From AIDS

Tracing, Tracing-Apps and Graphs

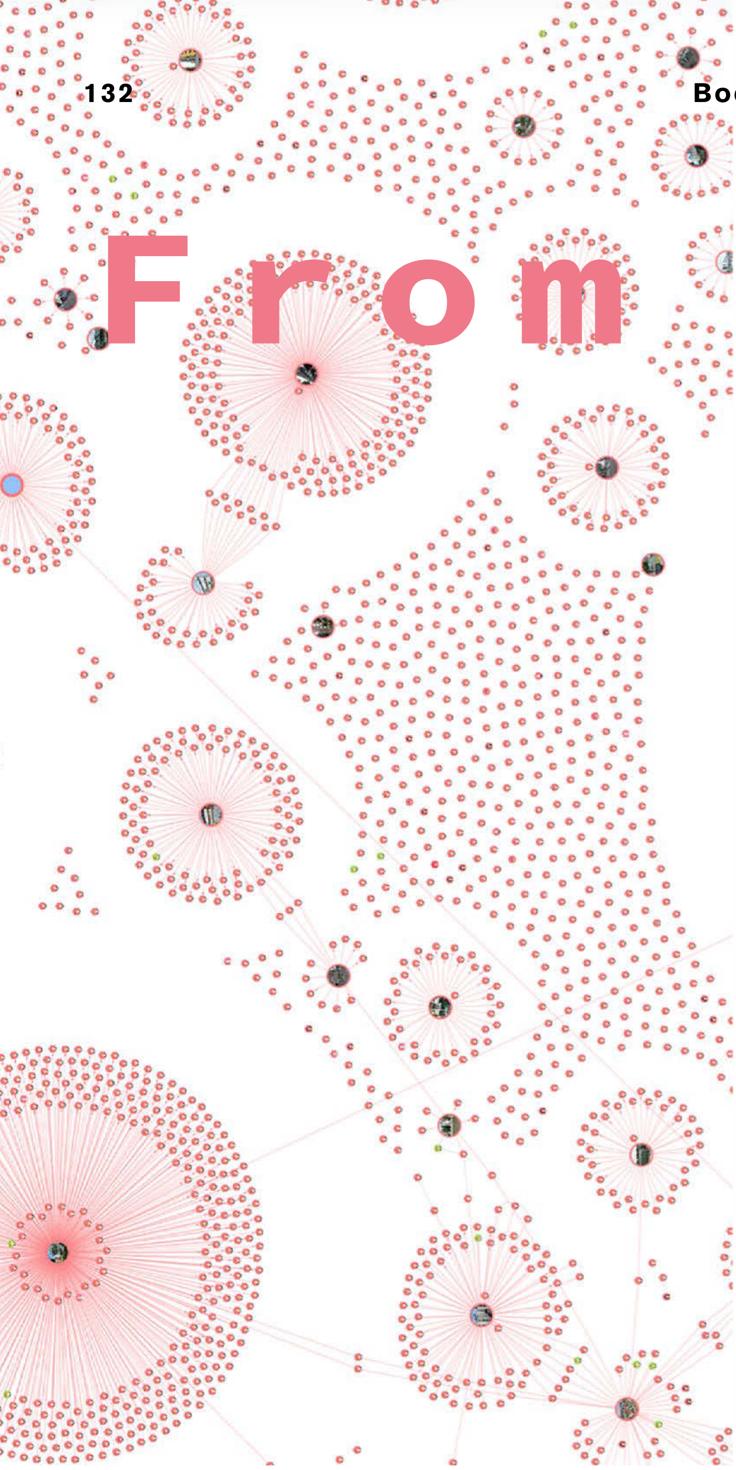

Fig. 2: Contact tracing graph visualization from Singapore, https://co.vid19.sg(link not available anymore, screenshot on file with the author. Link accessed March 4. 2022)

Christoph Engemann: Studied Psychology at the University of Bremen, PhD in Media Studies at the Bauhaus University Weimar. 2020/2021 Visiting Professor Media Studies International School Zhejiang University in Hangzhou, China. Previous positions Bremen International Graduate School of Social Sciences, Käthe-Hamburger Kolleg Internationales Kolleg für Kulturtechnikforschung und Medienphilosophie in Weimar, DFG Research Group Media Cultures of Computer Simulation in Lüneburg. Research stays at the Stanford Center for Internet and Society, the Science and Technology Program University of Texas at Austin and the Oxford Internet Institute. Post-Doc DFG SFB1567 Virtual Lifeworlds Ruhr-University Bochum, research and teaching on AI, computer simulation, digital identity, eHealth, transactions & graphs and barns.

to COVID-19

Text: Christoph Engemann

Without much fanfare, the German coronavirus tracing app was deactivated on 1 June 2023. German authorities followed the example of other European countries which too had ceased to use COVID tracing apps. The relative quietness of the phasing out of these smartphone apps stands in sharp contrast to their introduction during 2020 and early 2021. After the first wave of COVID in 2020, numerous actors proposed to use smart-phone based proximity sensing as a tool to trace potential encounters between infected persons. In the context of unpopular lockdowns and masking requirements such tracing was advertised as a gateway to permit mobility while enabling individuals to be made aware if they were exposed to infectious persons. Instead of being under permanent lockdowns, tracing apps would become part of the individual risk calculus of moving around in public situations.

Accordingly, tracing apps were promoted as tools to regain ›normality‹ under the exceptional conditions of a pandemic. Given the ubiquity of smartphones in most countries, there was a great expectation that the apps would provide substantial tracing coverage. In Germany, a concerted effort by politicians and media lead to 49 million downloads of the Corona-Warn-App. The number of activations and engaged use of the app remained lower, but nonetheless the app must be seen as a successful element of COVID politics. Public actors, scientists and the German government managed to implement a smartphone application for individual and public health. This is true for most countries in Europe, North America and large parts of Asia, where tracing apps were deployed from the second half of 2020 onwards (Baldwin 2021, 104f, Pandit et al. 2022). Adoption and actual use differed widely between countries and regions. Some authoritarian societies mandated the use of tracing apps and linked them to elaborate schemes controlling individual mobility, including the access to public transport and public buildings, but also shops and other spaces.

For the evolving history of data-bodies, tracing apps occupy a peculiar position. The apps used in liberal societies are not media of sensing or measuring individual bodies. They rather are media concerned with contacts between bodies. In tracing apps, human bodies are modelled as transmissive entities and reduced to senders and receivers of viral particles. What is transmitted between bodies are threats to individual bodies in the form of viral pathogens where microscopic particles of only a few nanometres can travel from body to body. In the worst case, such pathogens can kill bodies and even eradicate whole populations. Thus, tracing apps can be described as a form of conceptualizing and mediating an ominous, silent and unobservable "in-between" of bodies. COVID apps delineate this ›in-between‹ of bodies by creating a virtual diameter around each body. This virtual diameter itself is delineated, on the one hand, by the technical features of smartphones. On the other hand, epidemiological risk assessments of unsafe distances and exposure times in the presence of infected persons factor into the construction of the virtual diameter. When viruses cannot be seen and detected, the properties of smartphones as highly personalized sensor-carriers and as senders and receivers carried in close proximity or directly at the body become the media of sensing potentially dangerous contacts between bodies. Tracing apps thus mediated a peculiar substitution: data traveling between smartphones took the place of viruses traveling between bodies. Whenever two virtual diameters of bodies overlapped, COVID apps sensed the distance and duration of this overlap. Contacts between bodies thus were modelled as such overlaps that contained no data about the individual bodies except for having been present within the virtual diameter of another body.

Tracing apps translated bodies and their environments into invisible yet highly relevant virtual environments rendering the spaces of interaction and spacial agencies of their users into effects of a »sensor-algorithmic virtuality« (Sprenger 2023).

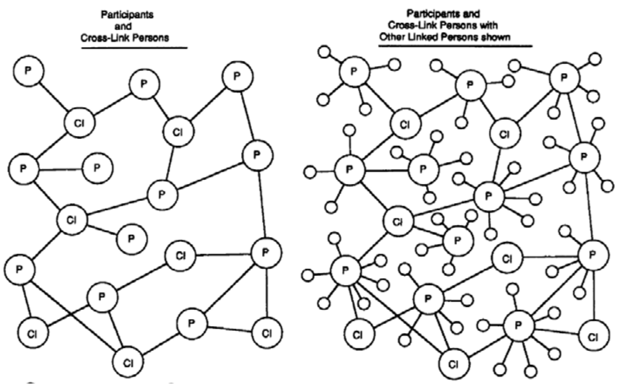

Fig. 1: Graph from the Colorado Springs Study. Klovdahl et al. (1994): Social Networks and Infectious Disease: The Colorado Springs Study. Social Science & Medicine 38(1): 85.

The precise makeup of sensors and data used to create these invisible virtual environments tracing contacts between bodies, however, was not solely defined by technical features of the sensor set of smartphones. Rather it was the result of political decisions in which data and sensorial capacities should govern the tracing of bodies under pandemic circumstances. The scope and design of tracing apps differed widely between countries and social systems: the *Governmediality* – the question of how to govern the media that govern us – developed distinctive forms. Liberal societies engage with the challenges of digital media to their values of autonomy, self-determination, freedom from surveillance – and in this context the access to and virtualization of bodies – differently than more authoritarian societies. How bodies, artefacts, and institutions are related to each other in particular social systems became a central question during the COVID pandemic since smartphones offered to remediate these relations (Schmidgen 2022: 138).

Authoritarian societies like Singapore or China chose less privacy-sensitive designs than those developed in most of the liberal democracies of the Western hemisphere (Baldwin ibid; von Carnap et al 2020). Even within Europe, several competing tracing apps with different privacy trade-offs were under debate between April and October 2020 before most countries agreed on an interoperable standard. The following describes the emergence of contact tracing and its merger with graph-based social network analysis. For the latter, the AIDS-epidemic will be analysed as a turning point during which graphs entered the toolbox of public health management. Graphs reshaped how the spaces of interaction and spatial agencies of citizens can be observed and delineated. With COVID tracing apps, this capacity of graphs became critical and the specific entanglements of media-technologies and political agencies afforded by graphs became contested.

Media of contact tracing: From paper to graphs

The emergence of contact tracing is closely tied to the establishment of the germ theory of disease in the mid-19th century (Baldwin 1999: 21). While the Aristotelian miasma theory of diseases had been increasingly contested since the late Middle Ages, Semmelweis, Pasteur and Koch, among others, were instrumental in establishing the epistemology of microbiological life. Diseases were now viewed as transmissible by contact. In fact, the question of transmission by aerosols and hence without direct contact between bodies remained contested for its semblance to miasma theory. Direct contact was conceptualised as contacting microbiodical pathogens that had travelled from one body to another through touch, smearing or inhalation of droplets launched by coughing and landing on skin. A contact thus was an encounter in which pathogens were exchanged. Diseases had become communicative. Consider the title of John Snows's 1849 pamphlet: »On the mode of communication of cholera«. Snow is often credited as one of the innovators of contact tracing. He marked disease cases in maps of London neighbourhoods and retroactively traced the locations of infected persons having shared particular locations. On this basis, he could show that cholera outbreaks in London were connected with public water pumps (Baldwin 1999, 147f; Gosh 2023: 68). By the end of the 19th century, mapping out disease outbreaks based on data acquired by patients, doctors and health care officials had become an epidemiolocal standard procedure used to manage tuberculosis and other infectious diseases.

Tuberculosis, gonorrhoea and syphilis epidemics in the first half of the 20th century saw the development of more sophisticated and individualized mechanisms to trace individual infection schemes (Baldwin 1999: 355, Baldwin 2006: 10 & 238; Fairchild, Colgrove & Bayer 2003). In this context, questions concerning the right to anonymity of infected

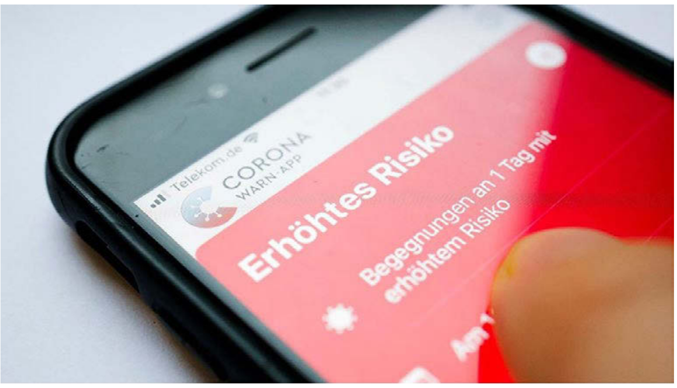

Fig 3: Risk alert on the German Corona-Warn-App (https://www.bundesregierung.de/breg-en/search/corona-warn-app-update-2-25-2068570 date of retrieval: 18.02.2024)

patients but also of the doctors became contested. Since sexually transmitted diseases were highly stigmatized and names were reported unblinded to health authorities, becoming a patient carried risks of exclusion. In the USA, patients who did not comply with medical advice, as well as people from marginalized communities and especially prostitutes often faced criminal prosecution when infected (ibid.). In contrast, men of status often were not reported or reported »veiled« (ibid; see Baldwin 2006: 227ff)) to the authorities. Up to the AIDS epidemic in the 1980s, numerous attempts were made in the USA to legislate and establish contract tracing infrastructures with state and federal health authorities. Nonetheless reporting differed highly by type of disease, and venereal disease reports remained low. Contract tracing relied on the tedious review of interviews, data from doctors, clinics and especially microbiological laboratories via surveys, and phone calls as of the 1930s. In addition, some health authorities employed contact investigators who visited doctors' offices to collect information. The collection, aggregation and analysis of this data remained paper-based and limited in scale and velocity, and contact tracing was dominated by manual data acquisition and compilation.

The same methods were implemented during the AIDS epidemic of the 1980s. With homosexuality stigmatized even in liberal societies and downright illegal in several US states, as well as the frequent link between AIDS and drug use, the debate about trade-offs between privacy concerns and public interest in contact tracing remerged (Shilts 2007, Baldwin 2006: 70). As for the aforementioned venereal diseases, contact tracing became mandatory for AIDS in the USA and almost all countries worldwide. In the USA and Europe, questions of how and by whom data about contacts between patients is collected, controlled and disseminated again came to the forefront (Baldwin 2006 ibid; Dembosky 2020; Shilts 2007). In this process, the fact that contact tracing was not a voluntary act but an institutional process to which patients and to some extent doctors are subjected was challenged by gay activists and privacy advocates (Potterat 2015: 7; Shilts 2007). In response, the already established informal practice of partner notification in case of infection became part of public health strategies (Bayer and Toomey 1992; Potterat 2015). Based on privacy protection measures, which became codified under the pressure of aforementioned civil society actors in the second half of the 1980s, the practice of using codes within the health care system became the norm. Doctors retained the role of gatekeepers interfacing with the patients, whose names and data they knew, and health authorities to which anonymized data was provided. Contact tracers mapping AIDS infections thus had to communicate with the doctors in order to reach patients. ›Contacted and educated‹ was a term used for this approach. The voluntary practice of mutual partner information in AIDS exposure here became partially augmented through the formal communication channels with the medical providers who were becoming part of a privacy-preserving contact tracing scheme.

AIDS brought the practice of contact tracing to the public eye and led the institutional and political contexts responsible for these measures to adapt participatory approaches to increase the legitimacy and adaptation of contact tracing (Baldwin 2006: 70f; Dembosky 2020; Potterat 2015). Contact tracing moved from the backstage of epidemiological management to the forefront. What once was deemed as a medium of stigmatization now increasingly became framed as a method to overcome it: timely notification augmented through contact tracing would help to slow the spread of AIDS and relieve endangered communities from the burden of being associated with the disease. The medium of contact tracing continued to be largely paper, and contact pairings were the unit of interest. AIDS fostered the introduction of graph-based social network analysis to public health management of epidemics. Graphs are mathematical means to model relations between entities, in this case between human bodies (Velminski 2009). Graphs are the basis of social media (Engemann 2016b, 2016a; Seemann 2021) and partially of artificial intelligence. The availability of minicomputers in the 1970 and personal computers in the 1980s yielded the development of social network analysis software allowing running graph analyses of social networks (Freemann 2004: 139f; Klovdahl 2001: 26). The application of this epistemology, mainly developed by sociologists in close exchange with mathematicians and computer scientists, to the epidemiology of AIDS was first undertaken by the Australian sociologist Alden Klovdahl in 1985. Based on data he received through personal contacts from the US Centre for Disease Control (CDC), Klovdahl published an influential paper showing the applicability of graph-based social network analysis to analyse, model and predict infection dynamics of AIDS (Klovdahl 1985). By feeding the CDC data of 40 AIDS patients from 1979–1982 into graph software (ibid.: 1205), he could show that this approach allowed to trace out infection pathways and develop new hypothesizes about possible dynamics of infections. With Klovdahl's analysis, the media of contact tracing began to transition from paper based, analogue methods to digital techniques. While data acquisition still remained pen-and-paper-based, computer-facilitated graph analysis of social networks rendered the individualized approach of contact tracing into the observation of populations as contact networks. Here, the individual behaviour becomes less of the focus, rather the position of an individual in a network. In graph-based social network analysis, the position determines the risk factors of a person. One of the early protagonists of the application of graph-based network analysis John Potterat enthused in his autobiography: "Contact tracing and the network approach to studying connections between people were twin disciplines that had emerged in the 1930s, but had been raised apart" (Potterat 2015: 138). In 1988, Potterat, who was the director of the Sexually Transmitted Diseases Program in Colorado Springs, co-opted Klovdahl to initiate the first large scale study in the applicability of network analysis for epidemic management. Financed by the CDC, the so-called Colorado Springs Study (Klovdahl et al. 1994) showed, that obtaining a graph – that is a mathematical description of the contact networks of the at-risk population – yielded positive implications from a disease management perspective (Fig. 1).

During the 1990s and 2000s, graph-based social network analysis established itself as an important paradigm in epidemiology and public health management (Heckathorn 1999: 125). The influx of funding for graph-based social network analysis on the basis of the pressing issues of the AIDS-epidemic »led to methodological innovations including improved means for measuring network structure and sampling hidden populations« (ibid.). This nexus of the development of graph theory, software packages for graph analysis, and visualisation in the AIDS-epidemic merits further research. For the purposes of this analysis, it is clear that with the advent of AIDS and the simultaneous availability of cheap computers enabling the development and application of graph network analyses, the media of contact tracing as well as the method of contact tracing changed profoundly. Contact tracing has become the means to acquire graphs, and graphs reshaped how the spaces of interaction and spatial agencies of bodies could be observed and made to spaces of intervention. A contact between bodies attained a risk value determined by a body' position within the graph in relation to other bodies. In the history of data bodies, this possibility of the envelopment of bodies by graphs, rendering them into risk carriers, marks an important development.

The New Media of Contact Tracing: Apps

Tracing apps are the automatization and individualization of contact tracing on the basis of the sensor capacities of smartphones. Instead of manually collecting data about contacts as described in the historical examples mentioned in this text and still the case for AIDS, smartphones can automatically collect data about location and encounters. The crucial question that emerged during the debates about the design of contact tracing apps in the first half of 2020 was the role of graphs in this process. Countries like Singapore and China openly employed graphs for their COVID tracing apps with Singapore even making the graph-data available online for citizens. The website co.vid.19.sg created fully navigable visualizations of infection graphs in Singapore.

In Europe, two competing proposals for developing COVID tracing apps emerged in 2020: the Pan-European Privacy-Preserving Proximity Tracing project (PEPP-PT) and the Decentralized Privacy-Preserving Proximity Tracing (DP-3T) consortium. Both groups were made up from epidemiologist, computer scientists, virologists, social scientists and lawyers who collaborated to build protocols, software and applications to enable contact tracing via smartphones. PEPP-PT and DP-3T differed in their approach to centralized vs. decentralized infrastructures and the role of graphs in managing the COVID pandemic. PEPP-PT, which was initially favoured by the German and French governments, set out to develop a centralized system in which the data collected on a device by the tracing app would be uploaded to servers and contact matching and tracing would be performed. The DP-3T protocol favoured a decentra-

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lized solution, fully relying on on-device detection and tracing. In providing their rationale for this design the DP-3T consortium refered to the privacy implications of generating large-scale graphs via tracing apps.

> In decentralized system where risk is processed on device locally This comes with the important benefit that the **server cannot learn the social graph**, which is data that can easily be repurposed and misused in ways that individuals would not reasonably expect and may not wish. (highlighted in the original on file with the author. The online version available in April 2024 now reads "No entity can observe or keep record of a global view of the social graph of a population, in anonymized form or otherwise." C.E. (DP-3T [2020] 2020 date of retrieval: 30.04.2024))

This position, expressed roughly 30 years after the application of graph-based social network analysis in the AIDS epidemic, reflects the change in the media landscape that occurred in this timeframe. During the 1980s and even the 1990s, computers were not nearly as prevalent and required considerable skill to use. Graph analysis was a specialized skill, and access and acquisition of data fit for graph-calculations required complex institutional infrastructures. Social media and smartphones, which emerged during the first decade of the 2000s, not only put computers in every pocket, but also put graphs at the centre of platform economies (Engemann 2020; Seemann 2021).

While the graphs of AIDS epidemiologists contained a few hundred or a few thousand persons, the graph industrial complex of social media extended into the billions. It is with this background that the notion of the risks and chances graphs provide changed. Centralized contact tracing would enable a »global view of the social graph of a population, in anonymized form or otherwise« (DP-3T, 3. The documents and statements of the DP-3T consortium exhibit the deliberations on how to govern graphs when they belong to the media that govern us. Liberal societies ultimately came to the decision that they would be betraying their fundamental principles if they were to build a centralized, graph-based system to tackle COVID via contact tracing apps.

> With access to the social graph, a bad actor (state, private sector, or hacker) could spy on citizens' real-world activities. Some countries are seeking to build systems which could enable them to access and process this social graph. (Veale et al. 2020: 2).

The design ultimately adopted for the German and most other European tracing apps reflect this debate. They maintain no centralized databases in which data can be graphed out. Rather they followed a decentralized approach. Based on Bluetooth proximity sensing, these apps do not know the location of the bodies, they only register time where phones where in close contact. Secondly, instead of involving health care authorities in the tracing process, the contact tracing is delegated to the individual via its device. Unlike classic contract tracing, it is not health care officials observing groups of bodies and how transmissible disease spread within a population. It's the individuals themselves who, via their smartphones, are rendered into observation posts observing each other. Crucially though, the access to these observations is only the notification of having had a potentially dangerous encounter in the recent past. The virtual diameters of bodies overlapping as sensed by the COVID apps would stay hidden and unobservable to the users. In an almost classical fashion described by the studies of governmentality (Burchell, Gordon, and Miller 1991; Foucault 2004) the tracing responsibility is delegated to the citizen. Contact tracing is not mandatory but becomes a deliberate decision by the citizen. This is a massive shift from the role contact tracing played historically and, at the same time, a distillation of the privacy-aware and privacy-preserving tracing formats that developed under the pressure of civil society advocates during the AIDS epidemic.

The spatial regime of bodies created with the European tracing apps is characterized through two peculiar dimensions. Firstly, as argued in the introduction, the sensor-algorithmic virtuality of tracing apps create invisible but highly relevant virtual diameters of bodies based on Bluetooth proximity sensing. Contacts between bodies are overlaps of such virtual diameters. Secondly, by foregoing aggregation via graphs, they create a highly exceptional situation in the context of smartphones: almost all apps and services used on smartphones are based on graphs generated on the servers of the vendors. Every smartphone user is permanently part of graph-topologies and acts and moves within spaces delineated by graphs. Since the early 2000s, graphs are the dominant dispositive for ordering and potentially exploiting relations between people, places and activities. Disconnecting bodies from graphs and at the same time providing them with an invisible virtual diameter enabling free movement created a paradox form of sensor-algorithmic virtuality: a space of virtual freedom. Freedom from surveillance and freedom to move. The spatial agency afforded by this graphless protocol resulted from identifying the minimal set of sensor activity, data aggregation and communication to enable citizens to exercise their rights to mobility.

It is thus simplifying to speak of »Pandemic Solutionism« (Maschewski & Nosthoff 2023) in the context of pandemic management. The negotiations about the media-technological foundations of contract tracing entail more complex questions about the implicit and explicit features of the media involved (Melamed, Keidl 2020: 14; see also Gosh 2023: 4). With regards to contract tracing apps in particular the question is if social graphs should be generated or not. Eschewing graphs became part of the governmedial regime in Europe, and such developments in the interaction between liberal values and media technologies and the question of how to govern the media, that govern us, require analyses that go beyond the surveillance paradigm.

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