

Investigating decision accountability and trustworthiness with dominance-based rough sets analysis. How fair were COVID19 restrictions?

Keywords: multi-criteria data analysis; dominance-based rough sets; covid-19; decision-trustworthiness; data-driven decision-making

Extended Abstract

Decision Support Systems have long looked to consider explainability, and its significance for tool adoption and trust, for those making decisions [1]. However, trustworthiness (and accountability) is also of high importance to those which decisions are impacting and/or made in the name of. It is of high importance to help distil the notion that decision making, such as in government, is too opaque [2].

During the covid-19 pandemic, several countries took a tiered approach to restrictions - making separate decisions to decide the level of restriction of movement to be imposed in different geographical areas - as opposed to a single country-wide decision for setting a restriction of movement policy. For example, towards the end of 2020 the UK government announced a tiered restriction system [3], where different geographic areas were assigned different tier levels between 1-4. Here, the higher the number the more severe the restrictions of movement. They proposed a set of five factors (criteria) to determine what level of restrictions (tier) should be imposed in each area. The set of five criteria, to determine which tier an area should be placed in were, (C1) covid-19 case detection rate in all age groups, (C2) covid-19 case detection in people aged 60 or above, (C3) how quickly covid-19 case rates were rising or falling, (C4) the ratio of positive covid-19 cases in the general population, (C5) pressure on the local healthcare service.

Although the tiered restriction system appeared to be a more sensible approach, than applying a nation-wide lockdown, many found it unsatisfactory, due to a lack of sufficient transparency. This impacted the trustworthiness, and fairness validity, in the allocation decisions. In this work, we explored the fairness of such allocation decisions by using the Dominance-based Rough Set Approach (DRSA) [4], a well-known method for multi-criteria classification used to extract understandable IF-THEN decision rules from analysing historical data. DRSA is invariably utilised to create a single set of decision rules from a (single) dataset, to then analyse for insights and future predictions. In this work we instead utilise separate data segments, pertaining to covid data for separate geographical areas, to create a separate DRSA rule set for each data segment. Then, we compared our separate rule sets in terms of their consistency and fairness.

For covid data pertaining to the set of 5 criteria, when two areas have similar data statistics, to be consistent, we should expect to also see similar tier allocations. That is, given a similar severity of covid-19 in an area (with respect to the 5 criteria) we should expect a similar level of restriction of movements to be applied. Identification of inconsistencies between different geographical areas may suggest unfairness and imbalance, hindering the trustworthiness of such a system. To make comparisons between different rule sets we identified where separate rule sets shared a rule, that related to the same set of 1 or more criteria, and resulted in the same tier level outcome. For such matches we could then compare the criteria values.

To explore the consistency between separate DRSA rule sets, created from separate data segments, we utilised different government and open-source data sources and APIs. From this we curated and wrangled a dataset concerning the values of the five criteria, and the assigned

tier values, for different geographical areas of England, for each day that the tiers system was in place. We plan to make this dataset available via a public GitHub repository.

Through comparisons of the different rule sets extracted, from different geographical areas, we found inconsistencies in the allocation of tiers. We found that the differences delineated an overall trend of inconsistency between the north and the south in England. The inconsistencies suggested that the south of England was treated more leniently in terms of how severe its restrictions were. When we drilled down further, the inconsistencies suggested that the divide was driven mostly by London, suggesting that London was treated more leniently than the rest of the country.

Figure 1 shows some of our comparison findings between rule sets, here comparing rules found from three separate data segments, namely 1) the north of England, 2) the south of England sans London, and 3) London. Only rules that were present in at least two of these segments are shown (so only where comparisons can be made). The x-axis denotes the 1 or more criteria in each rule, and the 3 facet titles shown which “at least tier” level resulted. The plot shows London was able to remain in less restriction of movement levels despite having larger criteria values than the north and/or the south. For example, London remained in Tier 2 despite having larger numbers of covid-19 cases (C1) than the north. Similarly, London remained in Tier 2 despite having much larger numbers of covid-19 cases in the over 60s (C2) than the south sans London. Inequalities between the north and south of England has been termed the North-South divide denoting socioeconomic differences between southern and northern England [5]. Whether the disparities are driven solely by government decision making is a provocative issue.

Our analysis demonstrates the usefulness of the DRSA for investigating decision making fairness, looking to reduce the notion that decision making is too opaque for those which decisions are impacting and/or are made in the name of. Such analysis can aid accountability of, and trustworthiness in, such decisions. In exploring this for the domain of covid-19, disparities between the consistency of restrictions of movement decisions were identified. Consistency within such decision making is vital to maintain trust in the fairness of the system, and to ensure societal cohesion. Perceptions that there is too high a disparity could lead to a breakdown of trust. This in turn could lead to non-conformity to restriction of movement rules, jeopardizing the whole tiered allocation system. Future work will further explore comparing the consistency between different DRSA rule sets within other domains, and the creation of an interactive online decision support tool for interactive rule sets comparisons.

References

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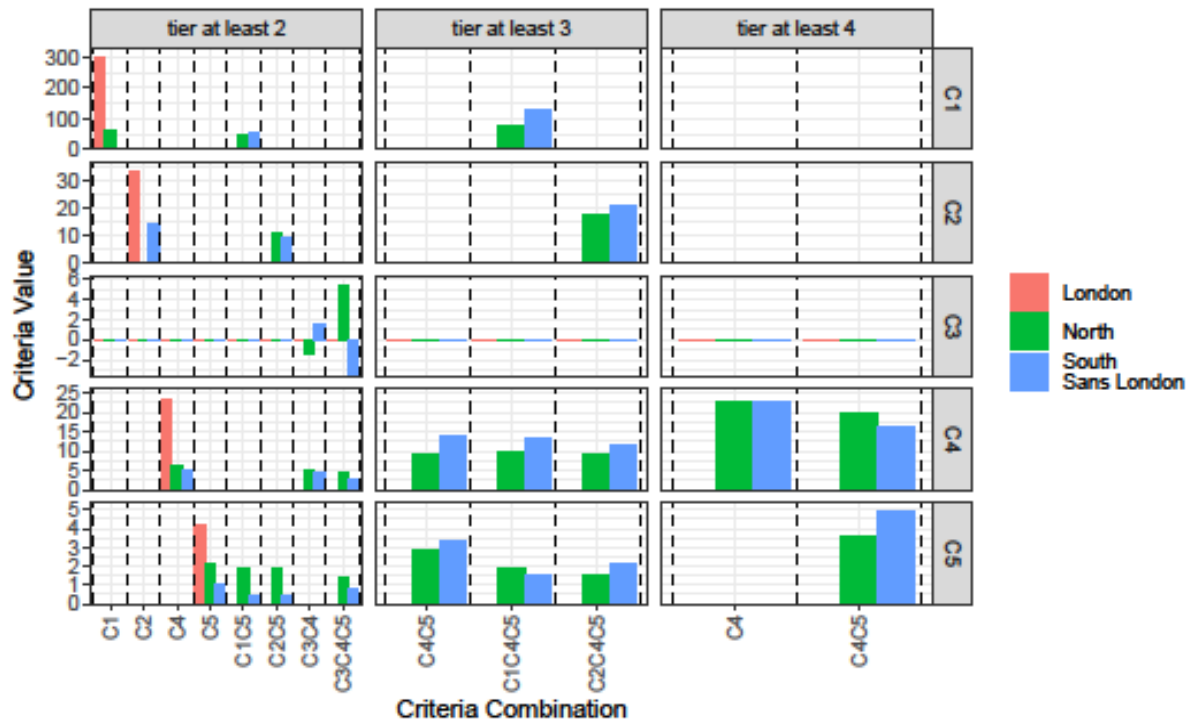


Figure 1. Comparison of DRSA rule sets, for "at least" rule types, comparing London, the North of England, and the South of England sans London.