

An Ensemble Based Approach to Population Prediction

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BSc Applied Computing

1. Introduction

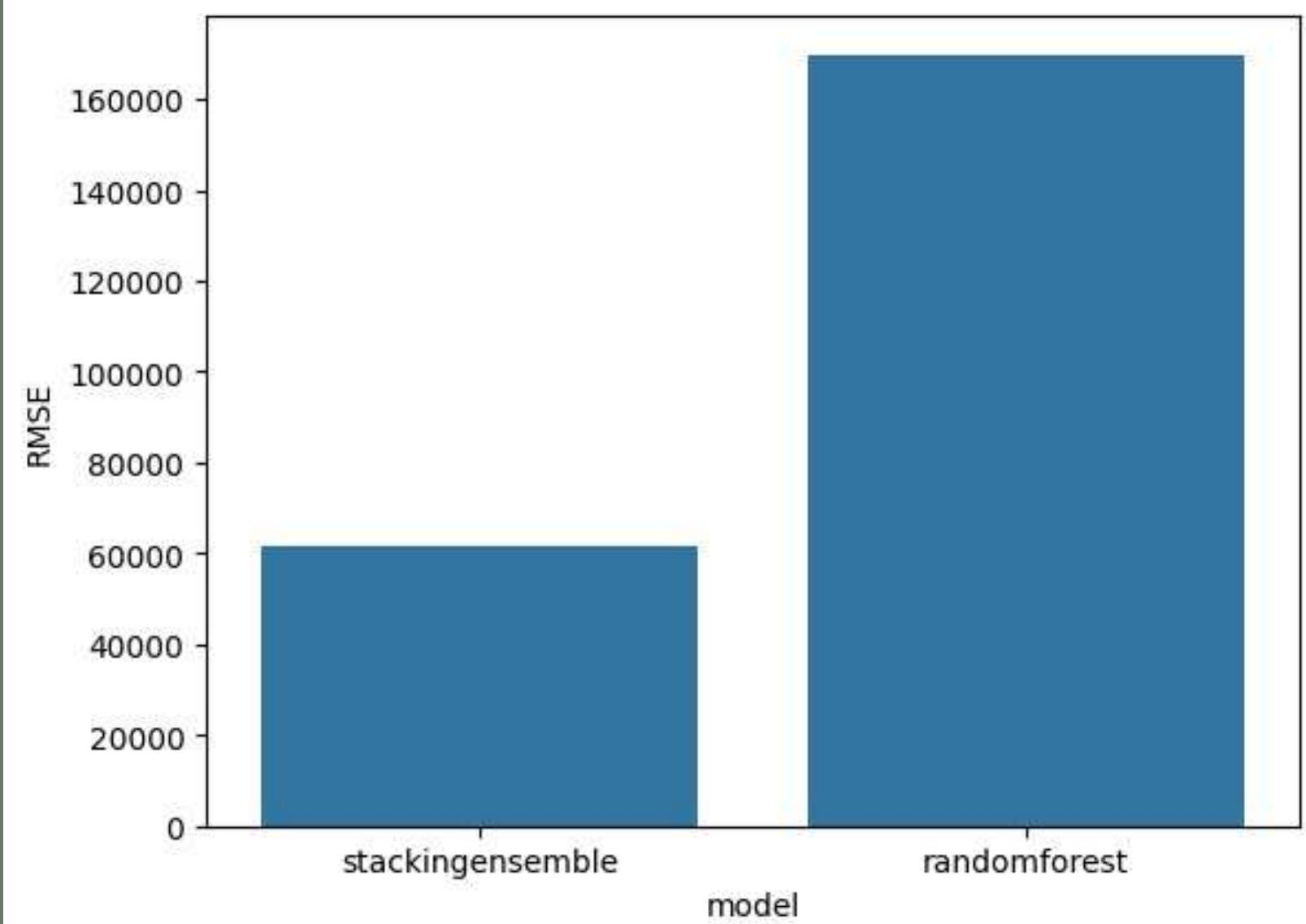
The most recent data from the Welsh government that showed population projections by local authority were based on 2022’s population estimate.

The Office for National Statistics (ONS) in a report said that they are planning to release a 2022 based projection on local authorities in England only

8. Conclusion

Overall, the stacking ensemble outperformed the random forest on all metrics including computation time. In the Wales population forecast, there were large differences between the predictions of the stacking ensemble and the random forest, with the random forest predicting a significant change in population for Blaenau Gwent.

2024-01-01	67474.158215	2024-01-01	121333.0
2025-01-01	67541.792829	2025-01-01	175310.0
2026-01-01	67383.351274	2026-01-01	229287.0
2027-01-01	67066.062497	2027-01-01	283264.0
2028-01-01	66757.042317	2028-01-01	337241.0
2029-01-01	66080.868388	2029-01-01	391218.0
2030-01-01	65688.200901	2030-01-01	445195.0
2031-01-01	65111.685965	2031-01-01	499172.0
2032-01-01	64735.245893	2032-01-01	553149.0
2033-01-01	64506.118842	2033-01-01	607126.0



2. Aim and Objectives

The aim of the project is to create a forecast of the Welsh population by local authority using an ensemble approach.

Objectives:

- 1)To develop a heterogeneous and homogeneous ensemble model for predicting population
- 2)To evaluate and compare the performance of the developed models using well known evaluation metrics
- 3)To integrate the prediction data and ensemble models into a web application

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Partial Forecast

Full Forecast

set number of lags

1

set number of predictions

20

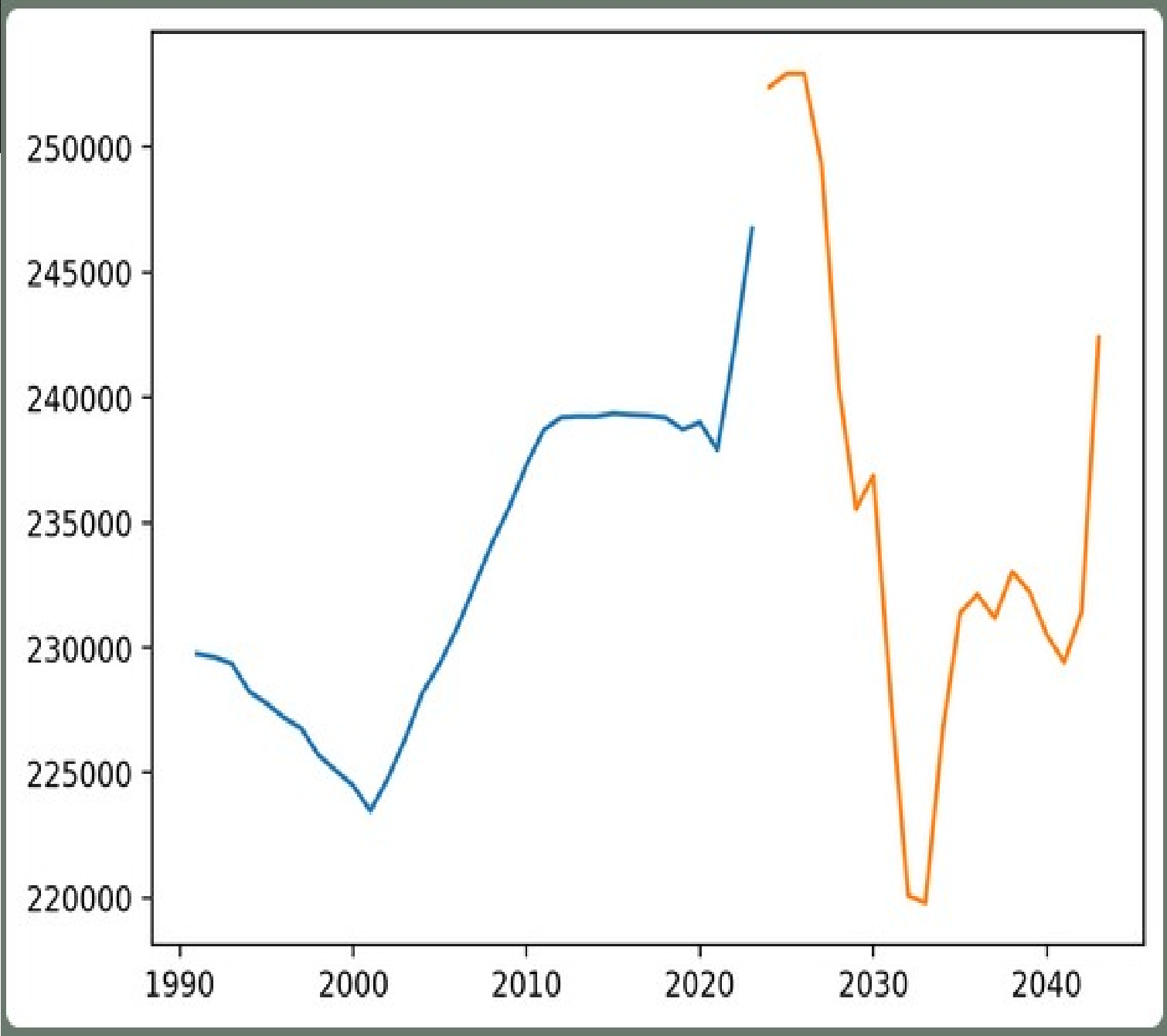
pick a local authority

Swansea

choose model

Stacking Ensemble

fit and predict



3. Methods

- Transposition, imputation, re-indexing were done on the training data to turn into a time series dataset
- Transposition was also done on the testing data
- The model’s parameter were optimised using an iterative function
- After training the models were exported and then imported into a web app
- The imported models were integrated into a forecasting function, which makes it able to make forecasts

7. Results

4. Tools

- Python (Streamlit, Scikit-learn, Matplotlib, Seaborn etc.)
- Microsoft Excel

5. Training Data

- Population estimates of regions in Australia, Denmark, Sweden and The Netherlands between 1942-2024 were used to train the algorithms

6. Testing Data

- Welsh region population estimates between 1991-2023 were used for forecasting

References

- [1] Welsh Government and Office for National Statistics. 2022-based population projections by local authority, age, sex, year and variant. Available: <https://stats.gov.wales/en-GB/036507d7-6671-4885-b2b4-af7f01e9ed5b#data>.
- [2] Office for National Statistics. (January). National population projections: 2022-based. Available: <https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2022based>.
- [3] Welsh Government. (July). Population estimates by local authority and year. Available: <https://statswales.gov.wales/Catalogue/Population-and-Migration/Population/Estimates/Local-Authority/populationestimates-by-localauthority-year>.

SPFX-Web

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Partial Forecast

Full Forecast

Testing Data

Date	Blaenau Gwent	Bridgend	Caerphilly	Cardiff	Carmarthenshire	Ceredigion	Conwy
1991-01-01 00:00:00	72666	129477	170615	296941	169725	65933	107951
1992-01-01 00:00:00	72592	129796	170129	297429	169265	67536	107782
1993-01-01 00:00:00	72521	130129	170243	299185	169255	68854	108142
1994-01-01 00:00:00	72770	130063	169559	299085	169962	69937	108891
1995-01-01 00:00:00	72569	129466	168186	300764	171060	70818	108940
1996-01-01 00:00:00	72289	128667	167385	305345	171145	70609	107897
1997-01-01 00:00:00	72031	127996	167532	307321	171534	71807	108174
1998-01-01 00:00:00	71292	128652	167921	308601	172039	72518	108470
1999-01-01 00:00:00	71028	128585	168566	310320	172329	74046	108322
2000-01-01 00:00:00	70537	128224	169045	311443	172874	74942	108651

Pick local authority

Blaenau Gwent

80,000

70,000

60,000

50,000

40,000

30,000

20,000

10,000

0

1992

1994

1996

1998

2000

2002

2004

2006

2008

2010

2012

2014

2016

2018

2020

2022