POST_NETWORK

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"A community might exist as the non-networked, the gap between the lines, filled, extracted, and enhanced."

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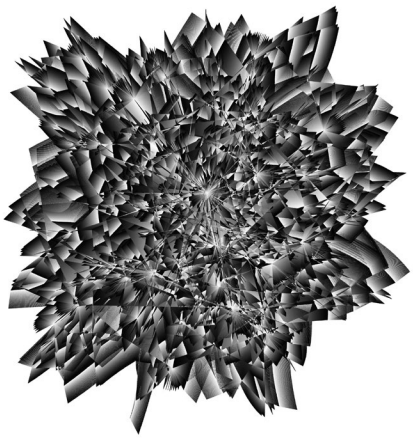

Fig. 0: Visualizing traces of the network forces of repulsion and drawing together.

How do humans interact with each other through technology? A major conceptualization of what is labeled the "digital" are network structures. A model based on two principles: Points and Lines. Within network science and visualization, each element contains one force.

Points repulse each other. They drift away from one another through time. Lines draw together, like springs; they keep the points in proximity and arrange their relationship towards one another.

What are the problems and how can we reimagine novel modes of how to interact within networks? Rather than being embedded within technology, this project explores modes to reshape the fundamental constitutions of the web. But before doing so: Where do the histories of networks come from? And how do these concepts render visible the world we live in?

Random walks

In 1959, two Hungarian mathematicians, Paul Erdős and Alfréd Rényi, defined the first network model.[1] The two forces of repulsion and proximity now come into play with one another. Connections are drawn by chance within this model. Who you are friends with, what you like on Twitter, comment on TikTok, or who you sit next to within a room is all pure luck. The degree distribution, the number of connections, friends, seating partners, and likes, is normally distributed; everyone has about the same number of connections. Within social media, this would mean that every post will receive the same number of likes and that everyone in the network has about the same number of followers.

Rich get richer

In 1999, physicists Albert-László Barabási and Réka Albert studied the structure of the World Wide Web and found that the distribution and connections are far from the randomness previously described. They initiated the idea that networks contain what they have called "preferential attachment," which means that some points within a network become much more connected than oth-

1 Paul Erdős and Alfréd Rényi, On Random Graphs. I. *Publicationes Mathematicae* (1959): 290–297.

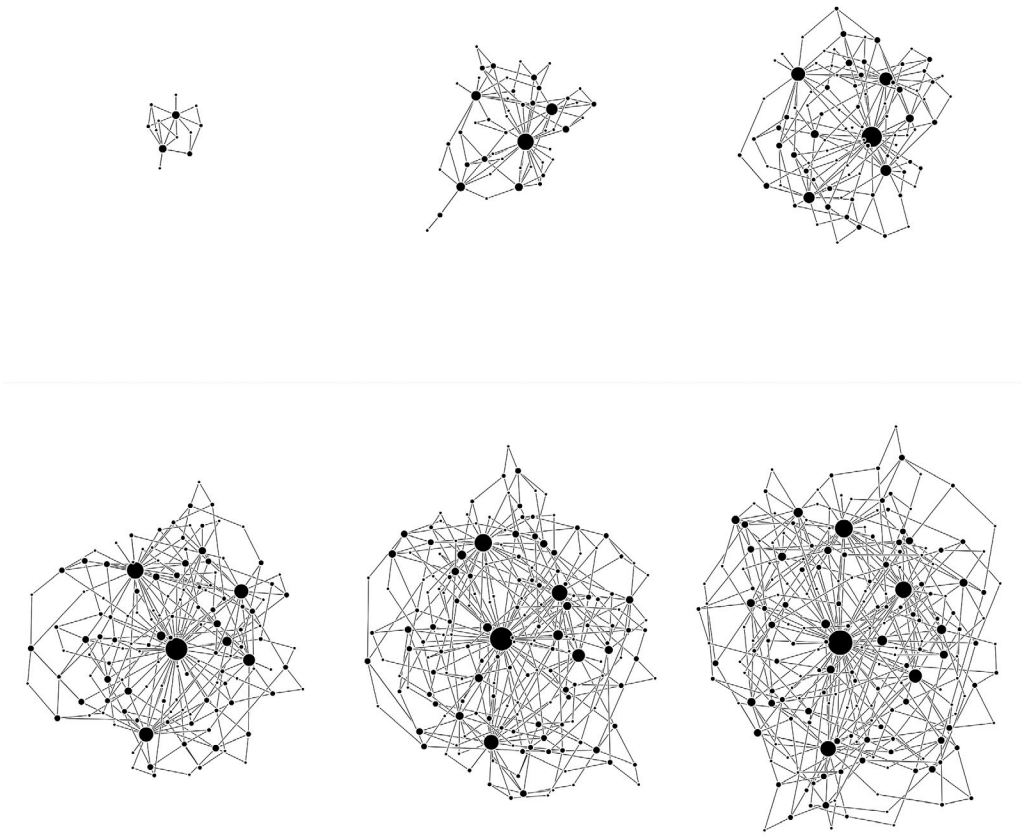

Fig. 1: A temporal visualization of the Barabási–Albert model generating random scale-free networks using a preferential attachment mechanism.

ers.[2] For this reason, Barack Obama, Justin Bieber, Katy Perry, and Rihanna all have over 100 million followers, while you do not. The model itself is time-based. Over time, new points emerge and connect to already existing nodes. This process is not random but determined by the effect that nodes already containing many connections gain even more links over time.

One year after discovering the rich-get-richer effect, the same researchers found a problem within the system.[3] The model is very stable to random attacks, but once you target the hubs – the highly connected points – the network falls apart quickly. Attackers can take apart these systems easily once they remove the right connections. What seems purely theoretical and speculative most prob-

2 Albert-László Barabási and Réka Albert, Emergence of Scaling in Random Networks. *Science* 286/5439 (1999): 509–512.

3 Réka Albert, Hawoong Jeong and Albert-László Barabási, Error and attack tolerance of complex networks. *Nature* 406/6794 (2000): 378–382.

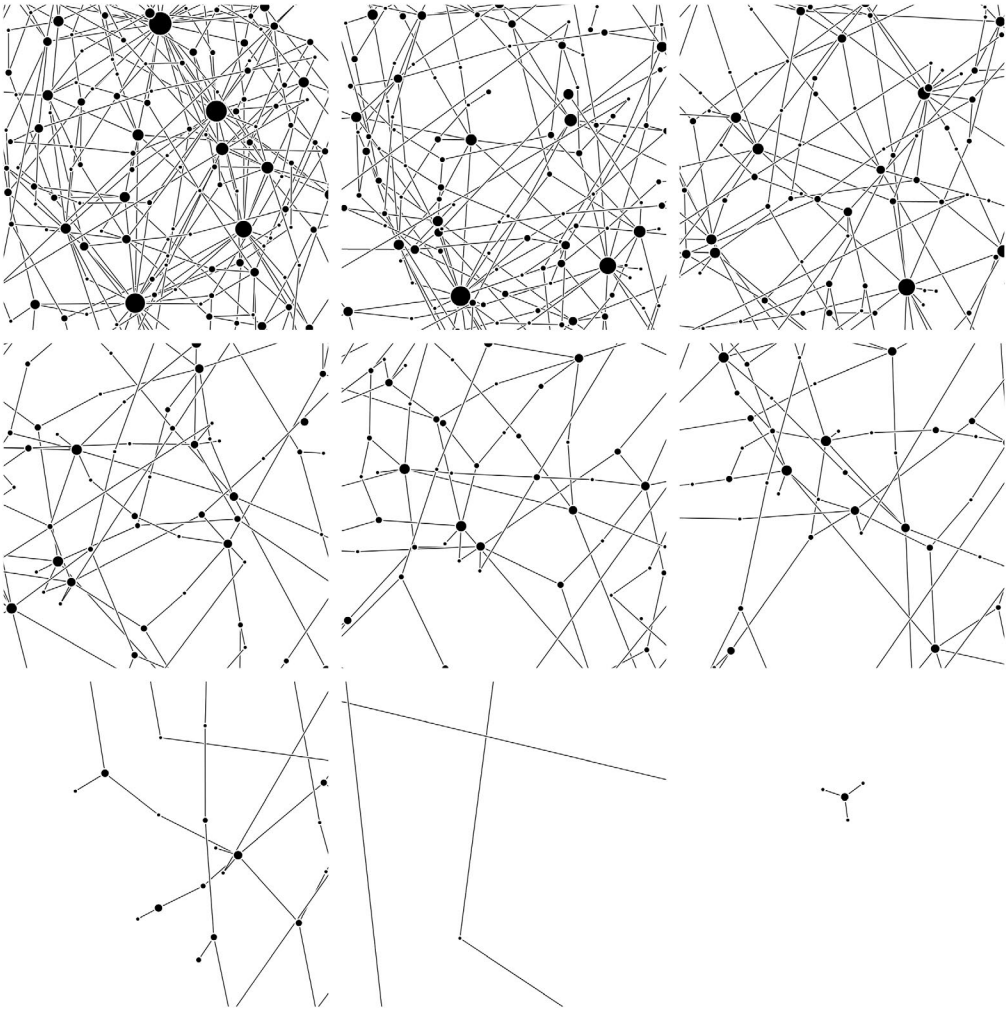

Fig. 2: A targeted attack on the hubs of a Barabási–Albert modelled network.

ably has significant consequences in the world we inhabit. One can only speculate on the destruction of social movements such as the Arab Spring. The speculation is much narrower when it comes to the COVID-19 pandemic.[4] The results of preferential attachment in global air traffic are well-studied. Without the airport hubs of a few places that connect the globe, the spreading of the virus would have been much slower and thus better to control.[5] The super spreader phenomenon is a network effect.

4 Romualdo Pastor-Satorras and Alessandro Vespignani, Epidemic Spreading in Scale-Free Networks. *Physical Review Letters* 86/14 (2001): 3200–3203.

5 Dirk Brockmann, Lars Hufnagel and Theo Geisel, The scaling laws of human travel. *Nature*, 439/7075 (2006): 462–465.

On October 8, 2021, the theory of network destruction moved from research into plain sight. The removal of an internet hub became a reality and with it its consequences. Facebook and all its apps — Instagram, WhatsApp, Messenger, and Oculus — disappeared from the internet. The outrage lasted over five hours. The consequences were devastating. As the New York Times wrote:

> *In some countries, like Myanmar and India, Facebook is synonymous with the internet. More than 3.5 billion people around the world use Facebook, Instagram, Messenger and WhatsApp to communicate with friends and family, distribute political messaging, and expand their businesses through advertising and outreach.*[6]

Might this have been the first of many major outages in the digital networks we are embedded in? The conception of rich-get-richer is how our digital social structure, economy, and technological infrastructure function.

Network sculptures

How could the previously discussed concepts of preferential attachment and the temporal shaping of communities be altered, navigated, politicized, and shaped to sculpt something more resilient and less pandemic? One path is to alter the possibilities of a network and restructure its politics.

In the first experiment, any point in the network can have no more than three connections. A political restriction on connectedness. What would Twitter look like if everyone could only follow ten people? This network's altered, sculptured structure would be much slower in transport – but more resilient. Removing connections would not significantly alter the given system. Hong Kong's 'be water' protests contained a similar strategy: There is no one to imprison when there is no apparent leader.

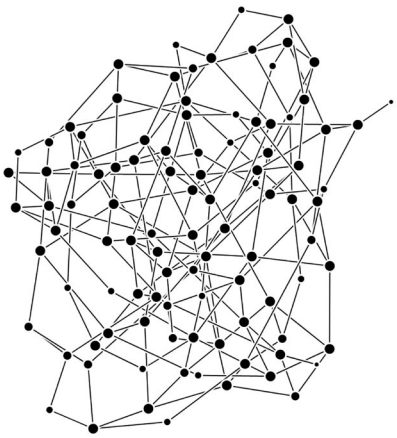

Fig. 3: Networks containing a maximum number of connections form non-hierarchical meshes.

In a second experiment, links decay over time. This network sculpture would only form connections for brief moments to reconstruct itself constantly. Relations within this system are always in question. The system is consistently on the edge of something else. Or within the

6 Mike Isaac and Sheera Frenkel, Gone in Minutes, Out for Hours: Outage Shakes Facebook. *The New York Times* (October 5, 2021); https://www.nytimes.com/2021/10/04/technology/facebook-down.html, access: October 19, 2022.

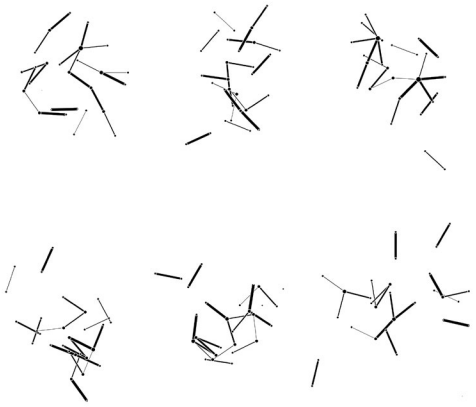

Fig. 4: Network models including decaying links form structures barely resembling the previous network structures.

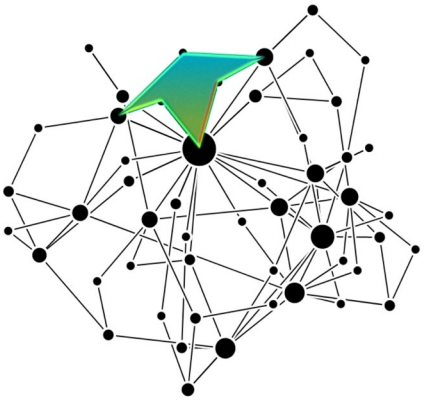

Fig. 5: What if the important aspect of a network visualization are not the points and lines but rather the spaces in between? The negative non-networked spaces?

concept of social networks: You only stay friends with your friends if you keep interacting with them

Negative networks

Previously, we observed alternative sculptures of network structures reshaping the politics of connectivity. But the social could also move beyond such a perspective and question the system of points and lines entirely. What if the network in its temporal emergence is not about the nodes and edges it is seemingly abstracted as? What if the network is about the space it fills throughout its movement? The negative space, the holes, non-spaces, the void, and the in-betweenness become the driving force rather than the point and lines. A community might exist as the non-networked, the gap between the lines, filled, extracted, and enhanced. Temporality leaves the traces behind, the connections, an emergent pattern of relatedness. The network becomes a mere illusion towards the surface it operates on. The trace, the past of the network, is the essential constitution within this model. Rather than focusing on whom I am connected to and how many likes and comments I receive, the focus shifts toward the aftermath of the networked.

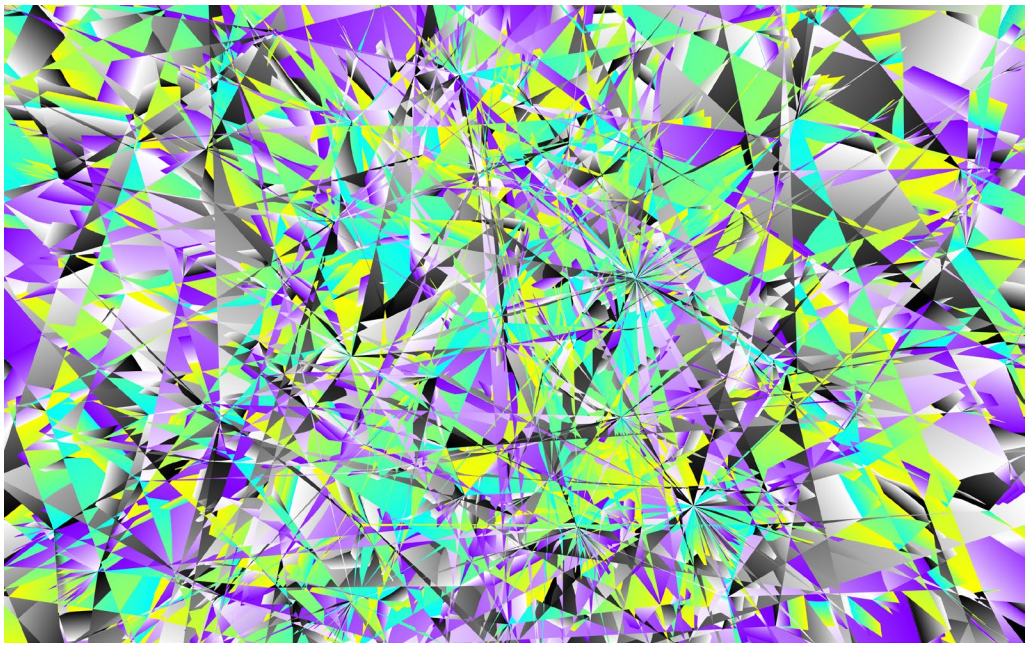

Fig 6: Not the network but its traces, the past movements of the two forces of repulsion and drawing together become visible in this visualization.

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