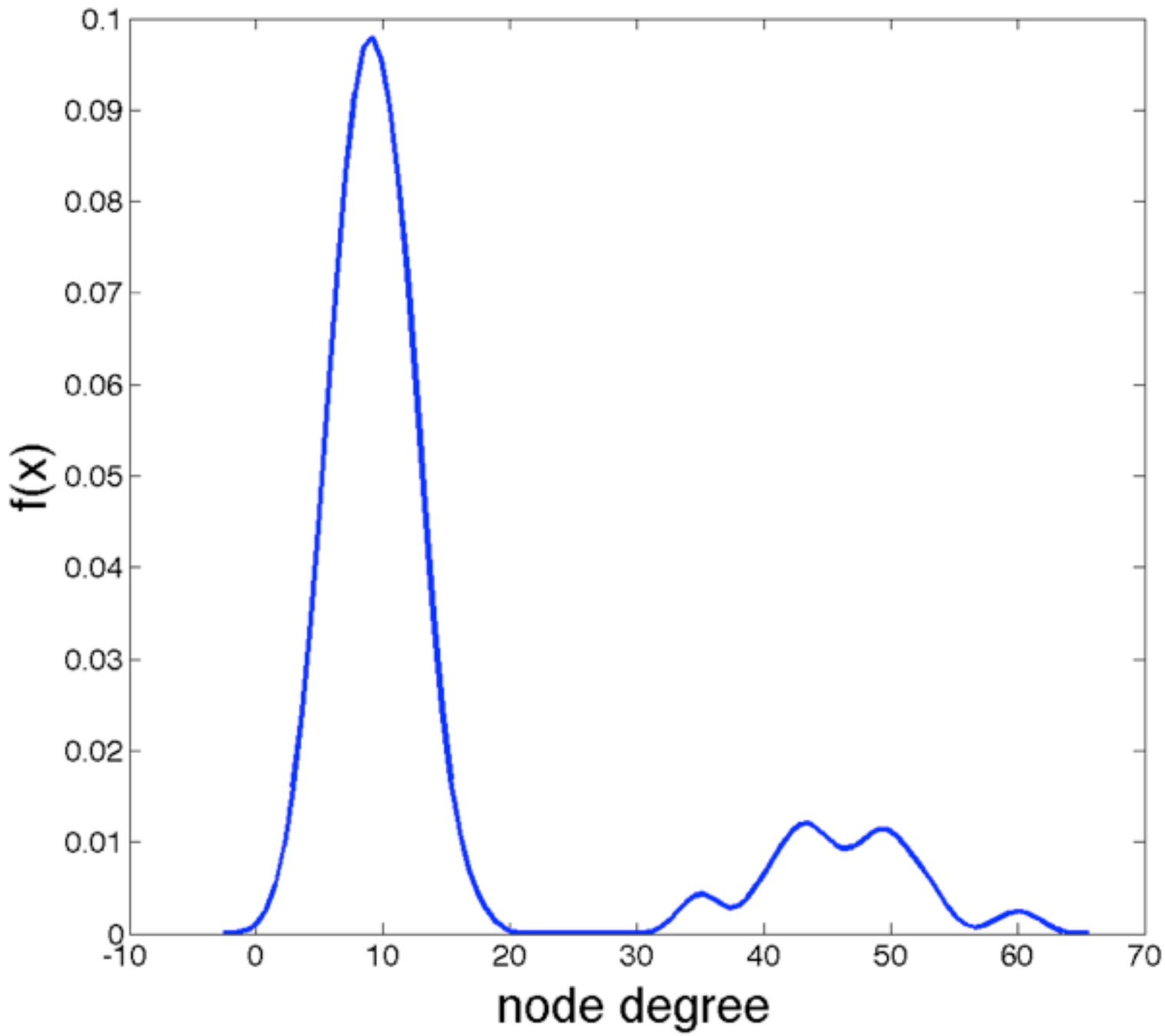
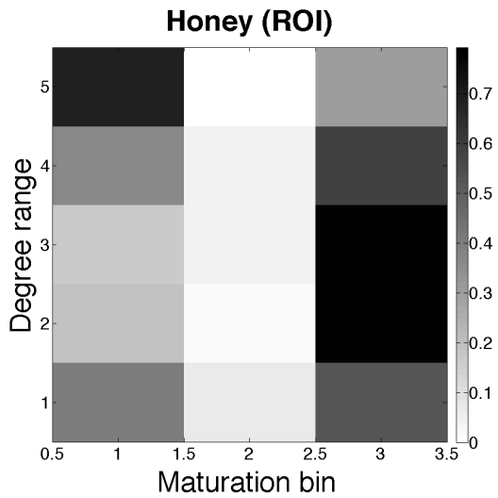


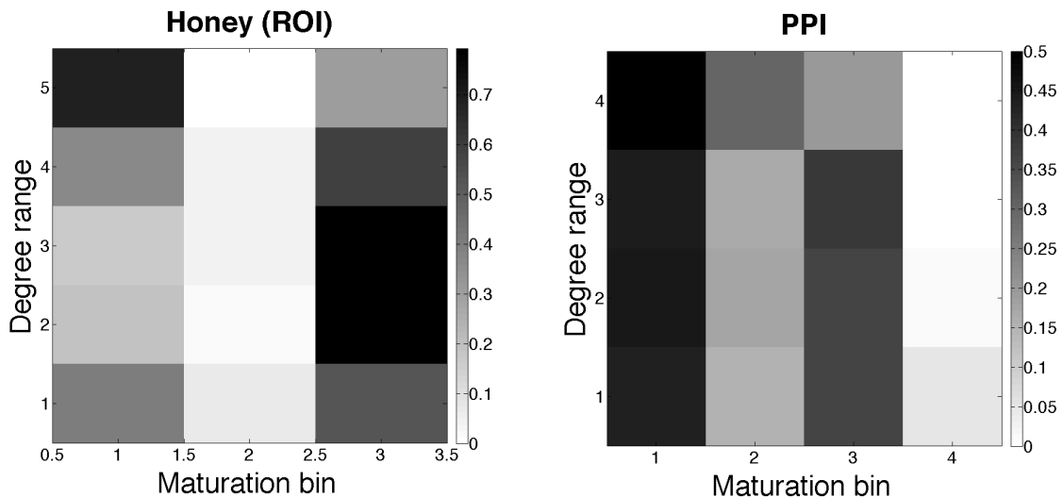
Nonlinear Growth: Degree Distribution



datasets


Honey (ROI)
Degree range
Maturation bin
5
4
3
2
1
0.5
1
1.5
2
2.5
3
3.5
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

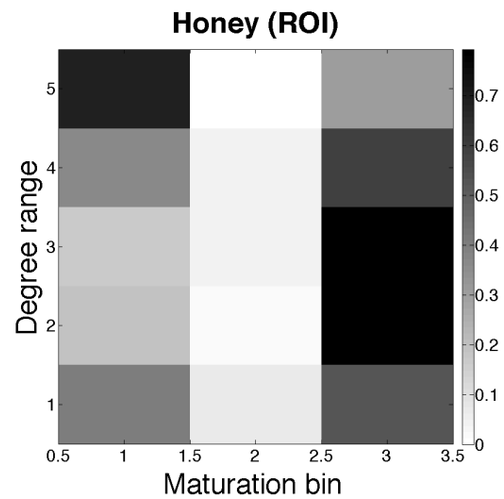
datasets

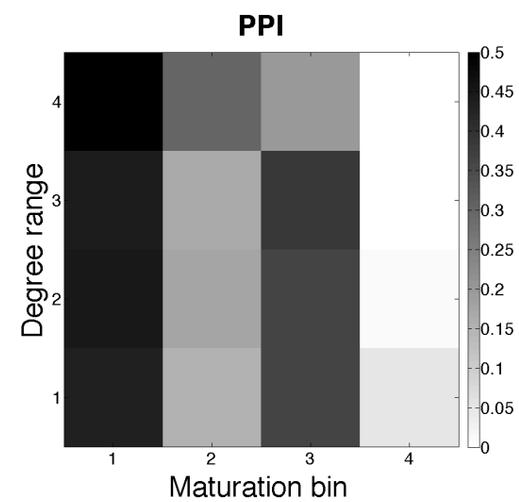


(protein age assignment from Kim & Marcotte, 2009)

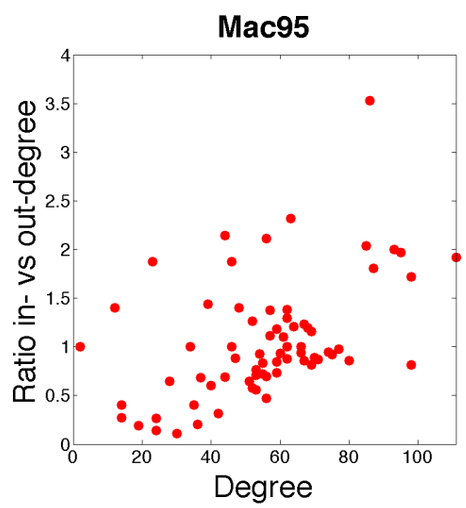
datasets

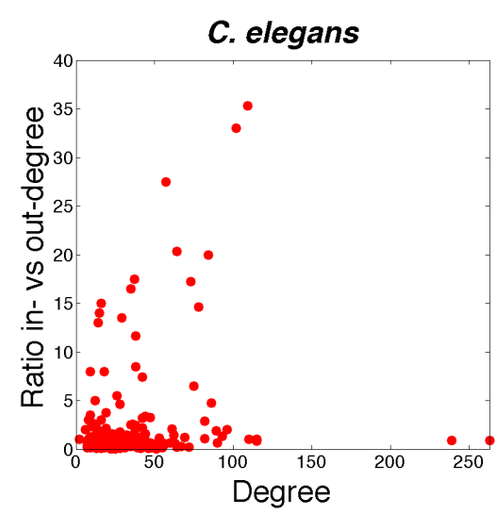
Undirected





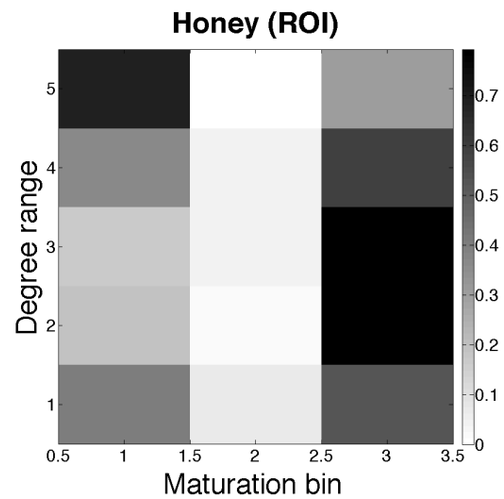
Directed

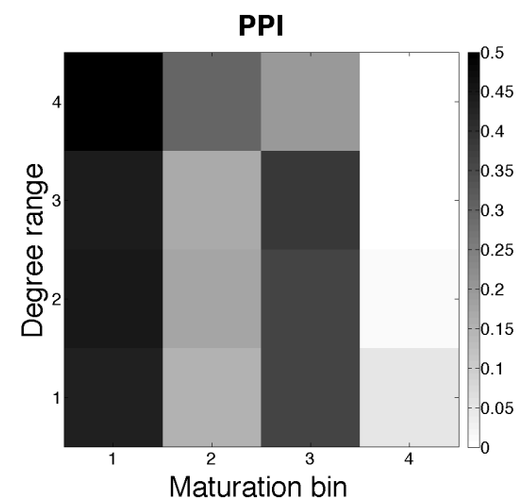




datasets

Undirected





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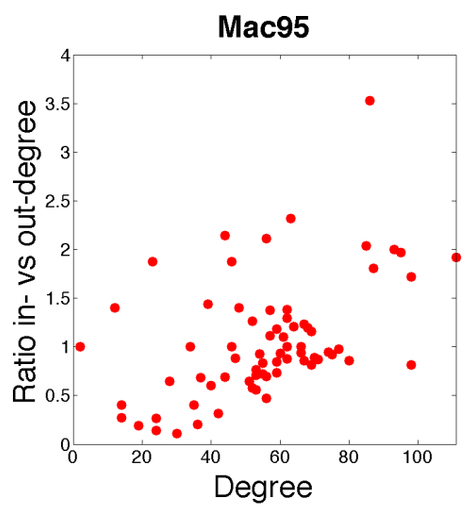
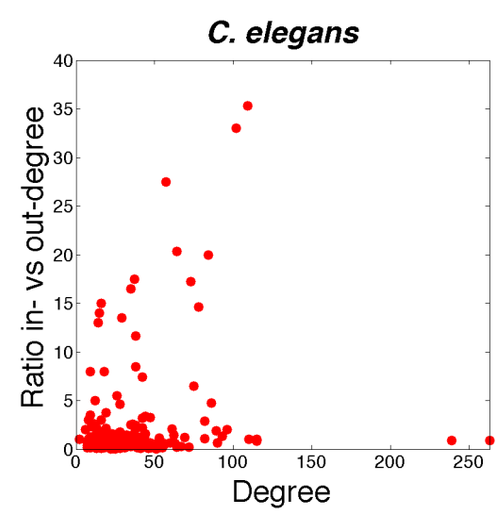
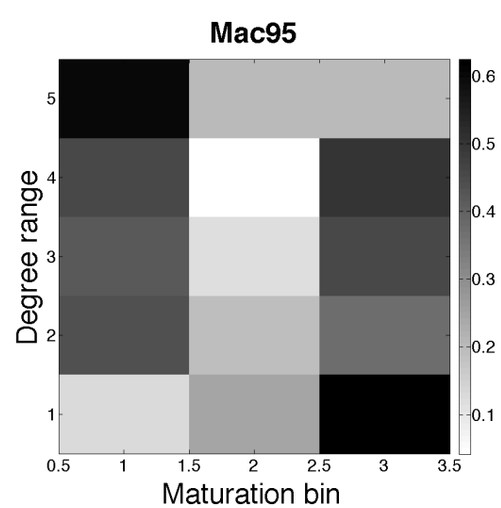
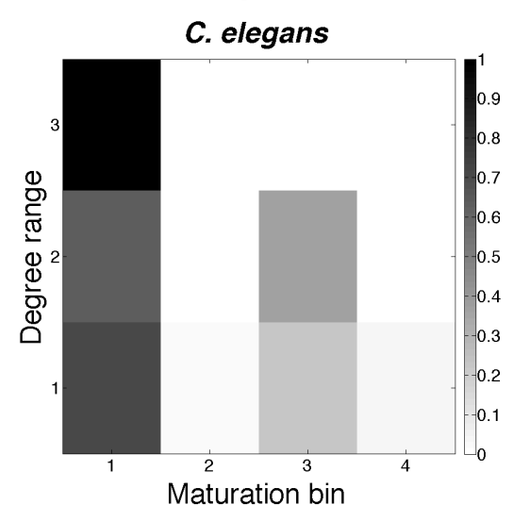
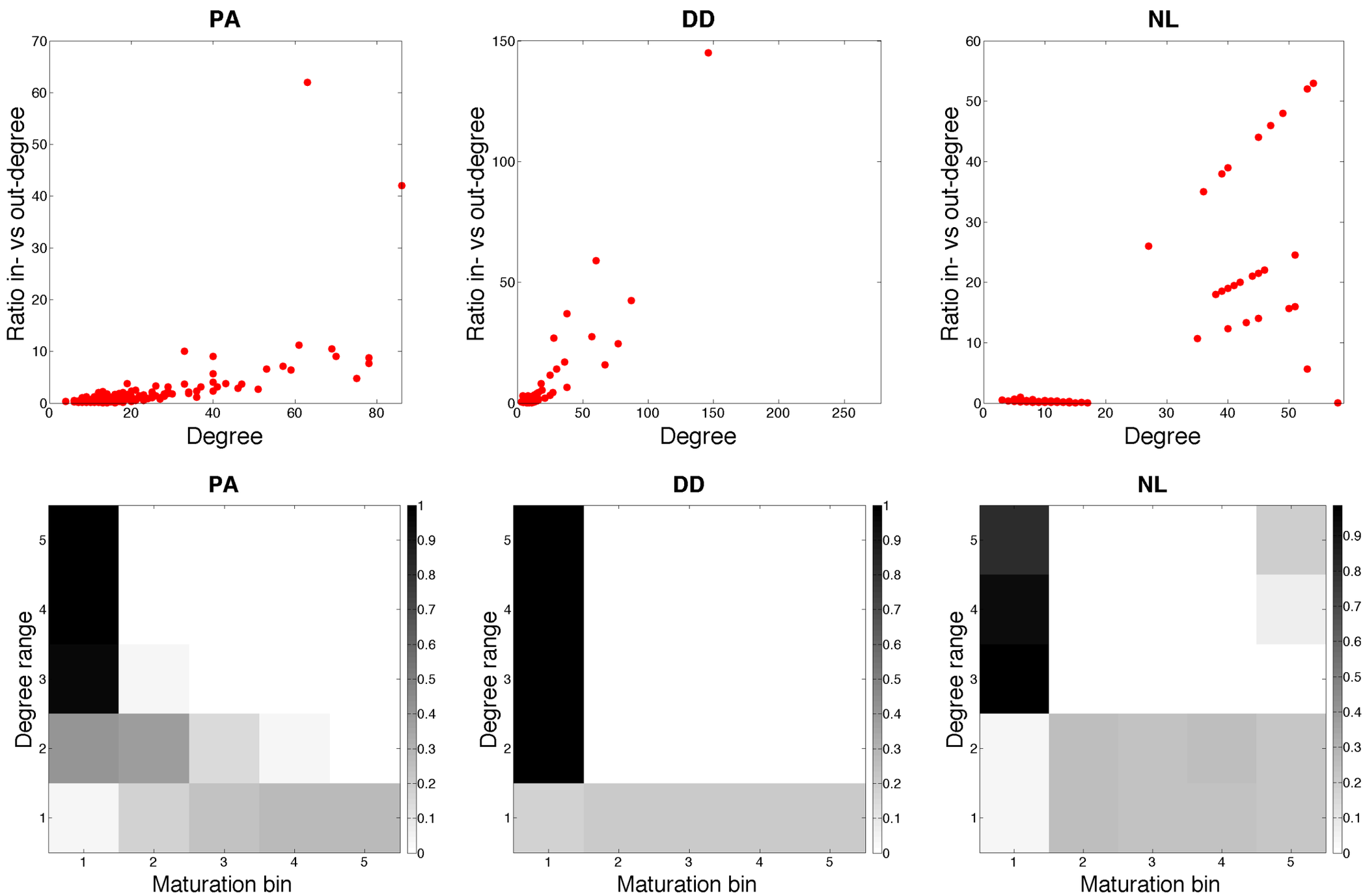








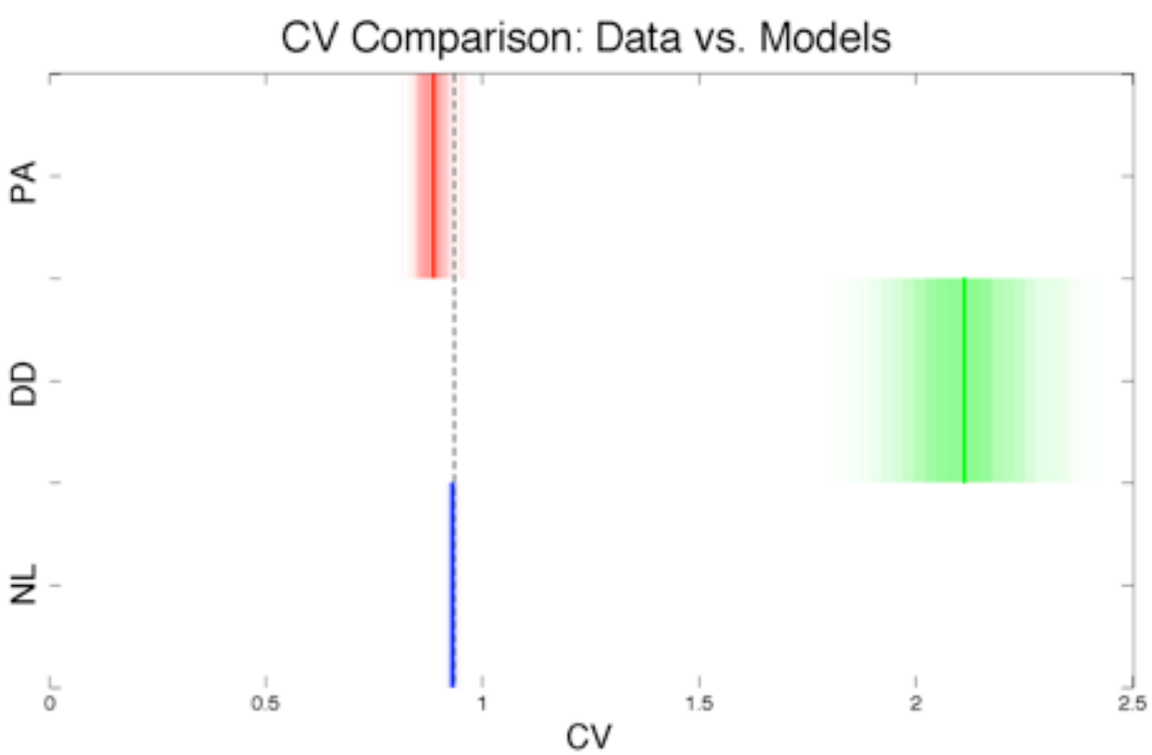
Model Networks



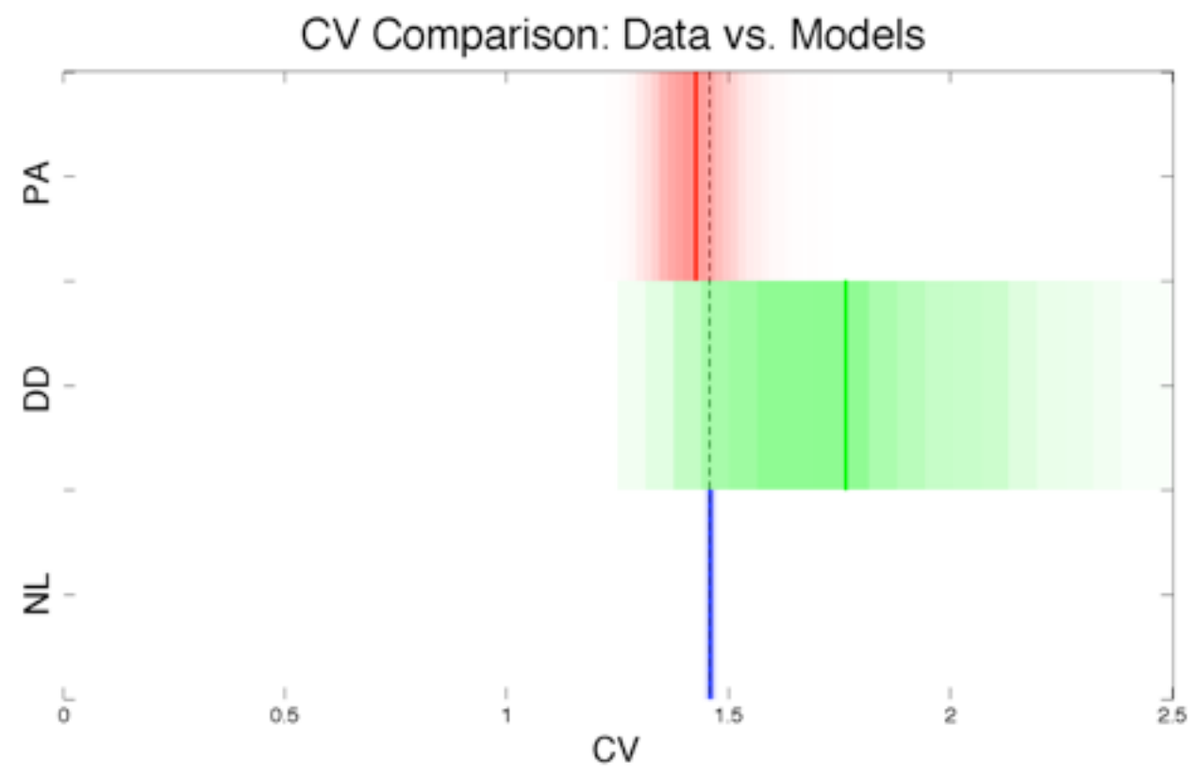
Coefficient of Variation

$$\frac{\sigma(\mathbf{k})}{\overline{\mathbf{k}}}$$

C. elegans



PPI



Comparison

	PA	DD	NL
local	✗	✗	✓
$CV_{Celegans}$	✓	✗	✓
CV_{MAC}	✗	✗	✓
CV_{PPI}	✓	✓	✓
$MEDIAN_{Celegans}$	✗	✗	✓
$MEDIAN_{MAC}$	✓	✗	✓
$MEDIAN_{PPI}$	✓	✓	✓

Summary

- local mechanisms more realistic (biologically, possibly also for other networks)
- nonlinear growth: better reproduction of hub architecture
- better link to concepts of network formation in biology (during brain development/evolution)