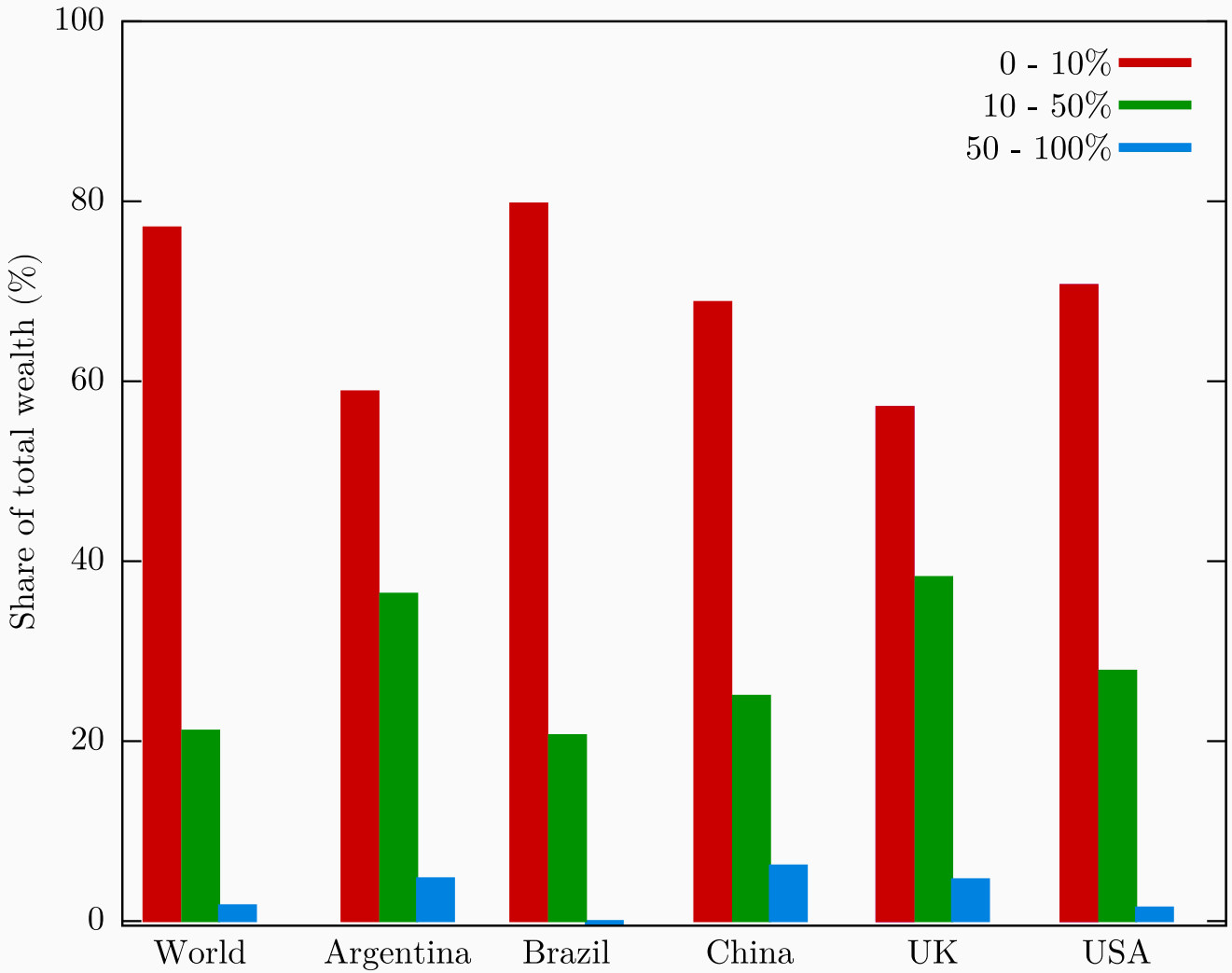
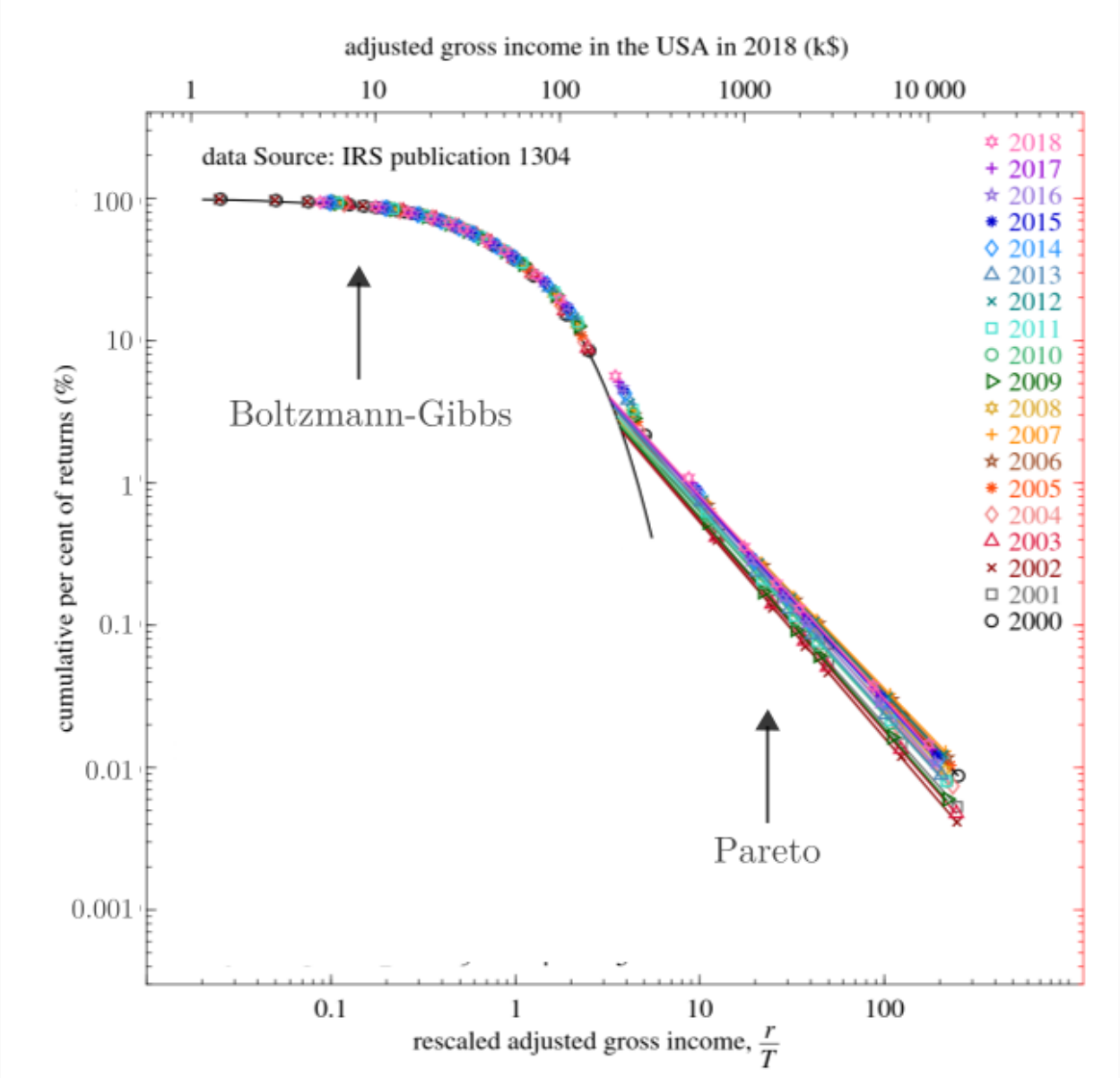
Wealth distribution on a dynamic complex network

Gustavo Kohlrausch and Sebastián Gonçalves



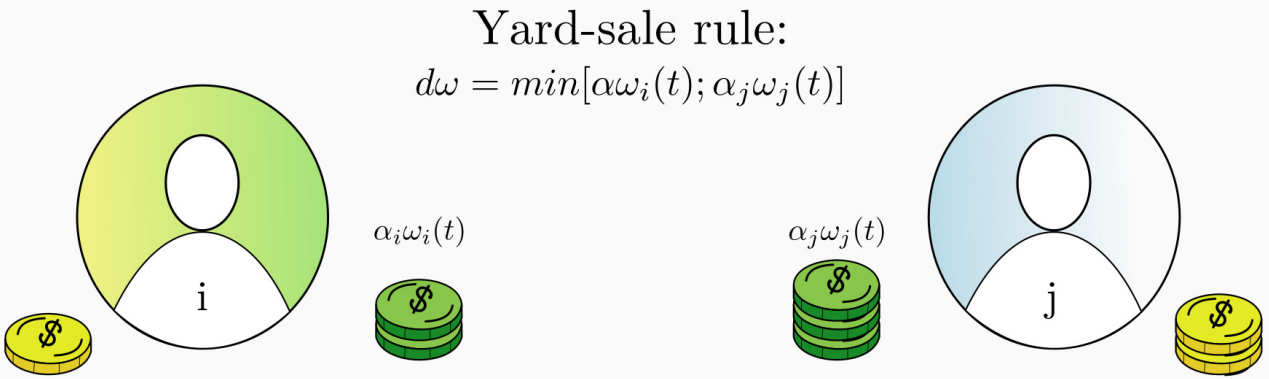
Share of the total wealth held by different percentiles of population in 2021.
Data collected from the World Inequality Database (https://wid.world/).



D. Ludwig and V. M. Yakovenko, Physics-inspired analysis of the two-class income distribution in the USA in 1983–2018, Phil. Trans. R. Soc. (2022).

Agent-base models

N agents with wealth ω and saving fraction α randomly distributed in the interval [0;1)

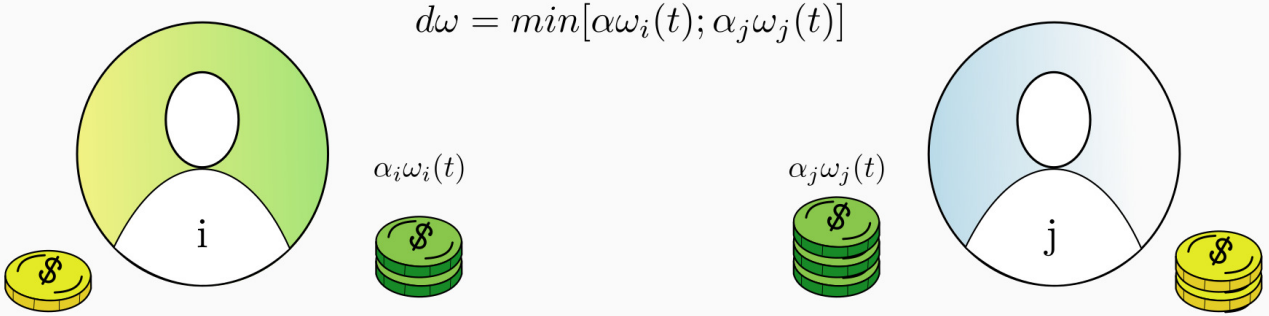


Agent-base models

N agents with wealth ω and saving fraction α randomly distributed in the interval [0;1)

Yard-sale rule:

$$d\omega = min[\alpha\omega_i(t); \alpha_j\omega_j(t)]$$

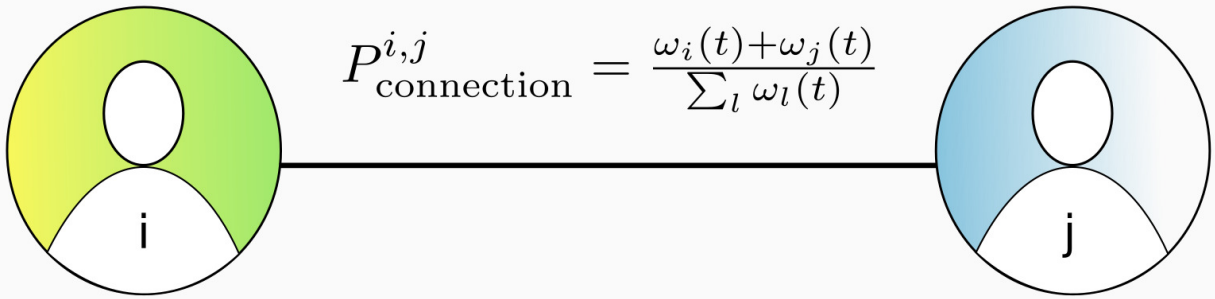


$$P^{i,j}_{\text{exchange}} = \frac{1}{2} + f \times \frac{|\omega_i(t) - \omega_j(t)|}{\omega_i(t) + \omega_j(t)}$$

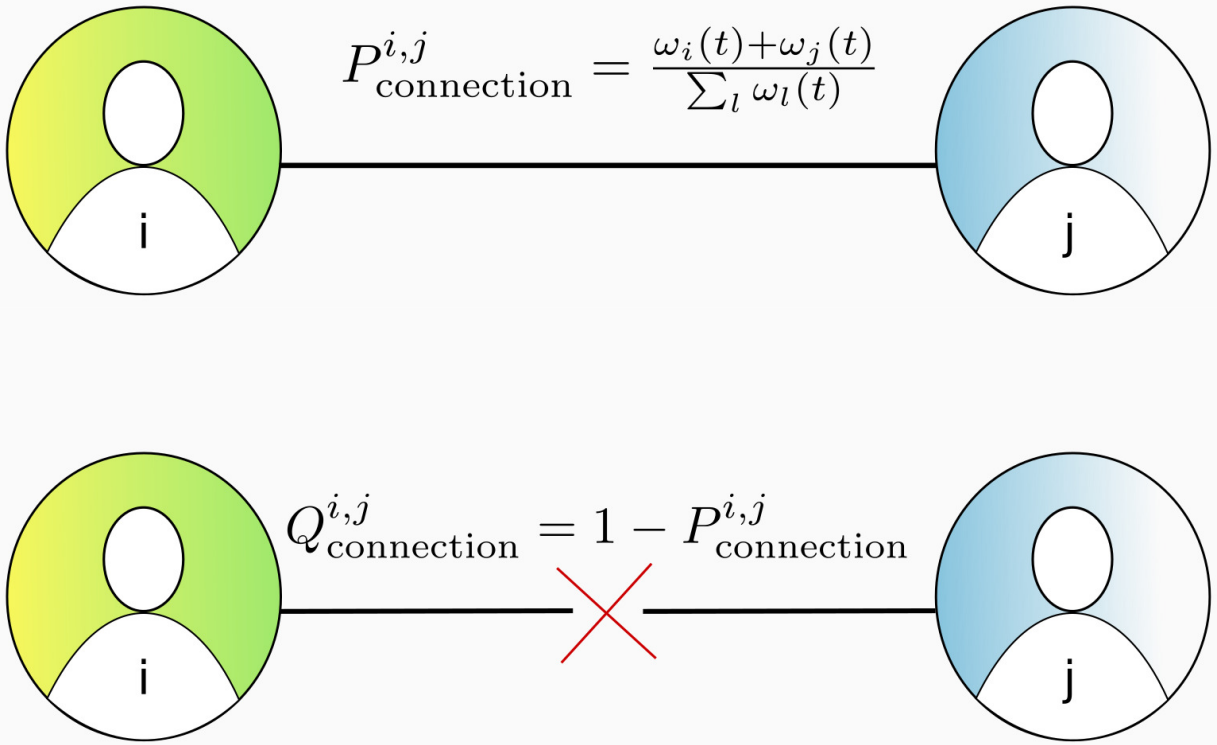
$\omega_i(t+1) = \omega_i(t) + d\omega$

$\omega_j(t+1) = \omega_j(t) - d\omega$

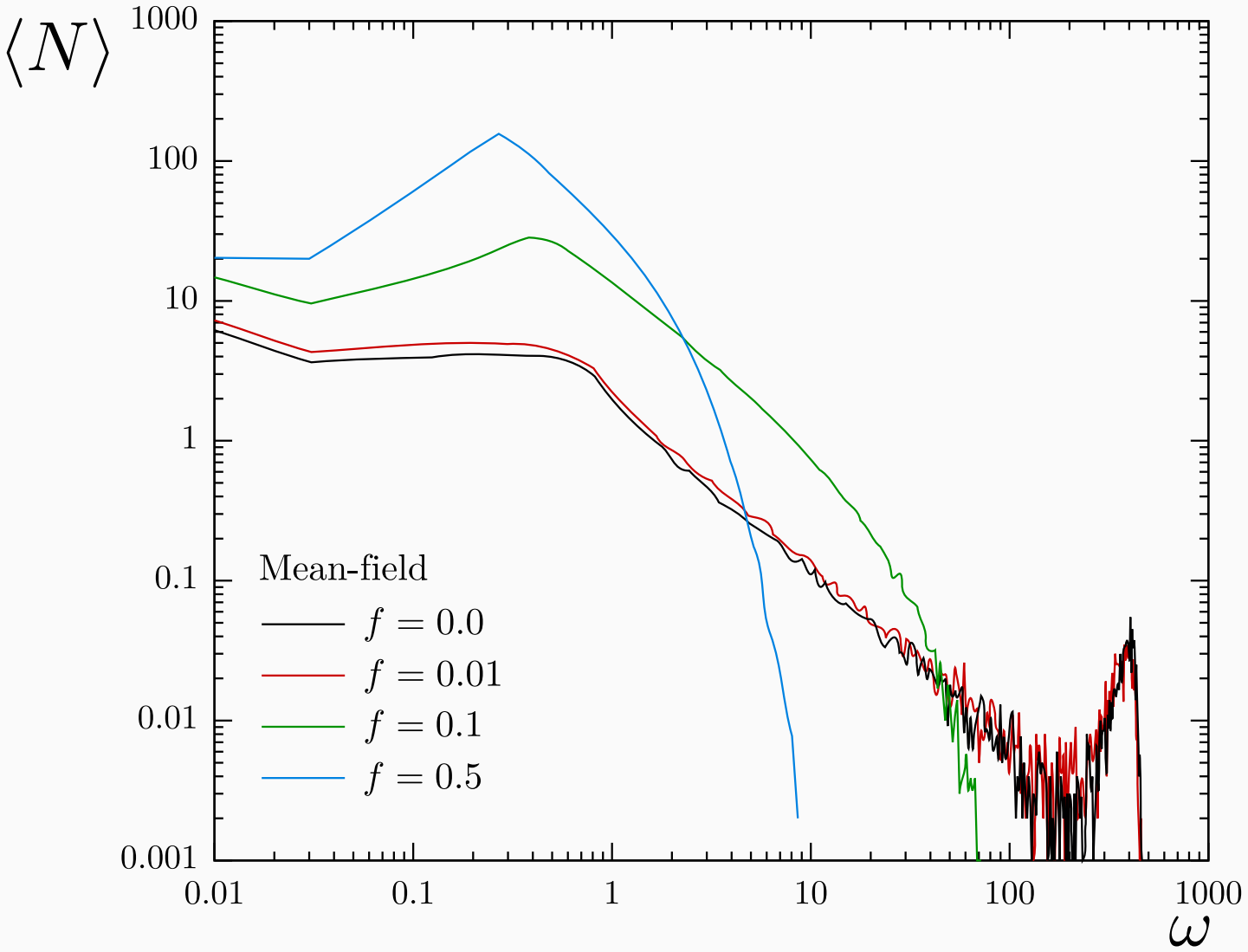
Dynamic network proposition



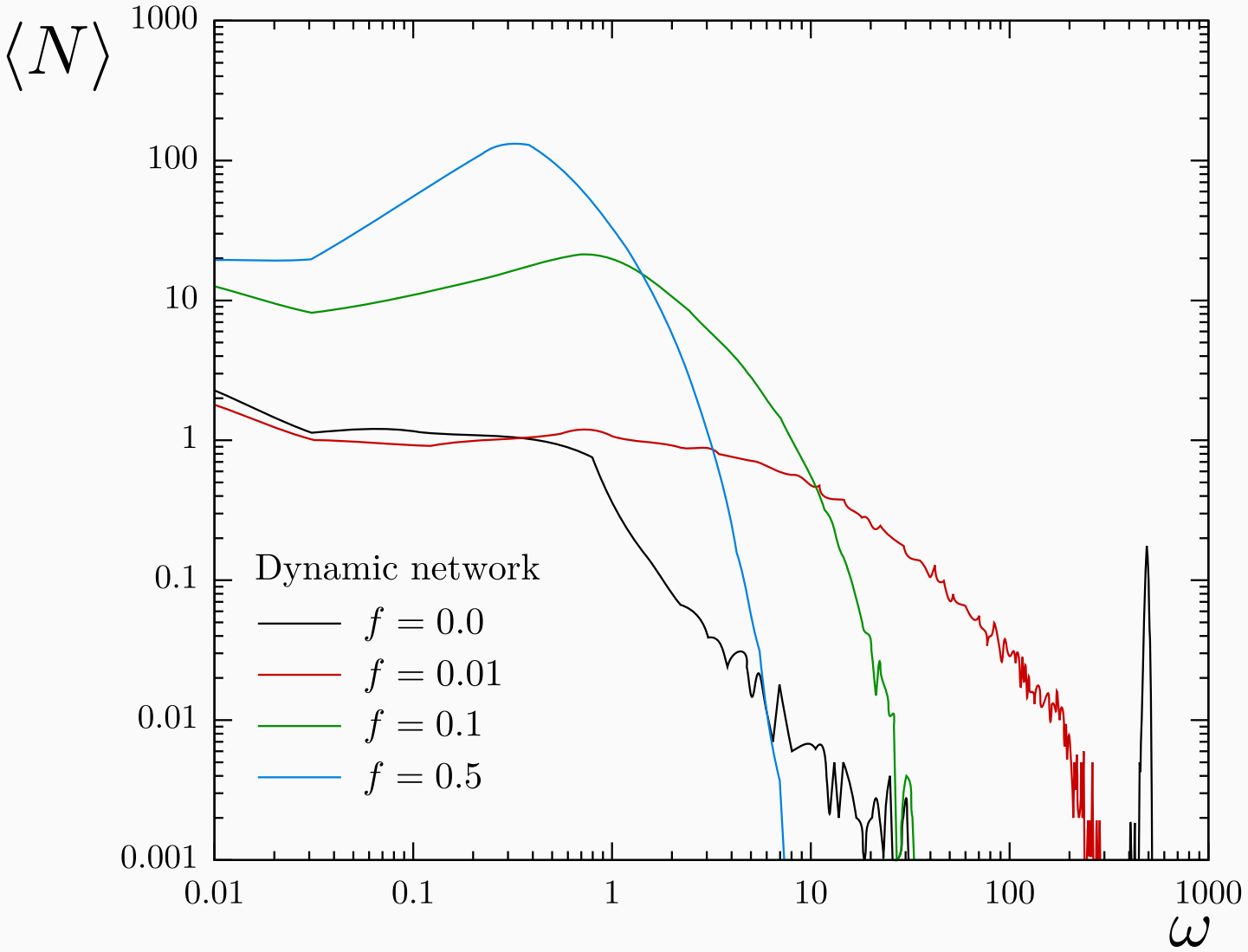
Dynamic network proposition



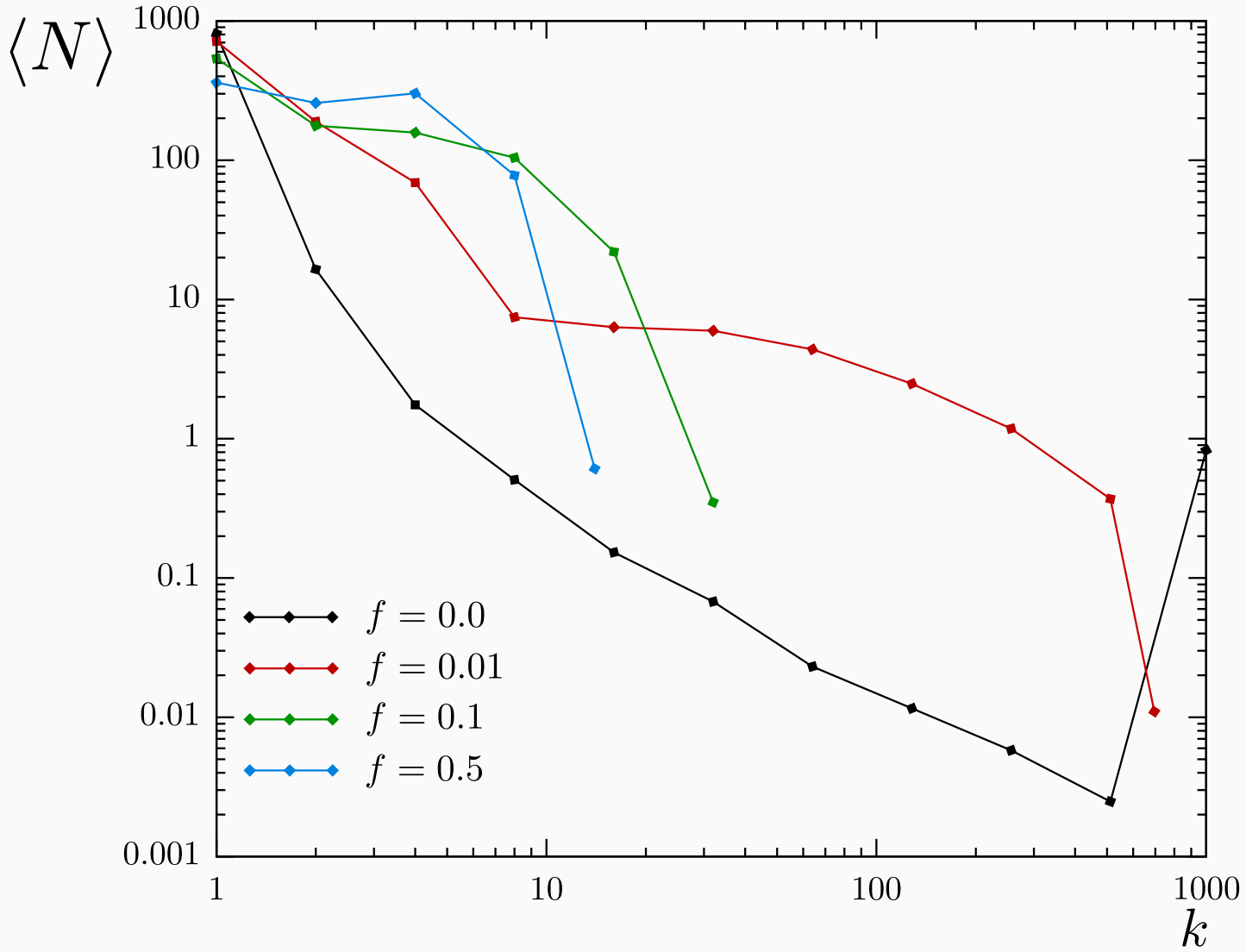
- We define $1MCS$ as the time necessary to make the wealth exchanges between connected agents and $N/2$ pairs of agents being randomly selected to reavaliate their connections
- All the following results are mean values between 10^3 independent samples, where $N = 10^3$, and $T = 4 \cdot 10^4 MCS$.
- Each samples has a total wealth $\Omega = 500$



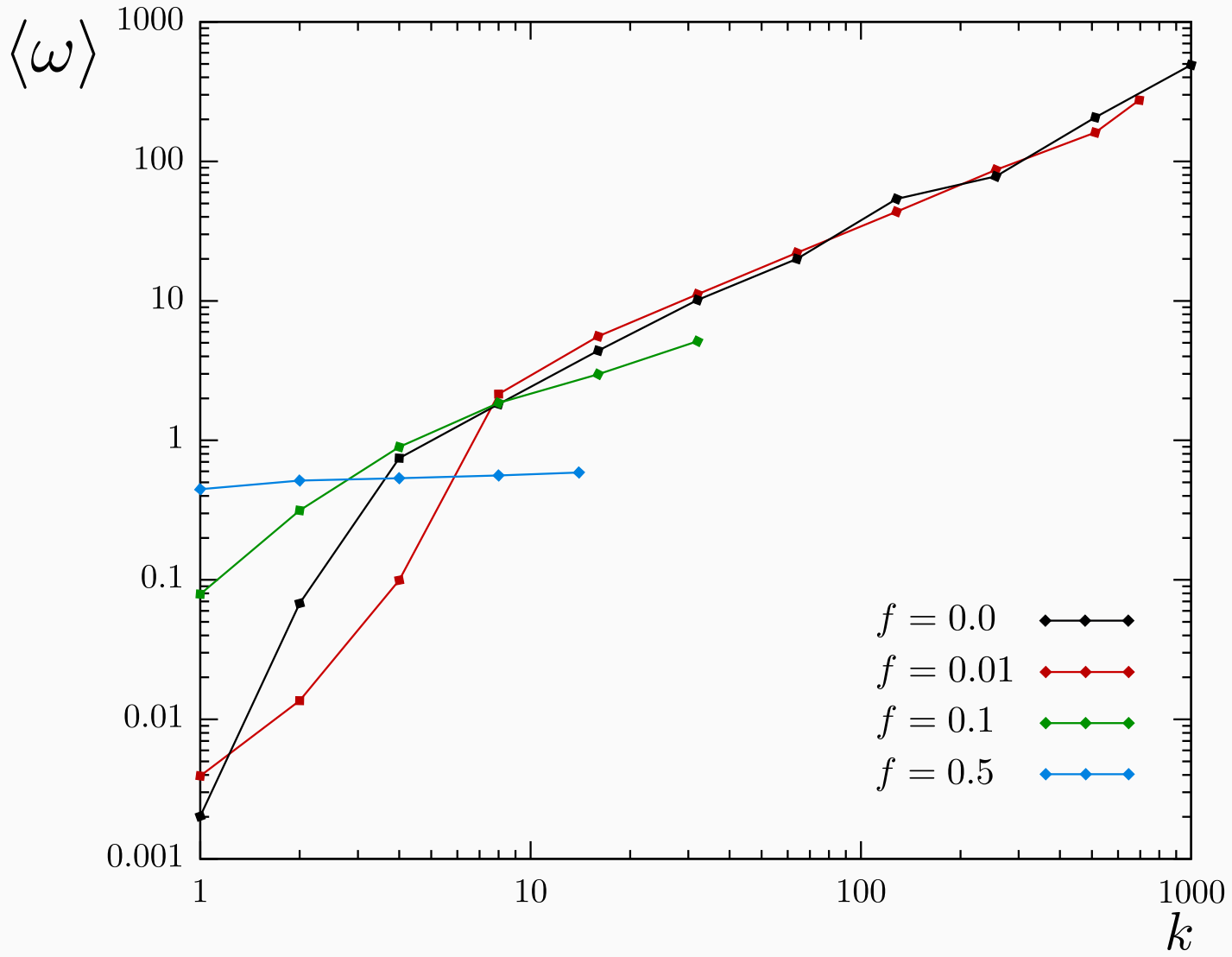
Number of agents with wealth ω for the mean-field case.



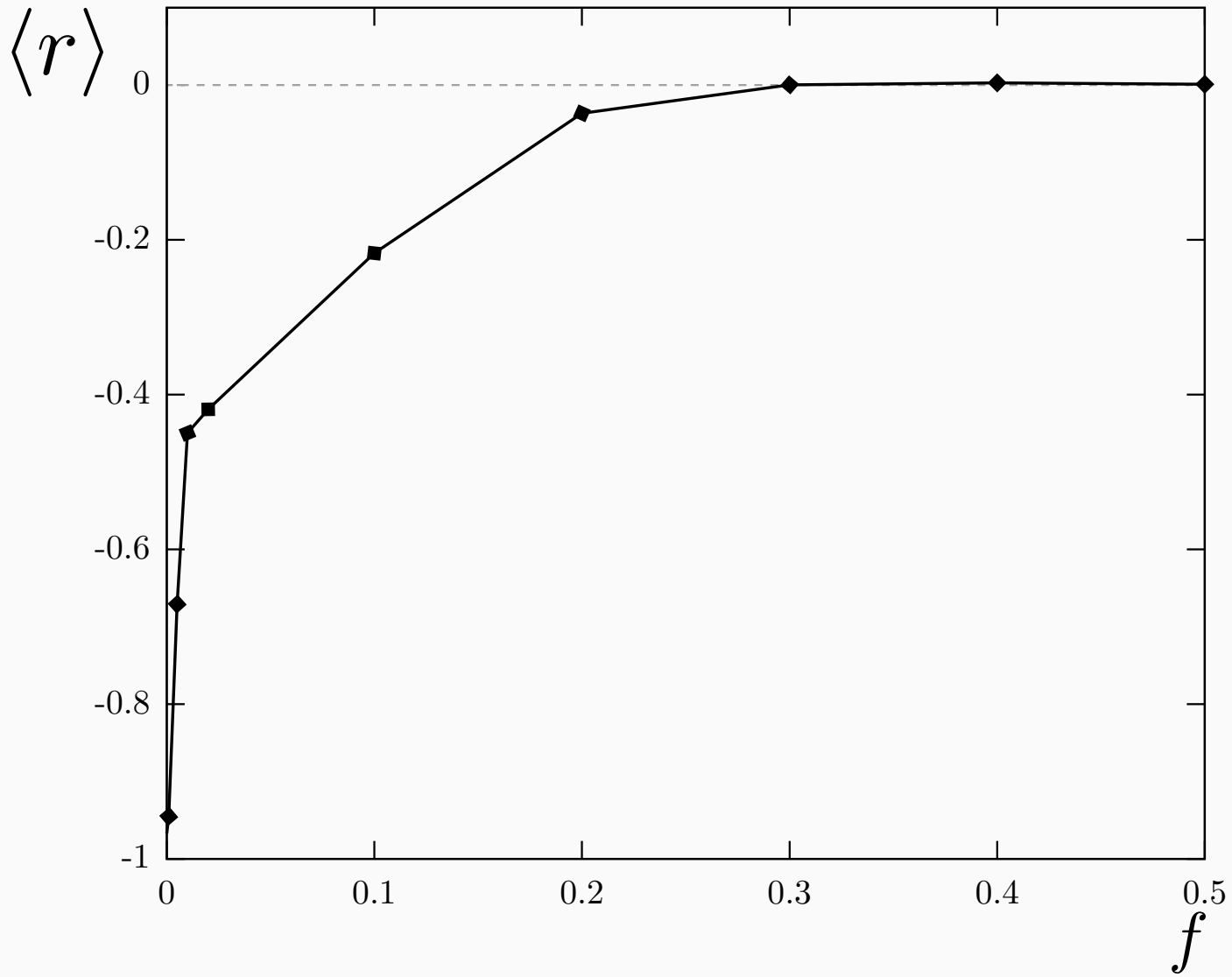
Number of agents with wealth ω for the dynamic network model.



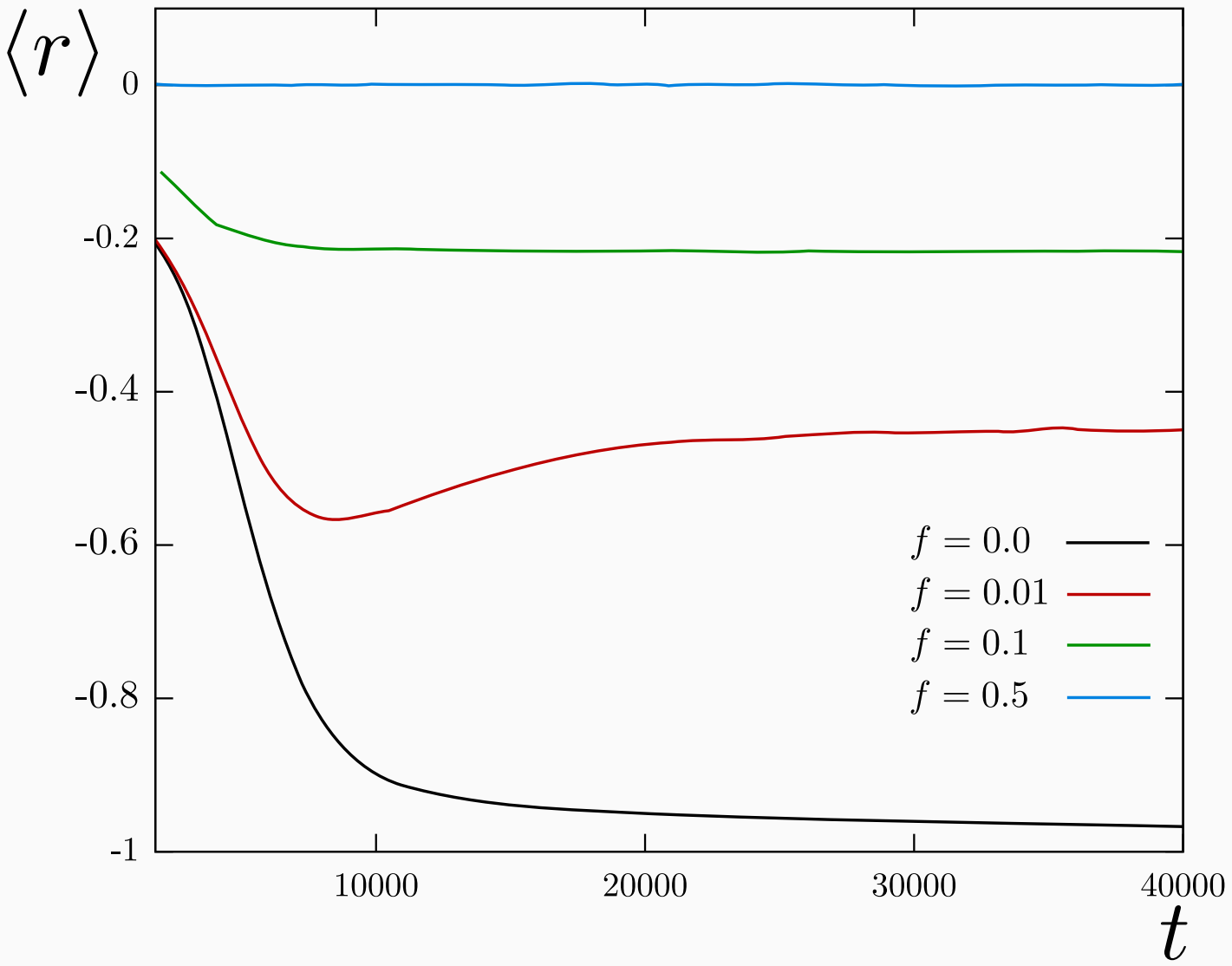
Degree distribution for different values of f.



Mean wealth for agents with degree k
for different values of f.



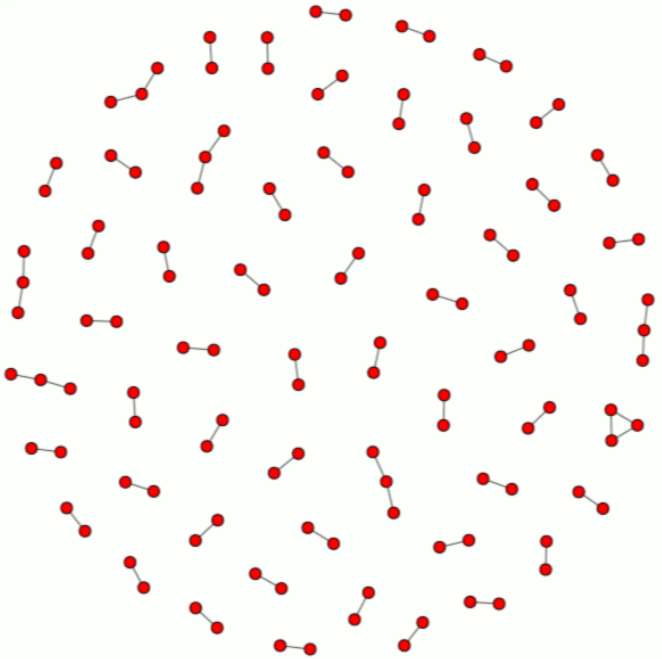
Assortative mixing as a function of f.



Assortative mixing as a function of time.

0 MC

f=0.0



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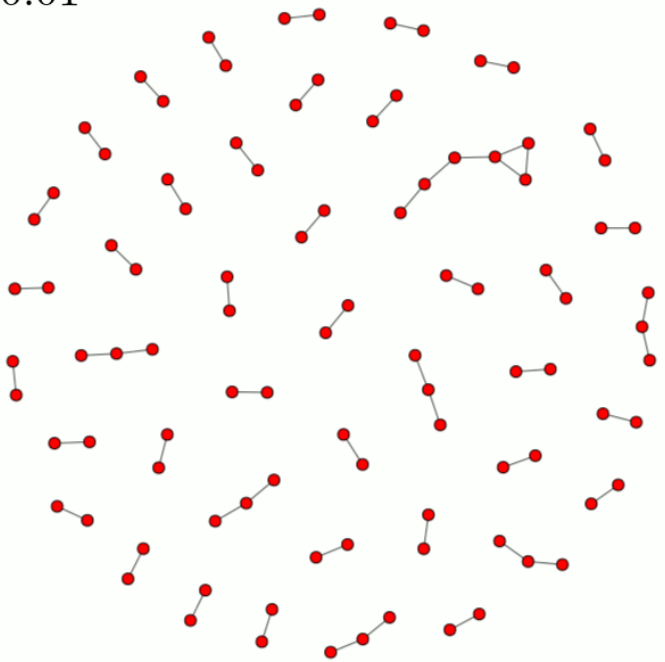

50 MC

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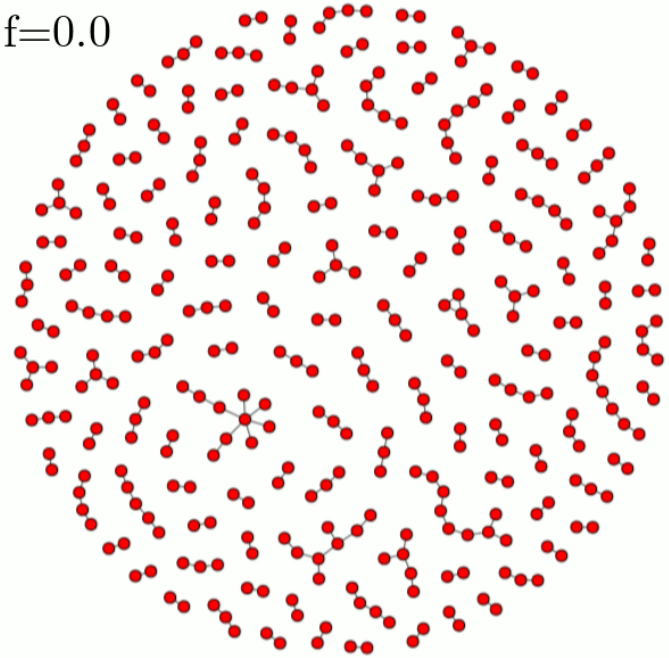

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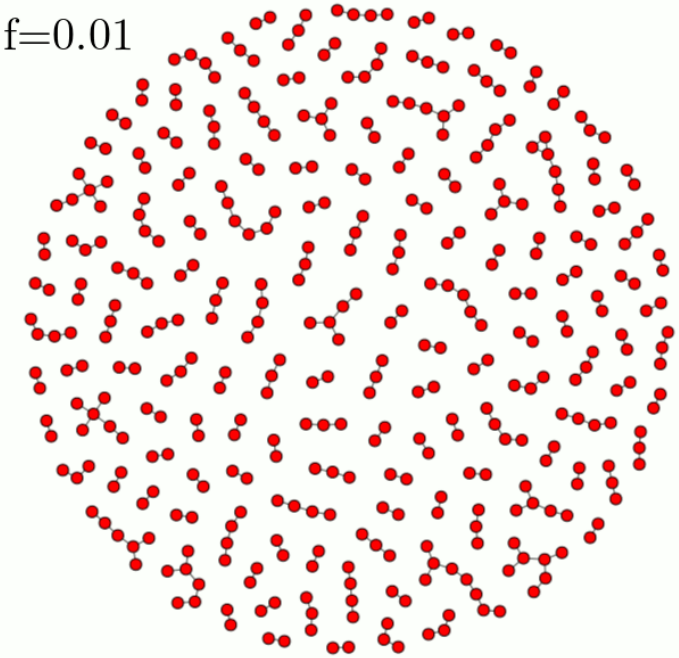

100 MC

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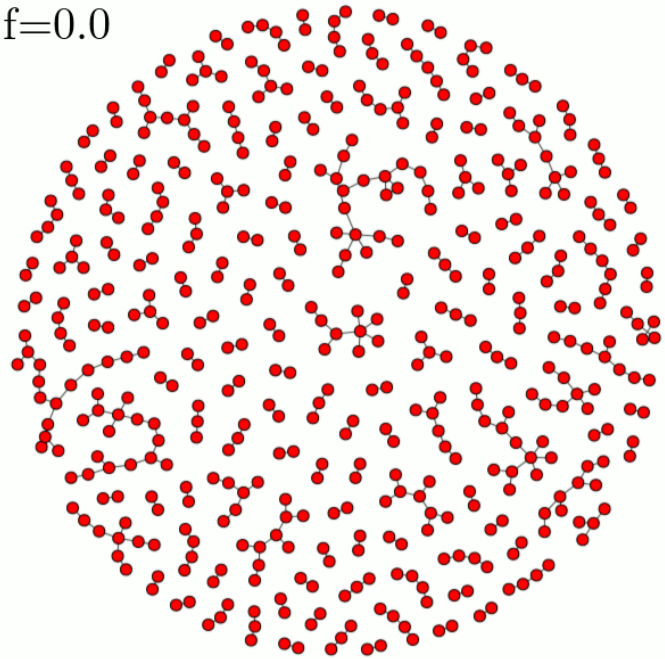

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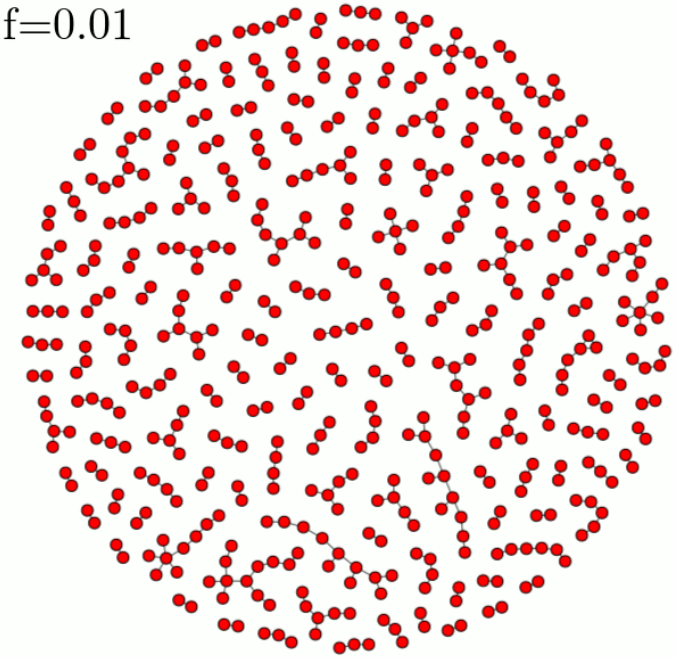

150 MC

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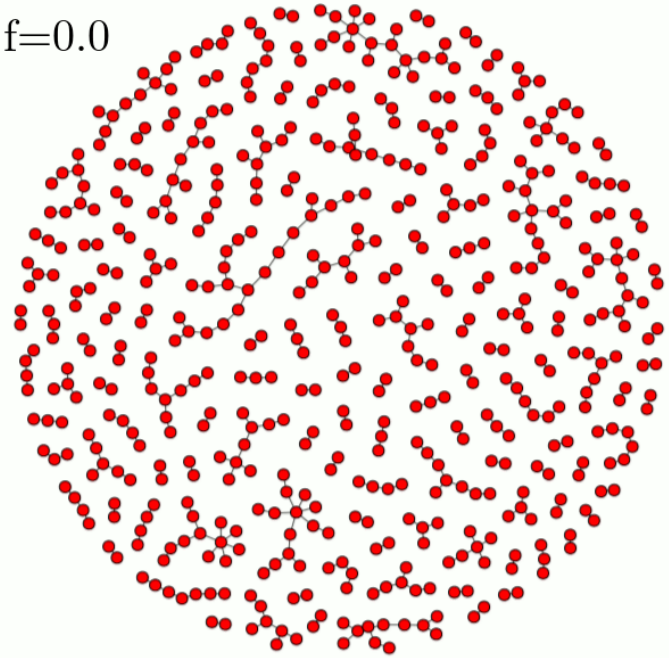

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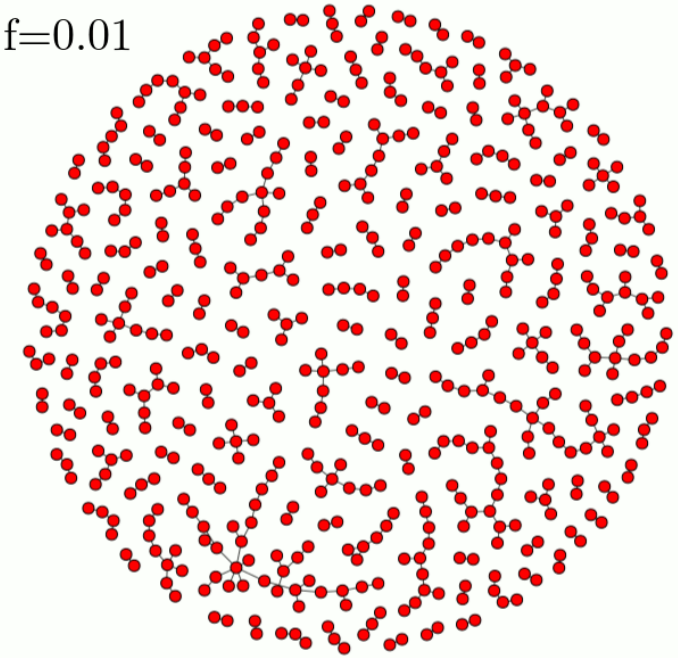

200 MC

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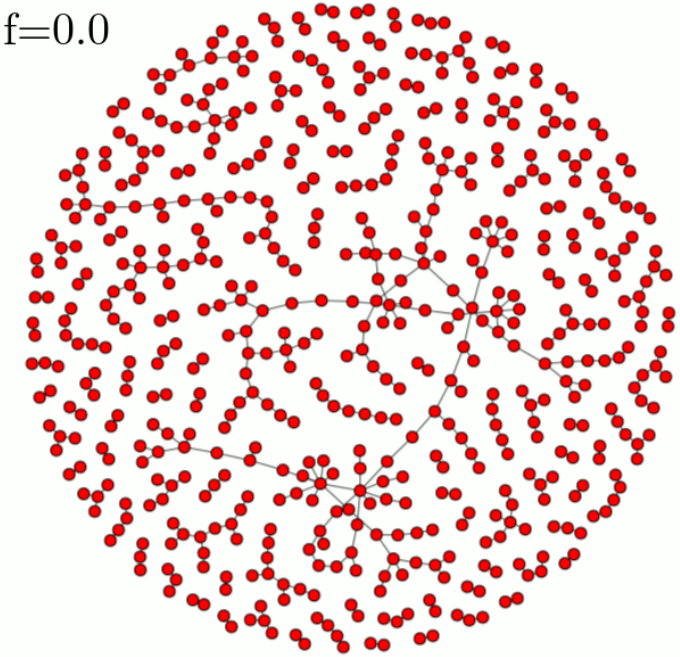

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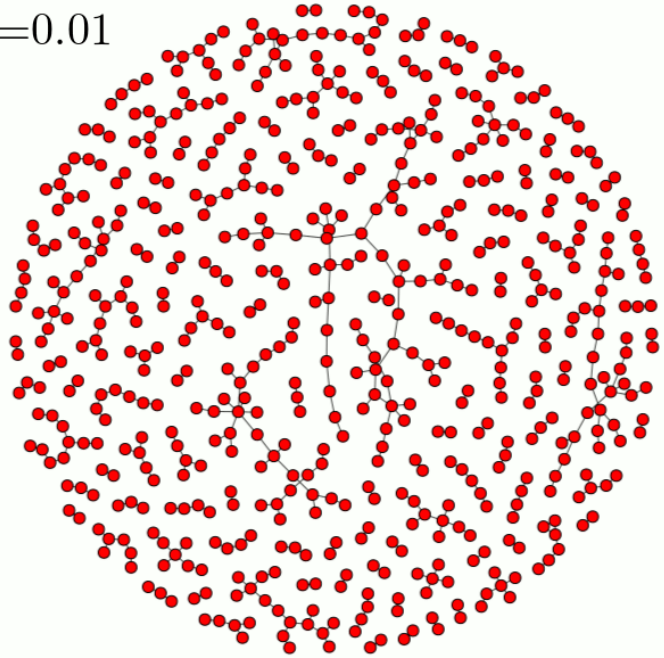

350 MC

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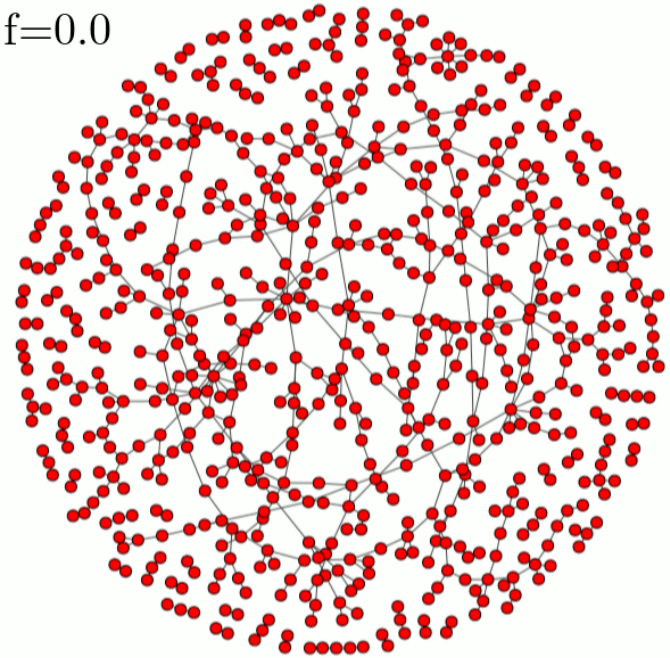

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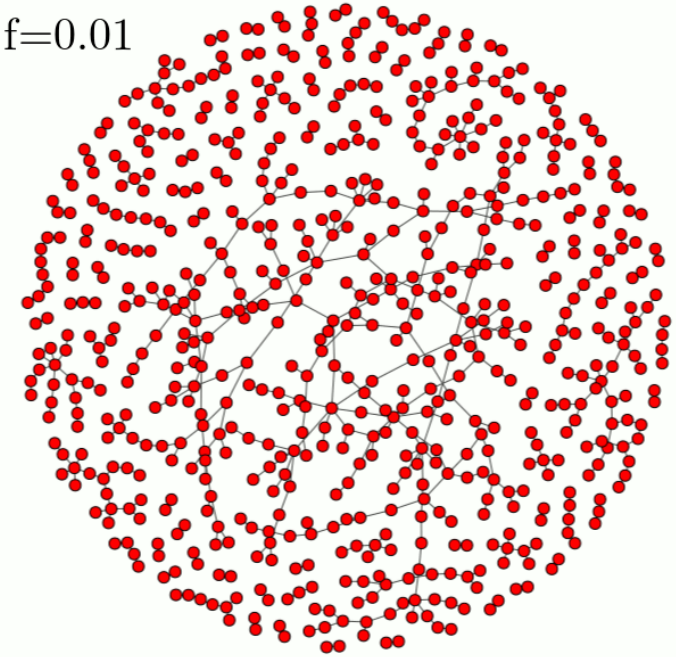

450 MC

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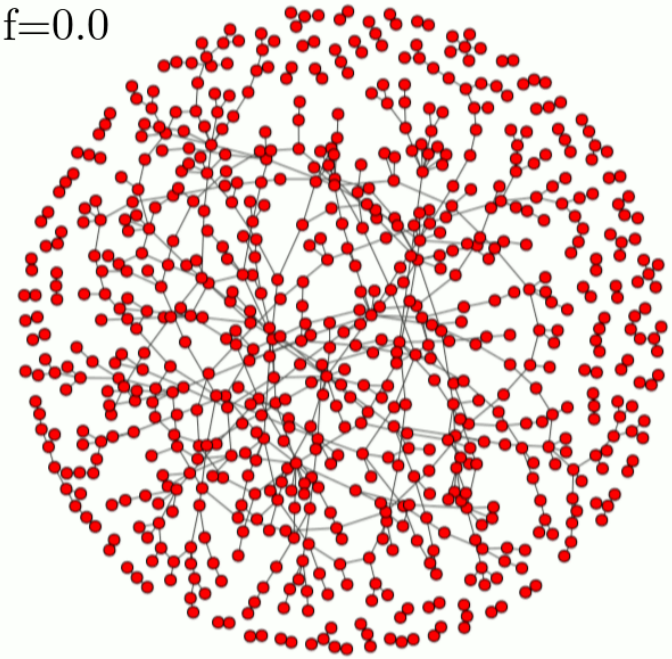

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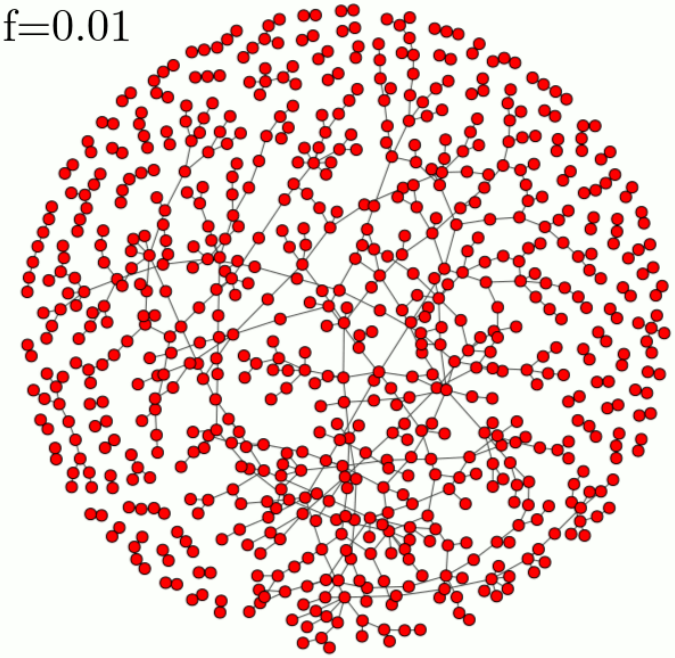

550 MC

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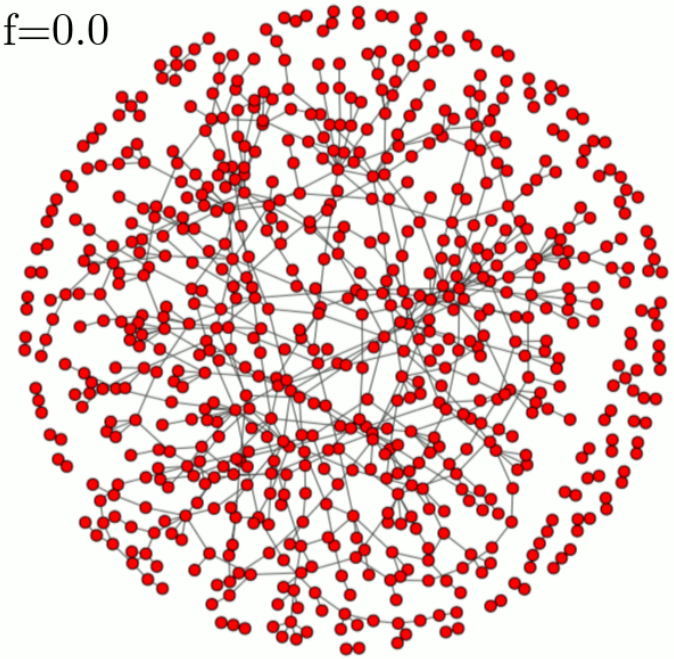

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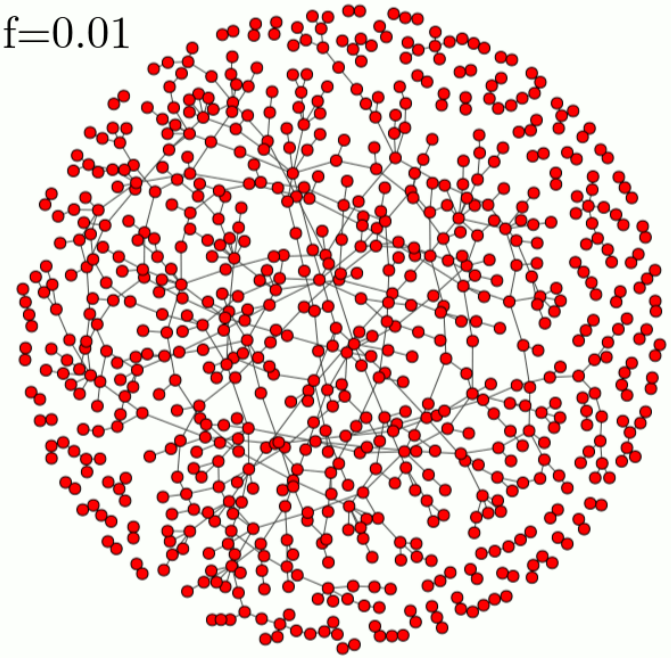

700 MC

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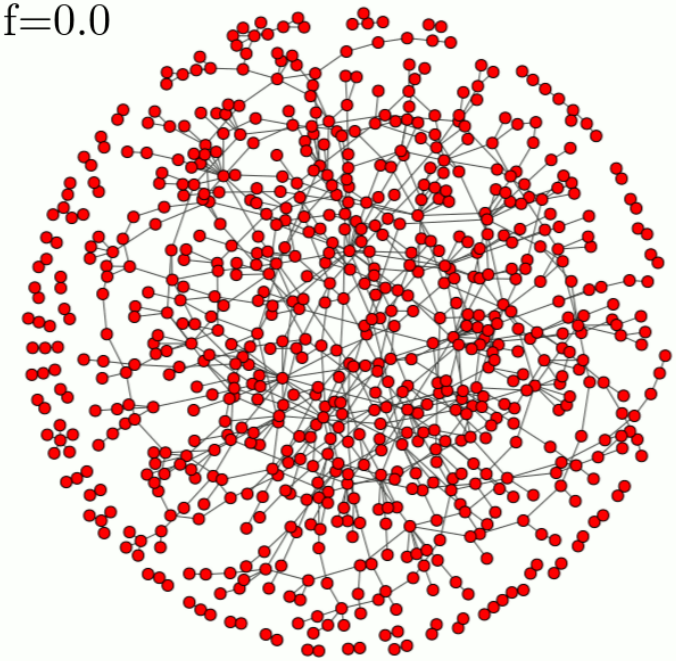

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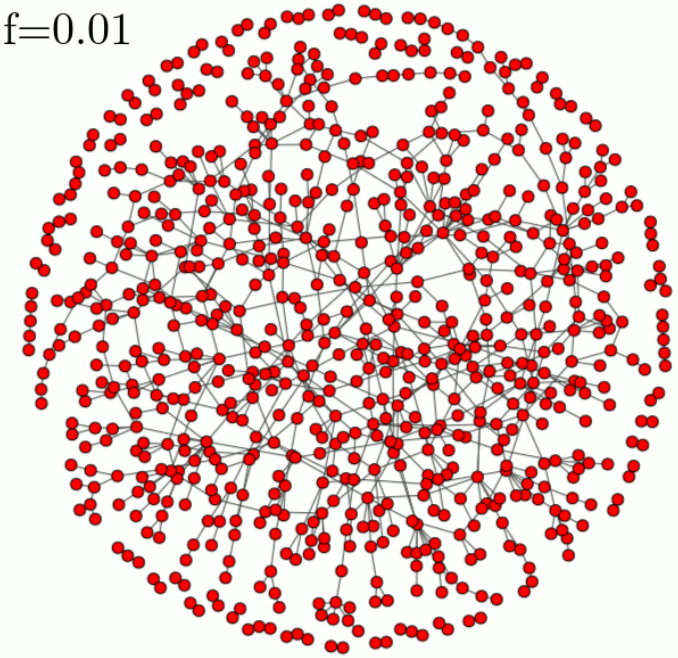

850 MC

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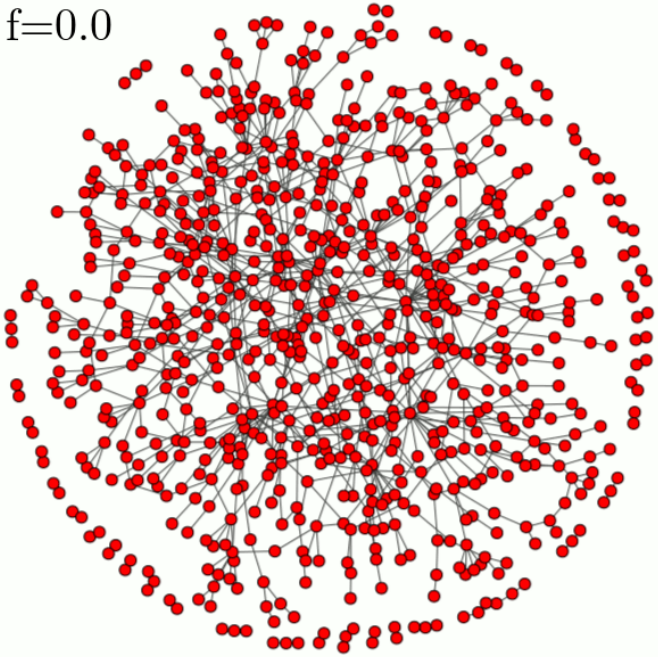

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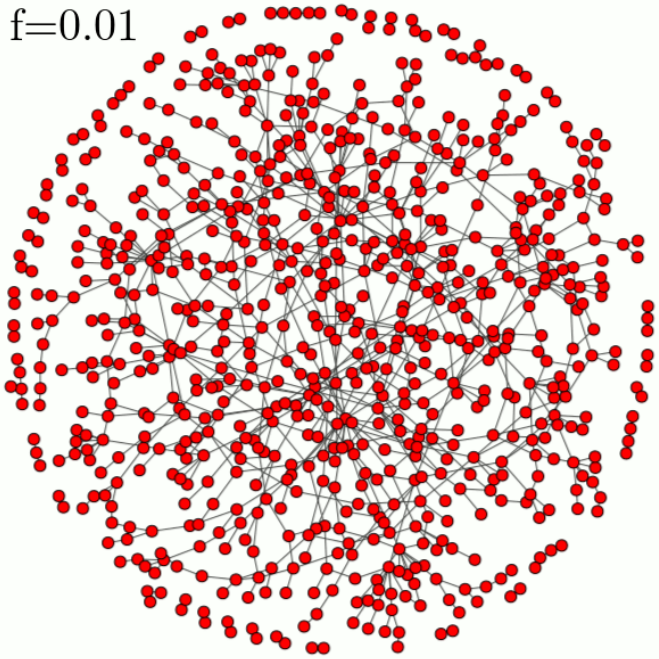

1 000 MC

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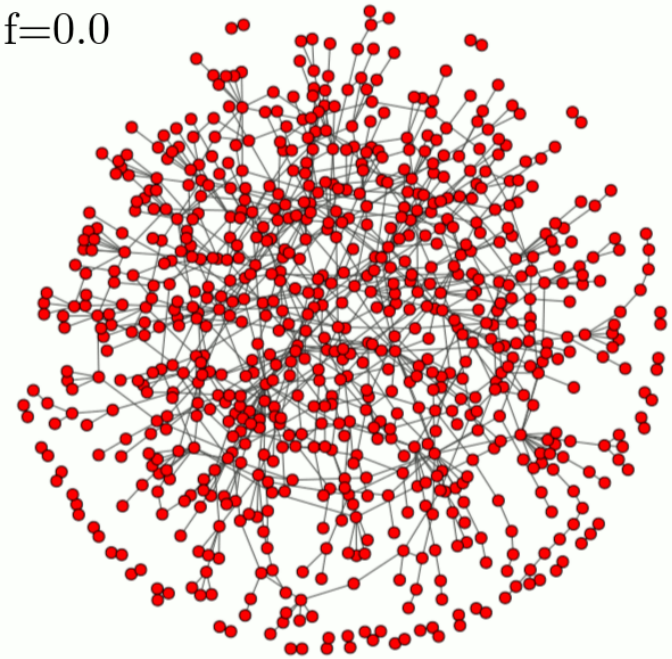

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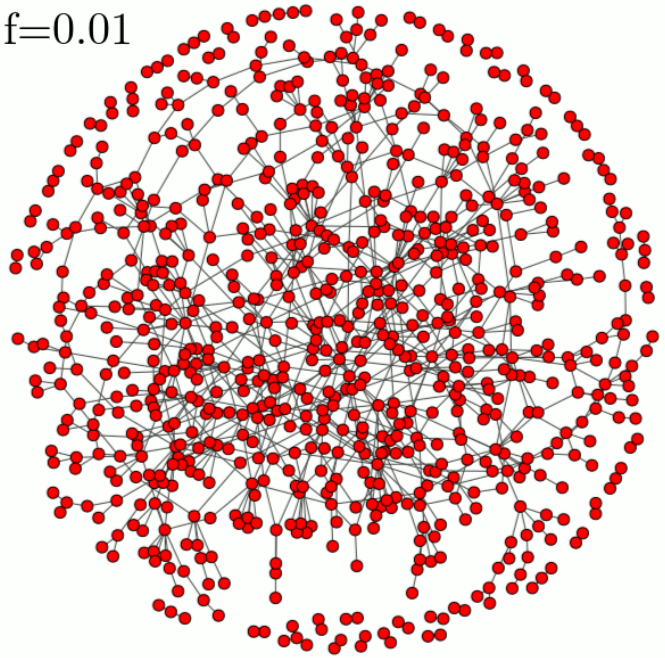

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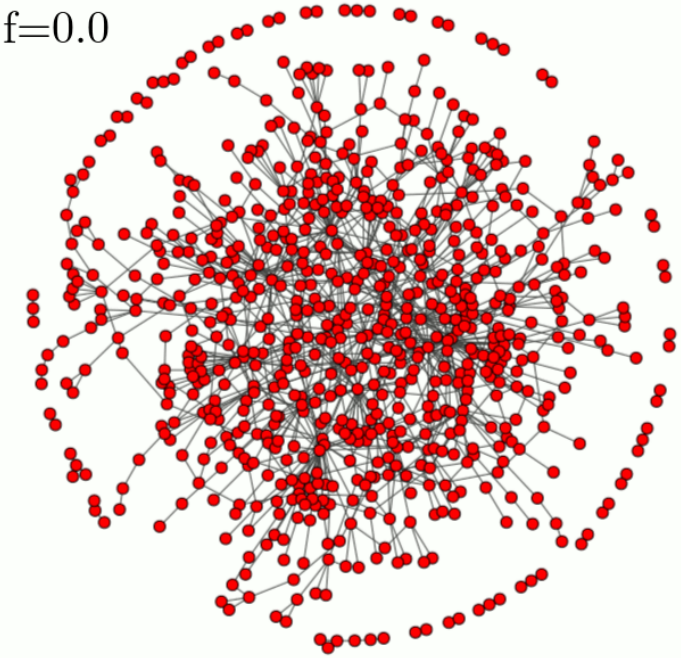

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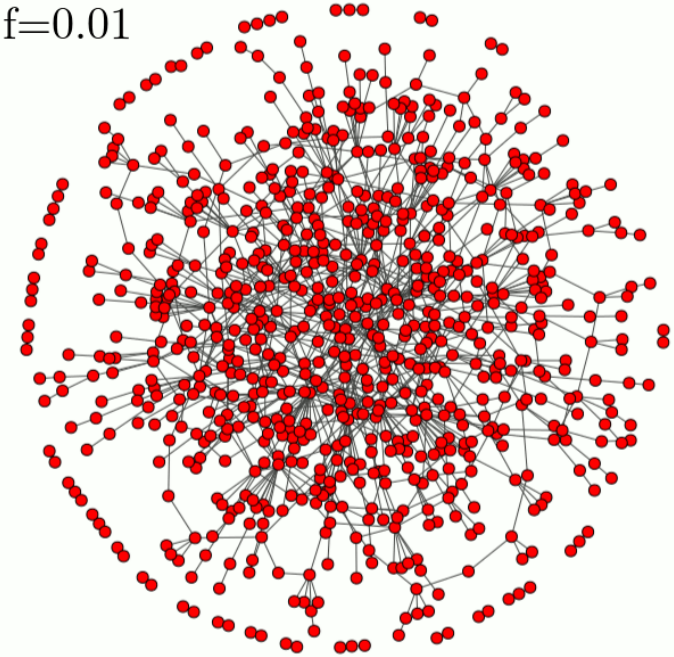

2 400 MC

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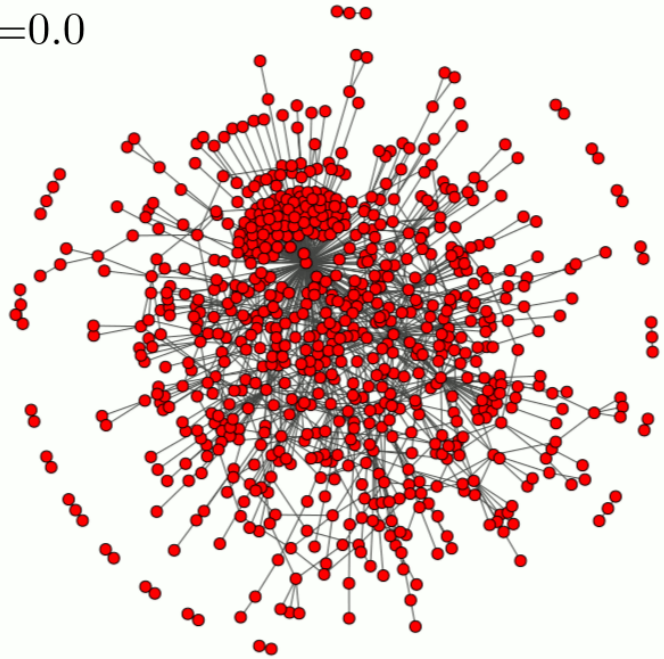

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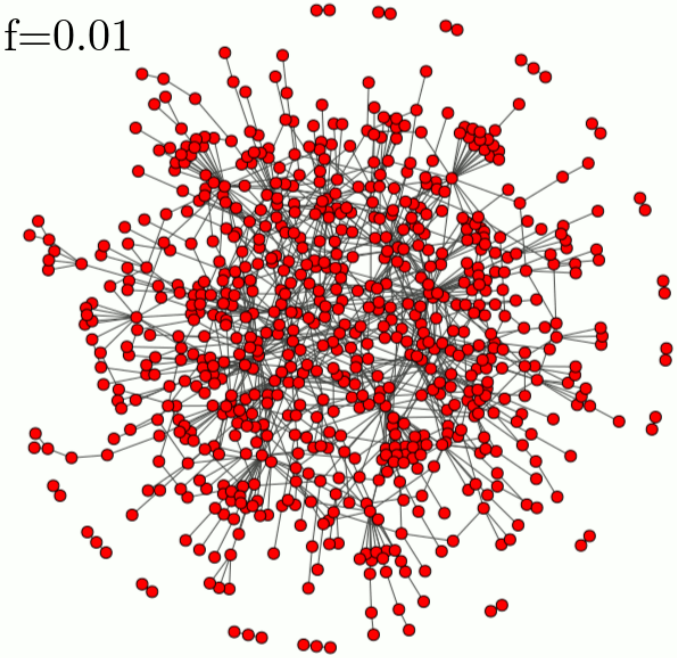

3 200 MC

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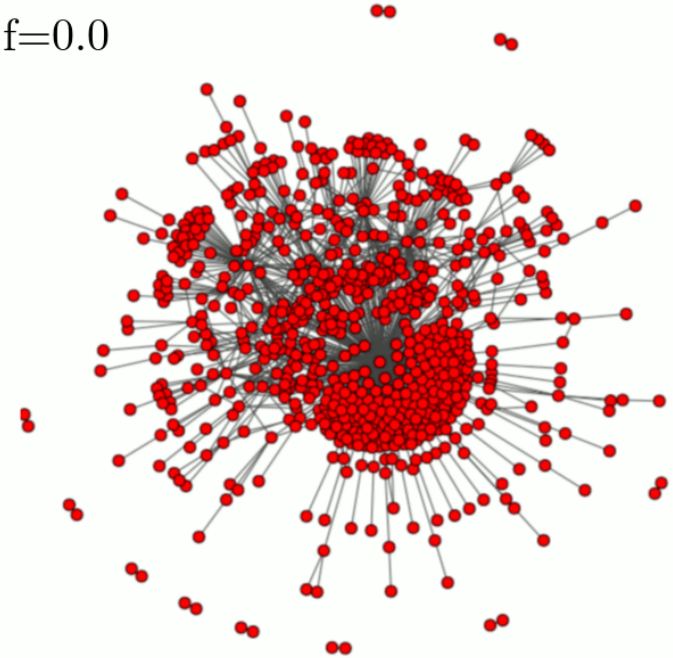

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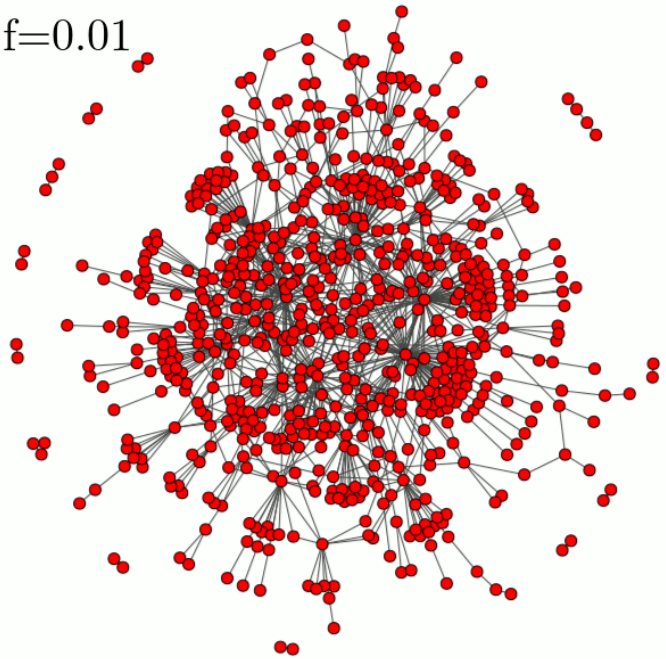

4 000 MC
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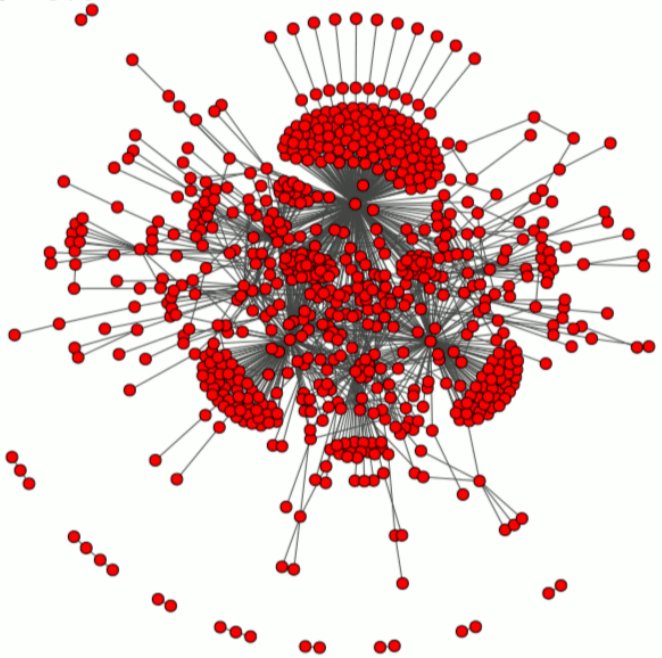

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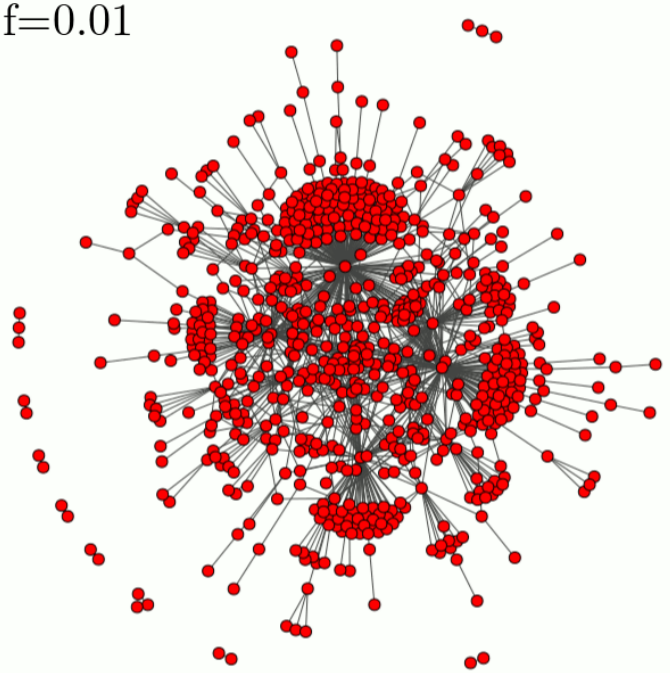

6 000 MC
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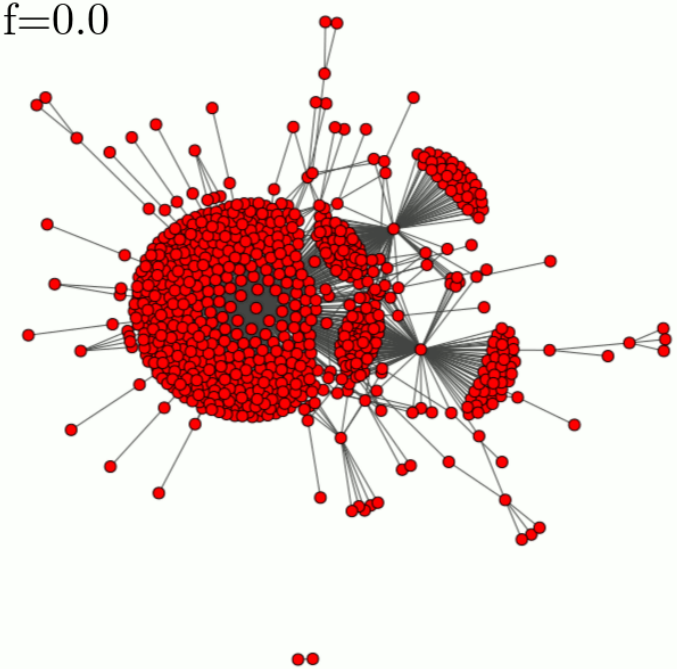

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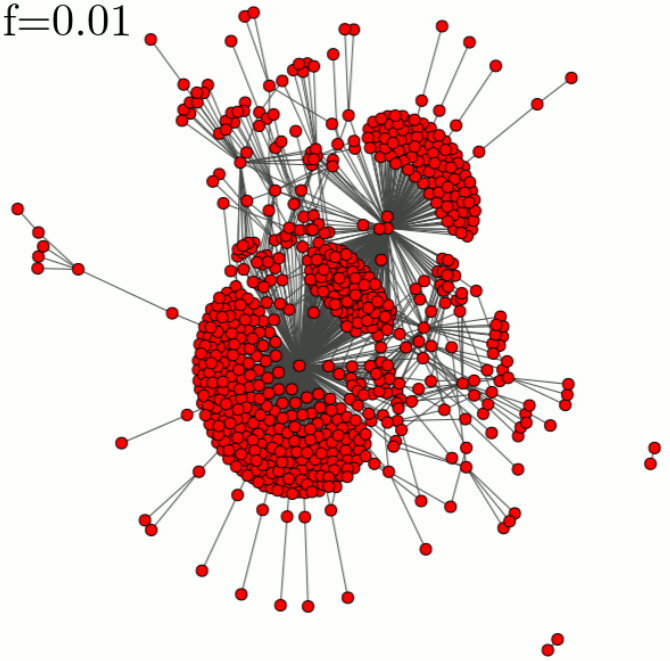

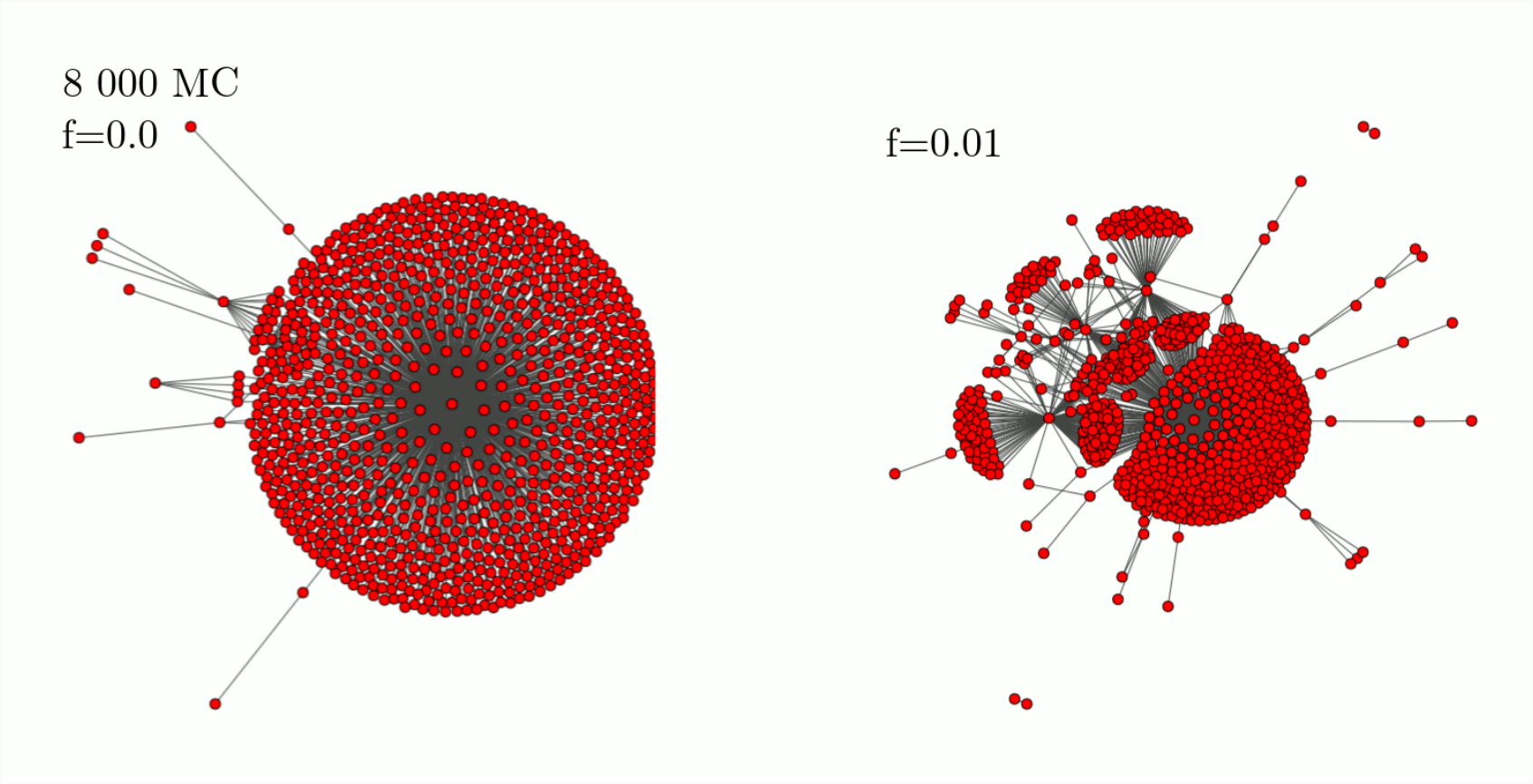
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14 000 MC
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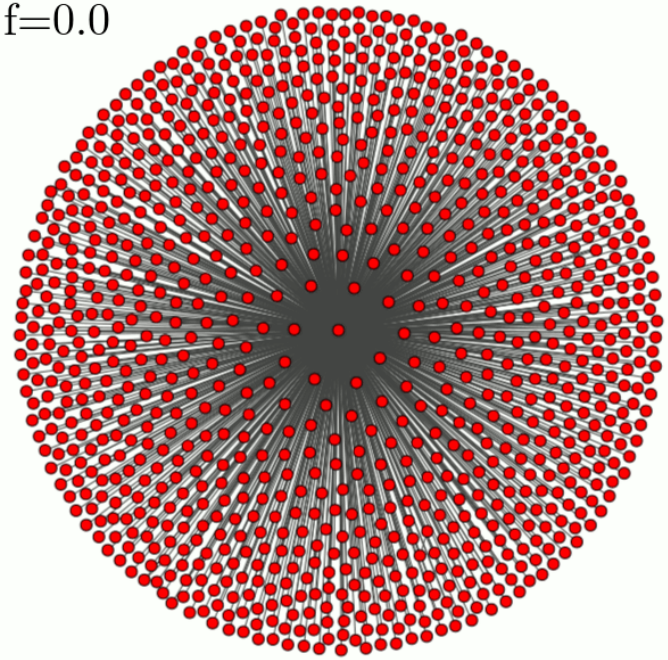

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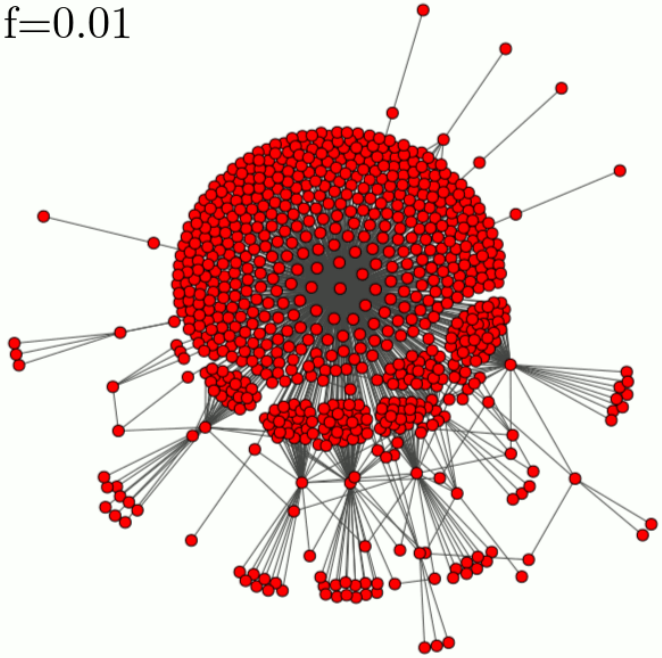

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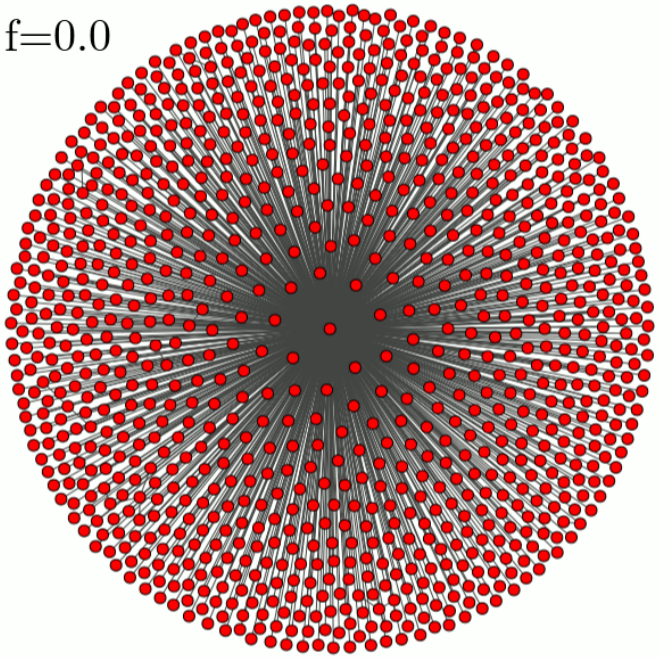

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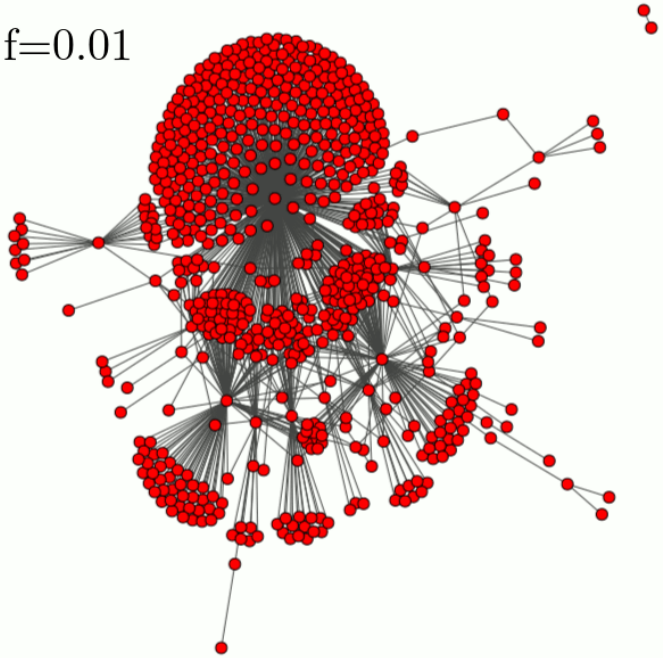

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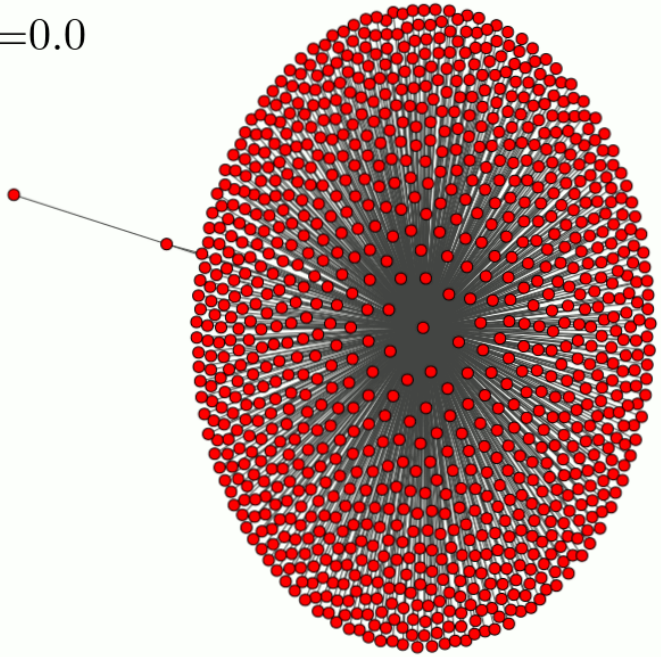

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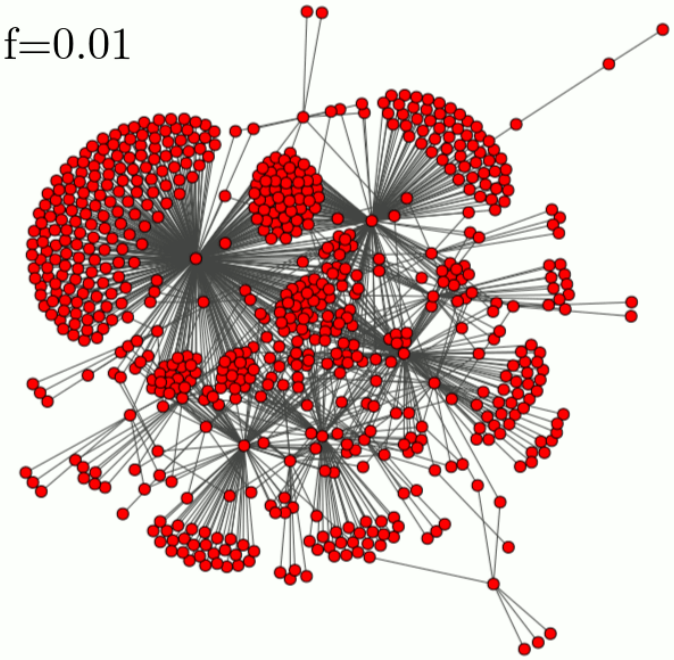
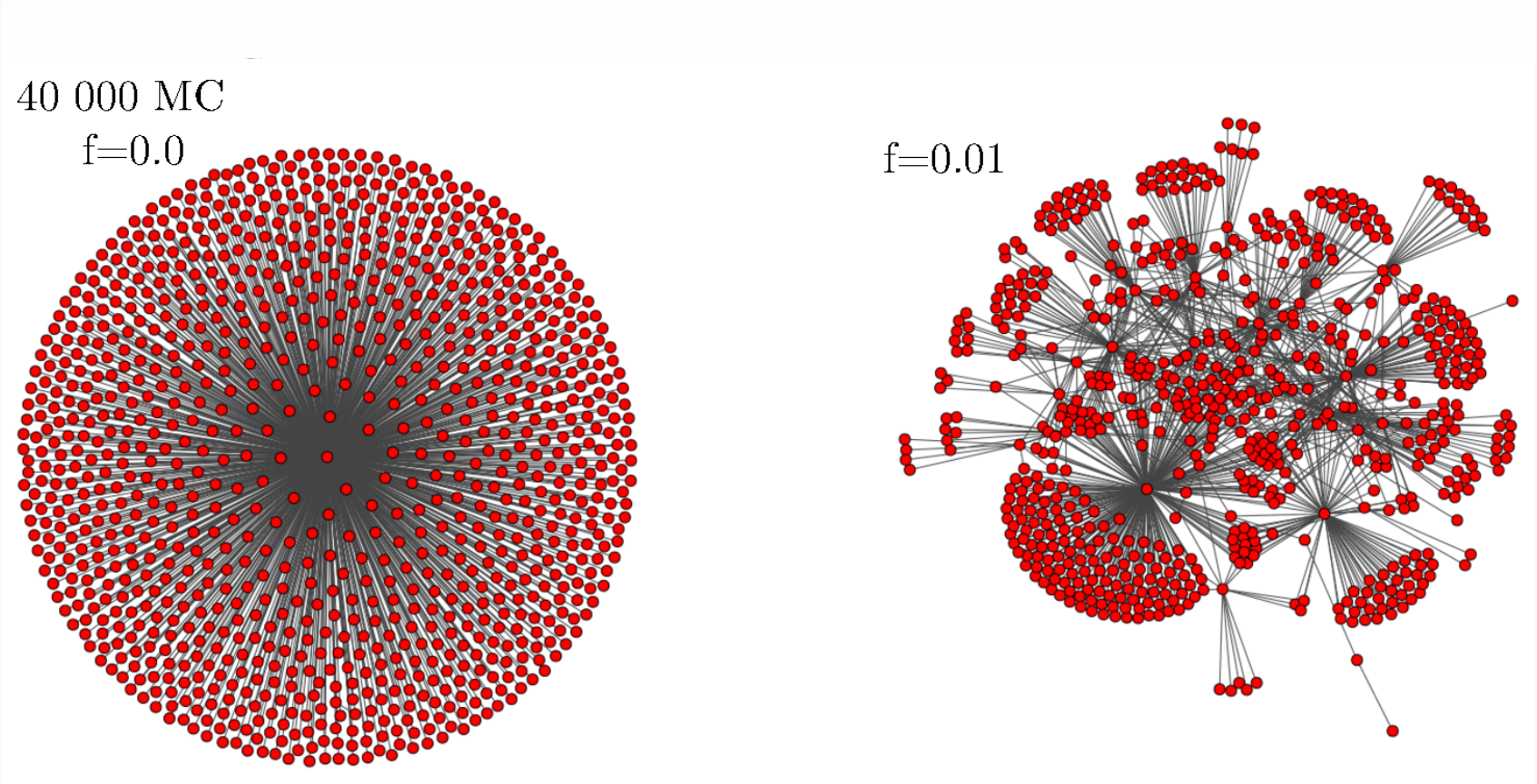
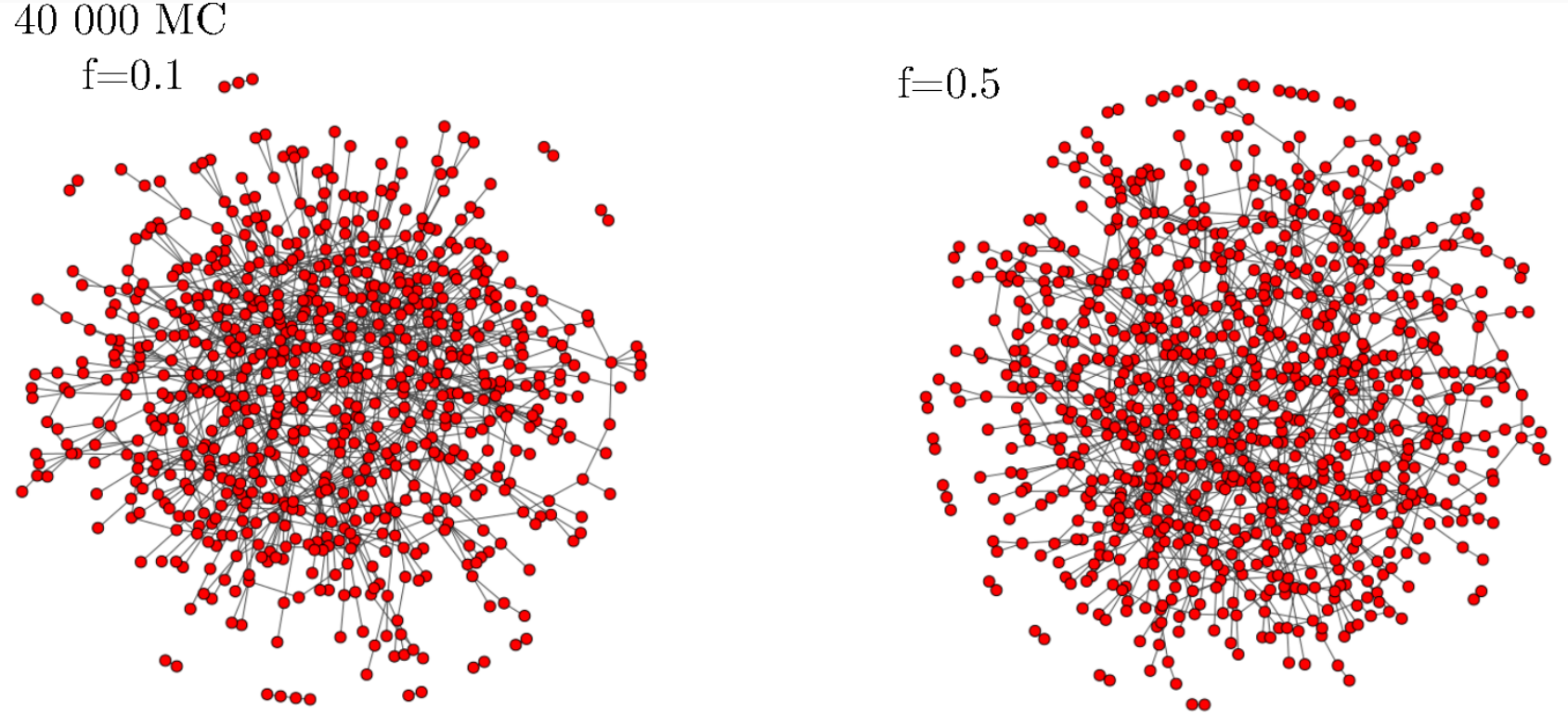



40 000 MC
f=0.0
f=0.01


40 000 MC
f=0.1
f=0.5

Conclusions

- $P^{i,j}_{\text{connection}} = \frac{\omega_i(t)+\omega_j(t)}{\sum_l \omega_l(t)}$
- In the $f = 0$ case there's a condensation of wealth and connections
- Low values of f favours middle class agents, leading to the formation of hubs in the network
- High values of f bring a more egalitarian society where the non-assortative characteristics approximate to the mean-field model

Thank you!

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