Undergraduate Thesis Prospectus

Predicting Coronavirus Hotspots

(technical research project in Computer Science)

Controlling the Coronavirus: The German Case

(sociotechnical research project)

by

Larry Cai

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.
Larry Cai

Technical advisor: Aaron Bloomfield, Department of Computer Science

STS advisor: Peter Norton, Department of Engineering and Society

General Research Problem

How can coronavirus be contained?

The World Health Organization (WHO) declared coronavirus a pandemic on March 11, 2020 (Cucinotta, 2020, p. 157). As of November 1, 2020, there are 46,386,903 COVID-19 cases globally and 1,199,500 COVID-19 related deaths (JHUSOM, 2020). Global cases increase as countries struggle to stop the virus from spreading. Like many countries, the US, France, and Italy have seen a steady rise in COVID-19 cases. By studying preventative measures and applying the lessons, public health experts, epidemiologists, policymakers, advocacies, and conscientious citizens can contain COVID-19.

Predicting Coronavirus Hotspots

How can AI effectively predict coronavirus hotspots?

My technical advisor is Computer Science department professor Aaron Bloomfield. He will oversee my independent project. In March, Guayaquil had a serious coronavirus outbreak. 778 people died on April 4, and corpses lay on the street (Dube, 2020). This changed when Hector Hugo identified where COVID-19 was most concentrated by mapping 911 calls to locations (Dube, 2020). Guayaquil mayor, Cynthia Viteri, dispatched medical officials to treat patients in coronavirus hotspots. After identifying coronavirus hotspots, health officials can treat areas in need.

Data from New York University Langone Health's City Health Dashboard (CHD) shows that the pandemic affects neighborhoods differently. CHD displays neighborhood coronavirus risk in cities and states based on 23 metrics, dividing neighborhoods by ZIP Code (Duscharme, 2020). Different neighborhoods have different conditions such as racial breakdown, poverty, and

local chronic conditions which affect infection rate (Duscharme, 2020). I will use reinforcement learning to predict the location of coronavirus hotspots by neighborhoods in Fairfax, Virginia.

The U.S. Centers for Disease Control and Prevention (CDC) predicts the number of cases by county and state with multiple models (2020b). Counties are too large to pinpoint coronavirus hotspots resulting in difficulties sending health officials to areas for COVID-19 testing. CHD displays neighborhood coronavirus risk in cities but does not have data on many cities including Fairfax, Virginia (CHD, 2020). The Virginia Department of Health has COVID-19 cases conveniently mapped by ZIP Code (VDH, 2020). The CDC, Johns Hopkins University School of Medicine (JHUSOM), and The COVID Tracking Project also have public databases. Information can be extracted from 911 calls. There are many open-source COVID-19 forecasting models which we can learn from. I will train my algorithm using existing data and models.

My algorithm will be able to predict coronavirus cases by neighborhood. Using the algorithm, we can send health officials to COVID-19 hotspots and implement preventive measures such as email warnings to residents about local outbreaks. Next, I plan to make my source code public, expand my algorithm and dataset to cover all neighborhoods in Virginia, and conduct maintenance on my algorithm. Once released, people can analyze my algorithm and provide feedback to improve it.

Controlling the Coronavirus: The German Case

How did health authorities in Germany achieve relative success in controlling the 2020 pandemic?

According to Johns Hopkins University School of Medicine, as of October 8, 2020, the US has the highest cases of COVID-19 by country at 7,550,731. Germany performed well by

European standards in containing COVID-19, having 311,503 cases in a population of 80 million (JHUSOM, 2020). There were 99,750 cases in the US on October 30 alone (CDC, 2020a). Germany, by contrast, reduced new cases from 6000 per day in March to 2000 by April and 460 in May (Wieler, 2020). It is important to study countries like Germany to learn what policies were effective in containing the spread of COVID-19.

According to Karadağ (2020), Germany's recovery rate is among the top five. This can be attributed to "measurements taken [to reduce new COVID-19 cases], health infrastructure, and different treatment strategies" (Karadağ, 2020). Such measures include self-isolation, quarantines, hand-washing, respiratory etiquette, and oxygen and mechanical ventilation. Germany reacted quickly to COVID-19; medical advisors assisted the decision-making process and people practiced social distancing (Schartau & Kirby, 2020, p.27). Over the last 20 years, Germany has accumulated more hospital beds, ventilators, intensive care unit (ICU) beds, and hospital doctors per capita than any other comparable country in Europe (Schartau & Kirby, 2020, p.27). The ICU increased from 28,000 to 40,000 and ventilators from 20,000 to 30,000 (Yaylali, 2020 p. 3).

Germany performed rigorous and early coronavirus testing. Multiple labs developed test cases for COVID-19 in early January resulting in widespread testing (Schartau & Kirby, 2020, p.27). When the pandemic began, Germany executed 100,000 tests per day which decreased to 50,000 per day in March, "ten times higher than the tests conducted in France" (Yaylali, 2020, p. 2). School and university closures before March 22 also helped reduce COVID-19 cases (Yaylali, 2020, p. 2).

German Chancellor Angela Merkel televised national health updates explaining COVID-19 preventive measures and rationale (Schartau & Kirby, 2020, p.26). People generally accepted

the measures due to trust in the administration. Self-quarantine can inflict negative emotions such as "frustration, anxiety, and boredom" (Mutz, 2020). It is important to maintain optimism as "frustration and dissatisfaction can erode commitment to public health measures" (Mutz, 2020).

In November 2019, Germany's parliament passed the Digital Care Act, which promotes the integration of telemedicine into the national healthcare system (Schartau & Kirby, 2020, p. 27). Germany's healthcare system was prepared for social distancing and self-quarantine. The Robert Koch Institute (RKI) produced COVID-19 chatbots, robots to clean hospitals, and drones to deliver food to patients (Schartau & Kirby, 2020, p. 27). The government held hackathons to develop techniques to manage the pandemic (Schartau & Kirby, 2020, p. 27).

To promote vaccination, RKI doctors Carsten Mantel and Thomas Cherian (2020, p. 26) suggest paying individuals, using methods that require no needles, and integrating vaccination for all age groups into primary healthcare (Mantel & Cherian, 2020, p. 30).

The Robert Koch Institute, Chancellor Merkel's administration, the German Center for Infection Research, German healthcare workers, the Federal Ministry for Consumer Protection, Food, and Agriculture, and Romanian seasonal workers are participants involved in controlling COVID-19 in Germany.

RKI is a government biomedical center that promotes general public health. They research to "observe and evaluate health trends and risks to the population" (RKI, n.d.). With that data, they can then provide reliable advice to the public and "daily coronavirus cases and deaths on [a] regional basis" (Yaylali, 2020, p. 7).

Angela Merkel pleaded people "take [COVID-19] seriously… since the Second World War – there has been no challenge to our nation that has demanded such a degree of common and united action" during a national television address on March 18, 2020 (Dempsey, 2020).

The German Center for Infection Research is researching how to stop the coronavirus. They recently began their first clinical trials on a vaccine and received a large grant from the Federal Ministry of Education and Research (DZIF, 2020).

In September, Nicoletta Wischnewsik, a hygiene and environmental medicine doctor, warned of a shortage of public healthcare workers: “it’s getting more and more difficult to hire new colleagues” (Thurau, 2020). Healthcare workers are working hard to treat patients. In Berlin, teams composed of students and Bundeswehr soldiers operate hospitals and call centers (Thurau, 2020).

The Federal Ministry for Consumer Protection, Food, and Agriculture wants to ensure Germany has a steady supply of food. Minister of Agriculture, Julia Klöckner, allowed “farmers [to] employ additional seasonal workers from abroad” (Gotev, 2020). While middlemen are practicing good social distance techniques, employing seasonal workers will inevitably increase the virus infection rate.

Romanian Interior Minister Ion Marcel Vela announced that seasonal workers could leave on April 4 (Kühnel, 2020). Ioan, a Romanian seasonal worker, harvests asparagus in Germany. In 2019, after working ten hours a week, seven days a week, for three months, Ioan earned 1,800 Euro or 2096 Dollars; the rest paid for food and lodging expenses (Kühnel, 2020). “It was not a pleasant experience,” Ioan admitted, but he had no other options (Kühnel, 2020). He was laid off and cannot find work due to strict emergency rules (Kühnel, 2020). Many seasonal workers have no choice but to accept offers from German middlemen to support themselves or their families.

References

Bundesregierung. (n.d.). *Federal and state governments adopt COVID-19 measures*. September 17, 2020, https://www.bundeskanzlerin.de/bkin-en/news/federal-state-resolution-1780654.

CDC (2020a, November 1). Centers for Disease Control and Prevention. *CDC COVID Data Tracker*. November 01, 2020, https://covid.cdc.gov/covid-data-tracker/

CDC (2020b, November 1). Centers for Disease Control and Prevention. *COVID-19 Forecasts: Cases*. November 01, 2020, https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/forecasts-cases.html

CHD (2020, November 1). City Health Dashboard. *City Health Dashboard.* November 01, 2020, https://www.cityhealthdashboard.com

Cucinotta, D., & Vanelli, M. (2020). WHO Declares COVID-19 a Pandemic. *Acta bio-medica : Atenei Parmensis*, *91*(1), 157–160. https://doi.org/10.23750/abm.v91i1.9397

Dempsey, J. (2020, March 24). *Why Merkel's Coronavirus Address Matters*. October 08, 2020, https://carnegieeurope.eu/2020/03/24/why-merkel-s-coronavirus-address-matters-pub-81357

Dube, R., & Córdoba, J. (2020, June 30). *Ecuador City Beat One of World's Worst Outbreaks of Covid-19*. WSJ. https://www.wsj.com/articles/ecuador-city-beat-one-of-worlds-worst-outbreaks-of-covid-19-11593532974

Ducharme, J. (2020, July 22). *These Maps Show How Drastically COVID-19 Risk Varies By Neighborhood*. Time. https://time.com/5870041/covid-19-neighborhood-risk/

DZIF (2020, October 08). Deutschen Zentrum für Infektionsforschung. *Bund fördert COVID-19-Impfstoffprojekt von DZIF und idt Biologika*. October 08, 2020, https://www.dzif.de/de/bund-foerdert-covid-19-impfstoffprojekt-von-dzif-und-idt-biologika

Gotev, G. (2020, June 10). *Germany relaxes restrictions on seasonal workers.* October 08, 2020, https://www.euractiv.com/section/economy-jobs/news/germany-relaxes-restrictions-on-seasonal-workers/

JHUSOM (2020, October 08). Johns Hopkins University School of Medicine. *COVID-19 Map.* October 08, 2020, https://coronavirus.jhu.edu/map.html

Karadağ, E. (2020). Increase in COVID-19 Cases and Case Fatality and Case Recovery Rates in Europe: A Cross Temporal Meta-Analysis. *Journal of Medical Virology*. https://doi.org/10.1002/jmv.26035

Kühnel, A. (2020, April 8). *Germany drafts Romanian farm labor for pandemic*. November 01, 2020, https://www.dw.com/en/germany-drafts-romanian-farm-labor-for-coronavirus-pandemic/a-53066735

Mantel, C., & Cherian, T. (2020). New immunization strategies: adapting to global challenges. *Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz*, *63*(1), 25-31. https://doi.org/10.1007/s00103-019-03066-x

Mutz, M. (2020). Forced adaptations of sporting behaviours during the Covid-19 pandemic and their effects on subjective well-being. *European Societies*, 1-15. https://doi.org/10.1080/14616696.2020.1821077

RKI. (n.d.). Robert Koch Institute. *Empfehlungen des Robert Koch-Instituts zur Meldung von Verdachtsfällen von COVID-19*. October 08, 2020, https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Empfehlung_Meldung.html

Schartau, P., & Kirby, M. (2020). Male mortality and the German response: lessons from COVID -19. *Trends in Urology & Men's Health*, *11*(3), 26–28. https://doi.org/10.1002/tre.752

Thurau, J. (2020, September 11). *Inside 'the heart' of Germany's coronavirus pandemic fight*. November 01, 2020, https://www.dw.com/en/germany-berlin-coronavirus-health-care-workers/a-54891323

USCB (2020, October 08). U.S. Census Bureau. *U.S. and World Population Clock.* October 08, 2020, https://www.census.gov/popclock/world

VDH (2020, November 1). Virginia Department of Health. *COVID-19 Data*. November 1, 2020, https://www.vdh.virginia.gov/coronavirus/

Wieler, L., Rexroth, U., & Gottschalk, R. (2020, June 30). *Emerging COVID-19 success story: Germany's strong enabling environment.* October 08, 2020, https://ourworldindata.org/covid-exemplar-germany

Yaylali, A. (2020). Factors Affecting the Number of COVID-19 Cases and the Death Rate: Empirical Evidence from the German States. *SSRN Electronic Journal*, 1–13. https://doi.org/10.2139/ssrn.3617986