

## **Dissertation title**

Machine learning classification and spatial analysis of planning data in Scotland in support of the monitoring of the housing policies of the National Planning Framework.

## **Literature review**

The literature in this area is disparate, although the research and use of machine learning (ML) and artificial intelligence (AI) in urban planning is growing and converging. From a technical perspective, Tekouabou et al (2021) have considered the application of machine learning methods in urban planning, with a useful taxonomy of methods, models and indicators. However, this does not cover NLP in detail, although it is mentioned in the context of neural networks. Likewise, Chaturvedi and de Vries (2021) provide a good overview of the technical applications, but largely in the context of earth observational data, albeit with a good breakdown of land use indicators, data sources, measurements and applications. Nevertheless, there is a comprehensive overview of ML and AI methods and applications that provides a useful baseline for methodological and model development and a recent overview of the use of machine learning for spatial analyses is also offered by Casali, Aydin and Comes (2022), drawing upon Google Scholar and the Web of Science with a focus upon 2021, identifying the most prominent topics and uses and also knowledge gaps in the sector.

NLP needs to be considered as a detailed subset of ML and AI for a more granular trawl of the literature. Recent research by Mieczko and Desmond (2023) considers the use of NLP in a national zoning and land use database from publicly available administrative data in the United States. Fu, Li and Zhai (2023) have also looked at NLP in the study of resilience plans from the 100 Resilience Cities network, with useful coverage of topic modelling. Brinkley and Stahmer (2021) have looked in more geographical detail at city planning in California. A systematic review of NLP for urban research is also provided by Cai (2021) highlighting a limited use of NLP in urban studies, albeit growing in use in recent years, with a comprehensive survey of literature and geographical areas of study.

Research in the UK is more limited but there are examples from the UK government. Dray (2019) has considered the use of NLP in government and there is a report by the Turing Institute (2021) researching the use of AI and ML in automating planning applications, which does not consider NLP in detail other than in data cleaning, but does look at the application of AI and ML techniques in the context of the English planning development management system, which is essentially the same as in Scotland.

From the perspective of planning in Scotland, there is no literature pertaining to the use of AI and ML in the planning system as it stands. Information is available on planning performance statistics and there is research into areas of policy, such as housing land, which is the focus of this paper. Planning performance statistical data is collected regularly and published annually by the Scottish Government. The most recent statistics (2021/22) provide a categorisation of application and development types which, aligned with the topic modelling and UK-specific research mentioned earlier, provides the elements of a taxonomy for NLP and categorisation. The recently-published NPF4 (2023) is the overarching land use policy document for Scotland and is accompanied by a more detailed explanatory report on the draft housing land requirement for Scotland. The area of housing land demand and supply is subject to change at the moment, given recent legislative and regulatory changes, but a review is provided by Ryden (2019) with a focus on the effective delivery of housing land and the role of associated audits. The Scottish Land Commission (2021) has also reviewed the operation of the housing land market more recently, from a public interest perspective. The significance of housing land supply as a policy area is also supported by one-off studies, such as the 50,000 affordable housing

requirement for Scotland, highlighted by Inside Housing in 2022 but with preceding mapping research by the Scottish Government dating from 2017 (Bragg et al) which provides a good case study of the use of housing and planning data in a policy monitoring context, in terms of potential demand.

Finally, the above research is largely exploratory, demonstrative or occasional, rather than operational. A systemic example of NLP in a production environment is provided by work by NatureScot (2021) reported on the UK Authority website (2022) that illustrate the progress of the InformedDecision platform. This provides for a further case study in terms of potential capability.

## References:

### Papers

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