Diffusion of innovation within an agent-based model: Spinsons, independence and advertising

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Introduction and motivation

Diffusion of innovations is a theory that seeks to explain how, why, and at what rate new ideas and technology spread.

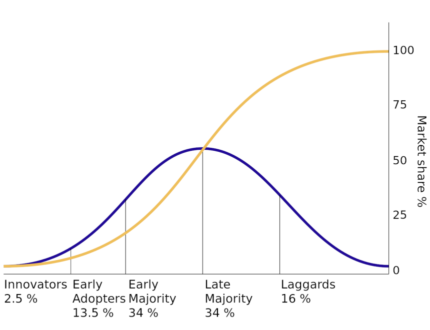


Figure 1: The diffusion of innovations according to E.Rogers. Source: `https://en.wikipedia.org/wiki/Diffusion_of_innovations#/media/File:Diffusion_of_ideas.svg`

Diffusion of innovation model

Model presentation

Model parameters

- Conformity p
- Independence f
- Advertising h

Conformity

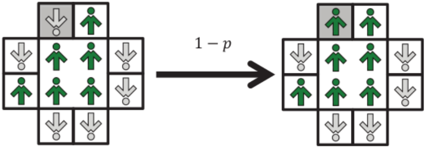


Figure 2: Schema of conformity p. Source: [1].

Independence

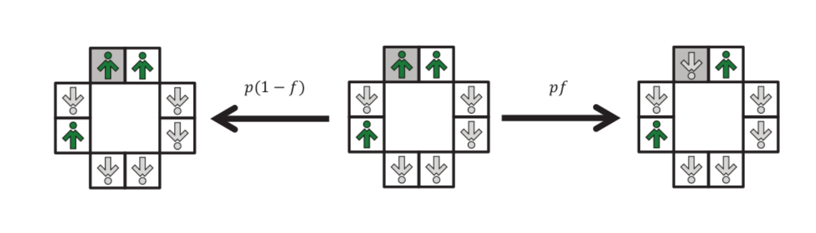


Figure 3: Schema of independence f. Source: [1].

Advertising

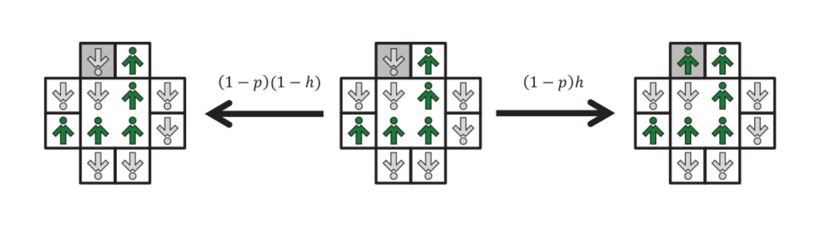


Figure 4: Schema of advertising *h*. Source: [1].

2D Lattice simulation

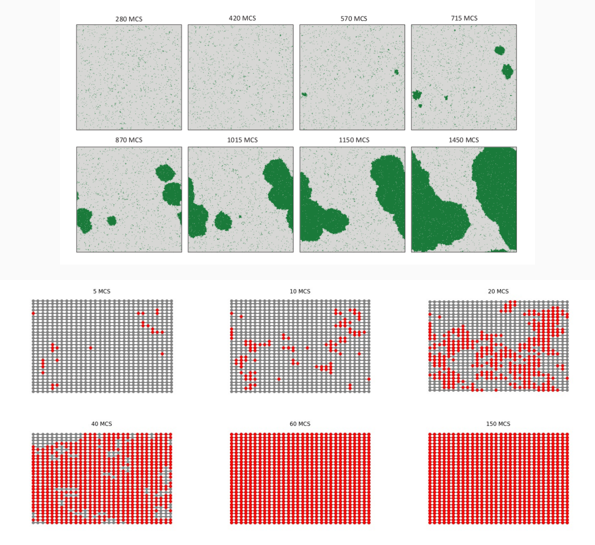


Figure 5: Up - publication; down - ours.

Concentration in time

Concentration

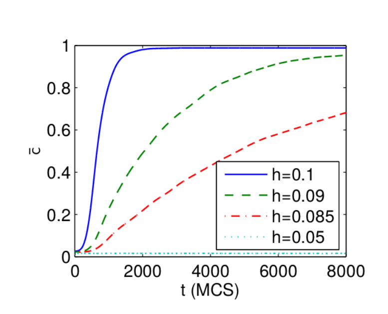
Concentration

$$c_t = \frac{N_{\uparrow}(t)}{N}$$

where

- $N_{\uparrow}(t)$ - number of adopted people, i.e. spinsons with opinion $= 1$
- N - number of people in network

2D Lattice results



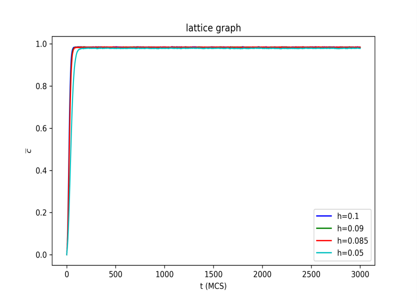


Figure 6: Left - publication; right - our simulation with 3000 MC steps and 100 independent runs on a grid lattice with 900 nodes. .

Complete graph results

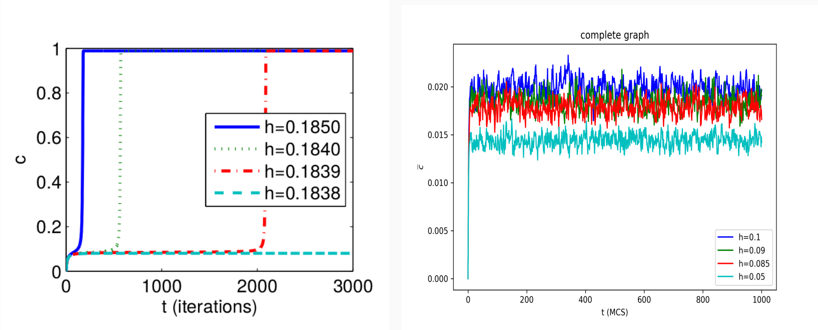


Figure 7: Left - publication; right - our simulation with 1000 MC steps and 100 independent runs on a complete graph with 400 nodes.

Watts-Strogatz results

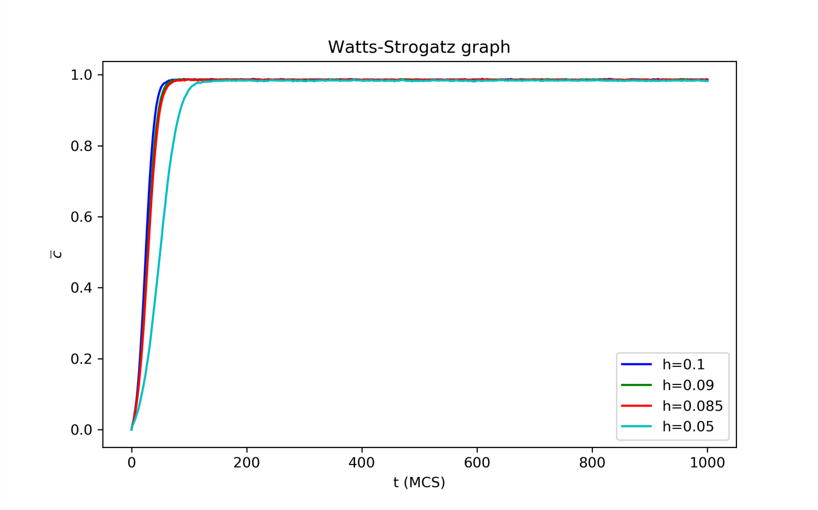


Figure 8: Our work - simulation with 1000 MC steps and 100 independent runs on a Watts-Strogatz (k=4,p=0.3) graph with 400 nodes.

Barabasi-Albert results

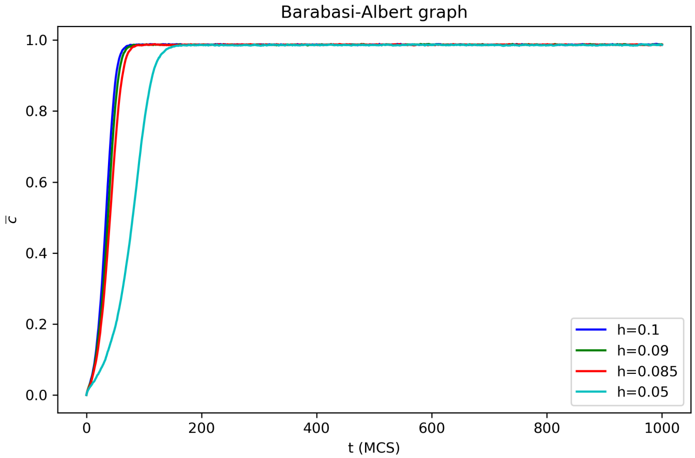


Figure 9: Our work - simulation with 1000 MC steps and 100 independent runs on a Barabasi-Albert (2) graph with 400 nodes.

Comparison of models

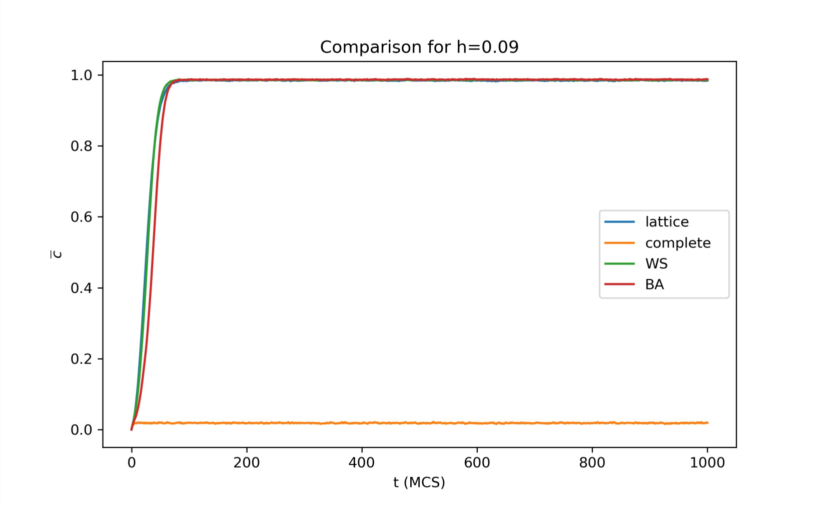


Figure 10: Our work - simulation with 1000 MC steps and 100 independent runs on graphs with 400 nodes, h=0.09.

Market penetration level

Valley of death

Valley of death is a metaphor of way from the laboratory to the market when in reality many innovators fail. Contrary to aggregate models, such as Bass model, this kind of phenomena can be explained by agent-based models.

We can observe that phenomenon near the threshold values of p and h.

2D Lattice results

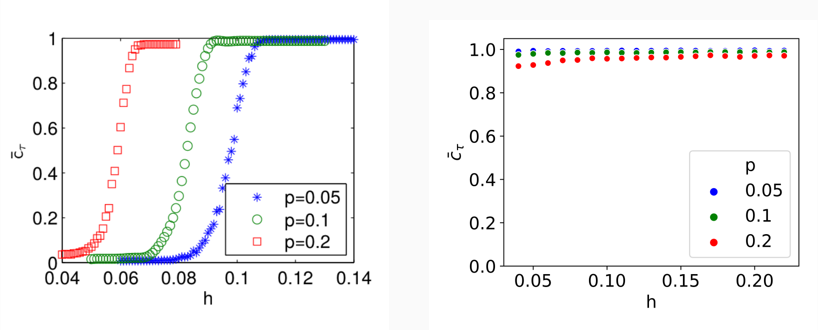


Figure 11: Left - publication; right - our simulation with 300 MC steps and 50 independent runs on a grid lattice with 400 nodes.

Complete graph results

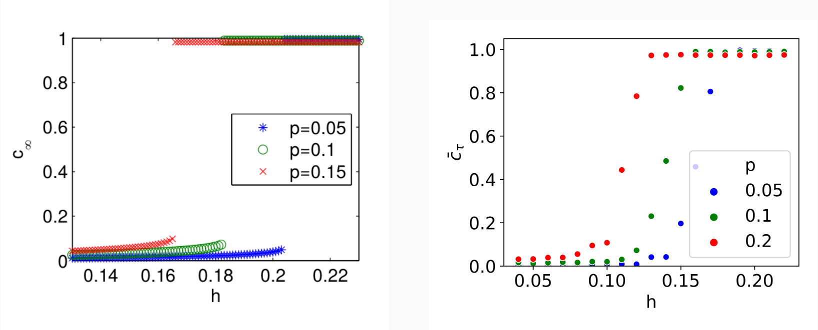


Figure 12: Left - publication; right - our simulation with 300 MC steps and 50 independent runs on a complete graph with 400 nodes.

Watts-Strogatz results

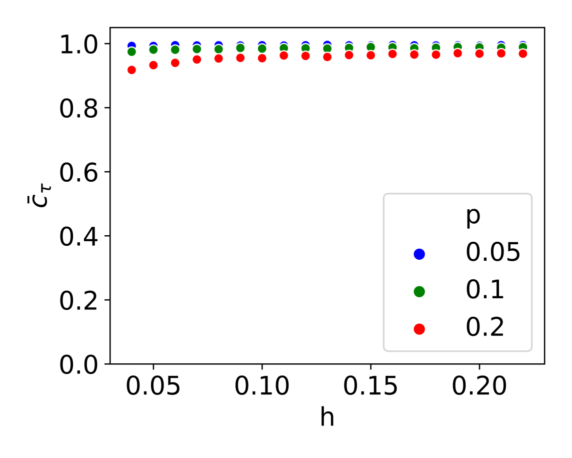


Figure 13: Our work - simulation with 300 MC steps and 50 independent runs on a Watts-Strogatz ($k = 4, p = 0.3$) with 400 nodes.

Barabasi-Albert results

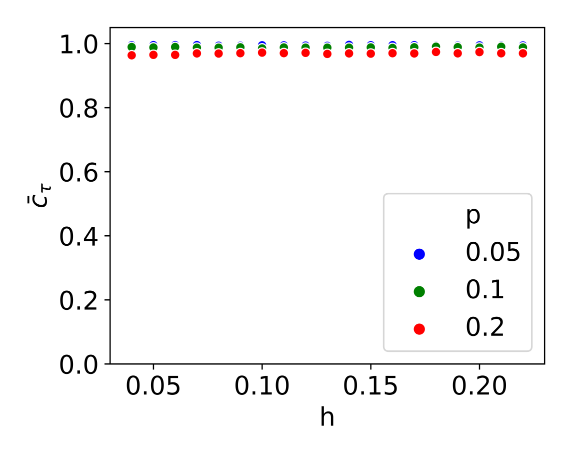


Figure 14: Our work - simulation with 300 MC steps and 50 independent runs on a Barabasi-Albert (2) graph with 400 nodes.

Comparison of models

We wanted to try to find universal h.

	p		
Graph	0.05	0.1	0.2
2D Lattice grid	< 0.05	< 0.05	< 0.05
Complete graph	0.17	0.15	0.12
Watts-Strogatz	< 0.05	< 0.05	< 0.05
Barabasi-Albert	< 0.05	< 0.05	< 0.05

Conclusions

Conclusions

- Smaller graphs converges much faster than bigger ones.
- Shape of curves in time for different h preserve for Watts-Strogatz and Barabasi-Albert graphs. (our results)
- Shape of curves for $h^*(p)$ for Watts-Strogatz and Barabasi-Albert acts similarly to 2D lattice graph. Threshold of h is smaller than 0.05 and we haven't observed discontinuous transition. (our results)
- Differences between the article and our simulations may arise from the use of much smaller graphs.

Contributions

Presentation:

- Patryk Wielopolski

Plots and analysis:

- Maria Kowalczyk
- Anna Szymanek

Simulations:

- Patryk Wielopolski

References i

P. Przybyła, K. Sznajd-Weron, and R. Weron.
Diffusion of innovation within an agent-based model: Spinsons, independence and advertising.
Advances in Complex Systems, 17, 04 2014.

Thank you for your attention!