Non-intrusive occupancy detection in smart buildings

A data-driven modelling approach

Semester Project
End Presentation

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Motivation

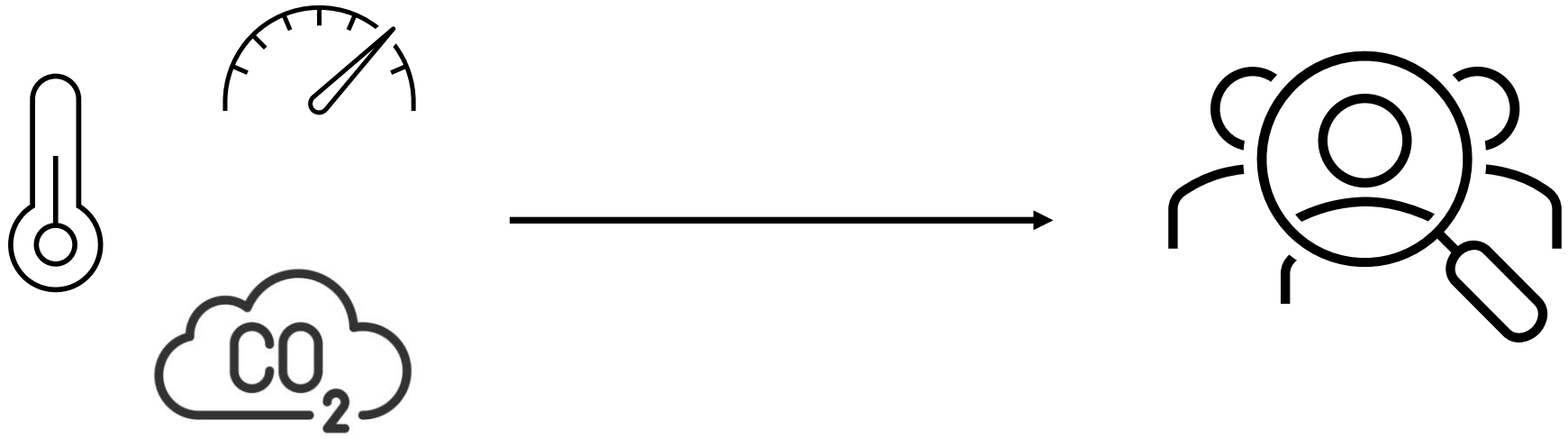
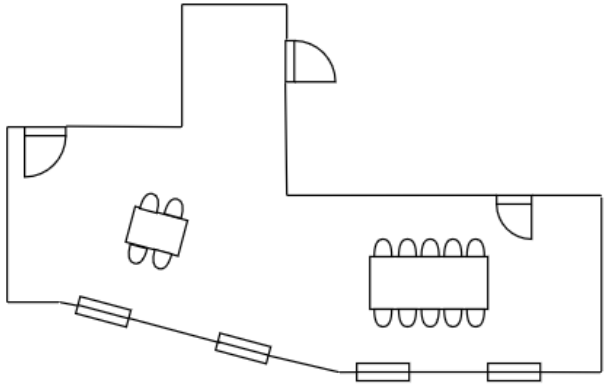
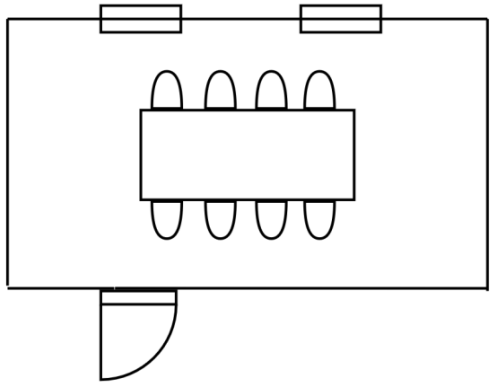


Table of Contents

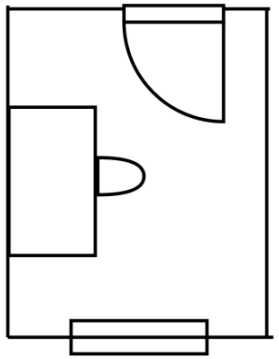
Goal: Different Domains



Room A
Big Open Workspace
3 Doors
4 Windows
70 Sensors



Room B
Small Meeting Room
1 Door
2 Windows
20 Sensors

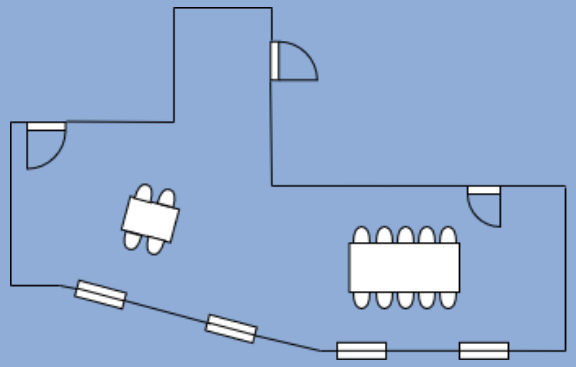


Room C
Small Office
1 Door
1 Window
9 Sensors

Goal: Data-driven Model for non-intrusive occupancy detection

State of Room
Non-intrusive Sensors

- CO2
- Ventilation Flow
- Temperature
- Relative Humidity
- VOC



Black-Box Model

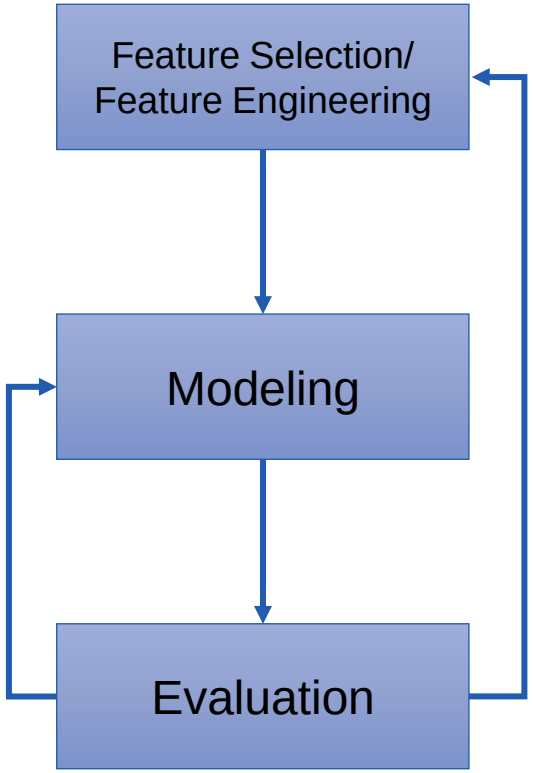
White-Box Model
(from external partner)

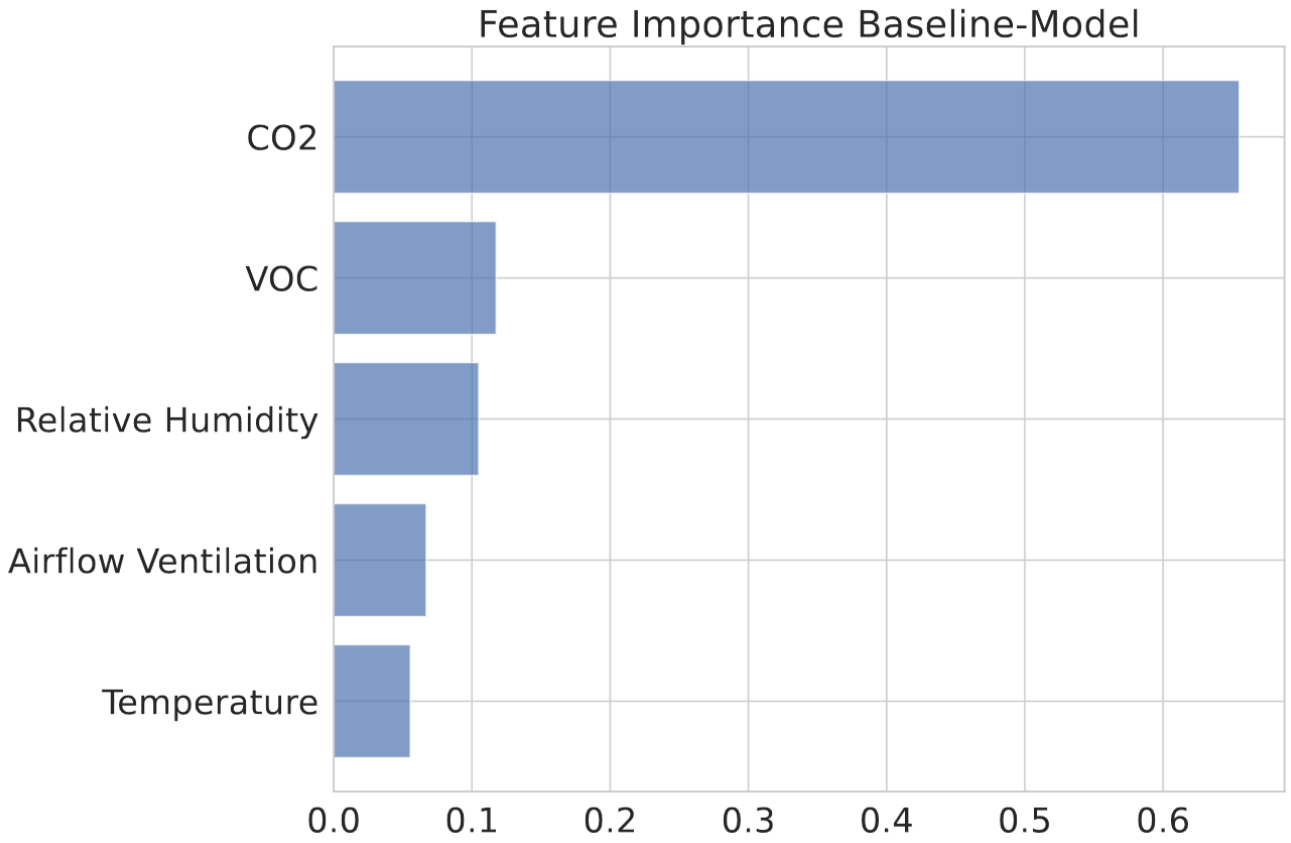
Estimated Number of People

comparison

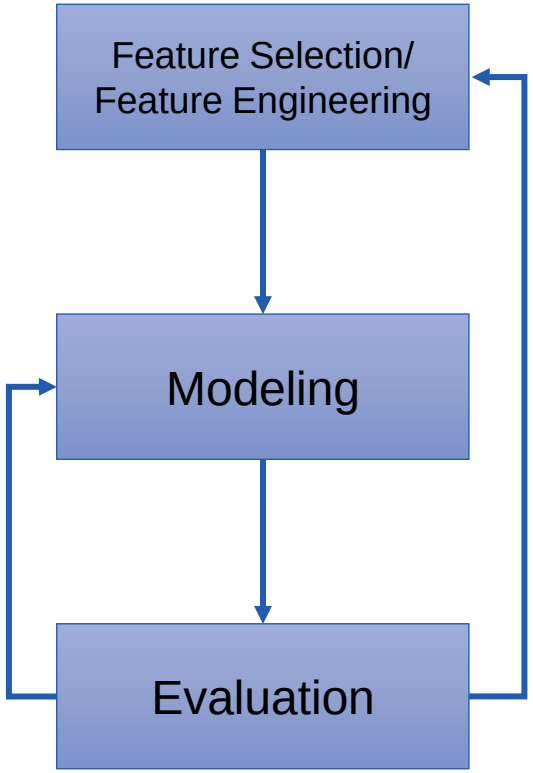
Estimated Number of People

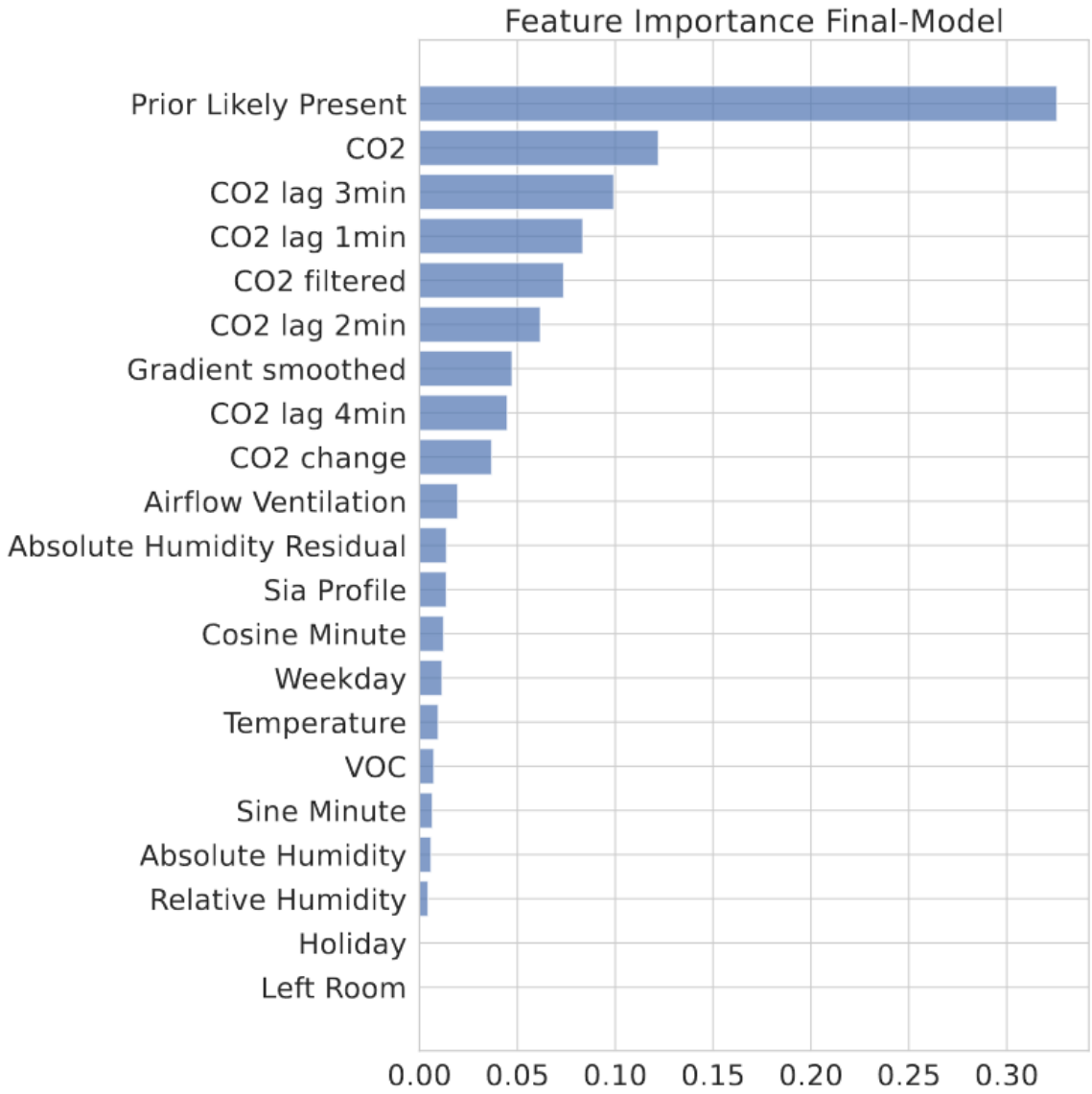
Developement





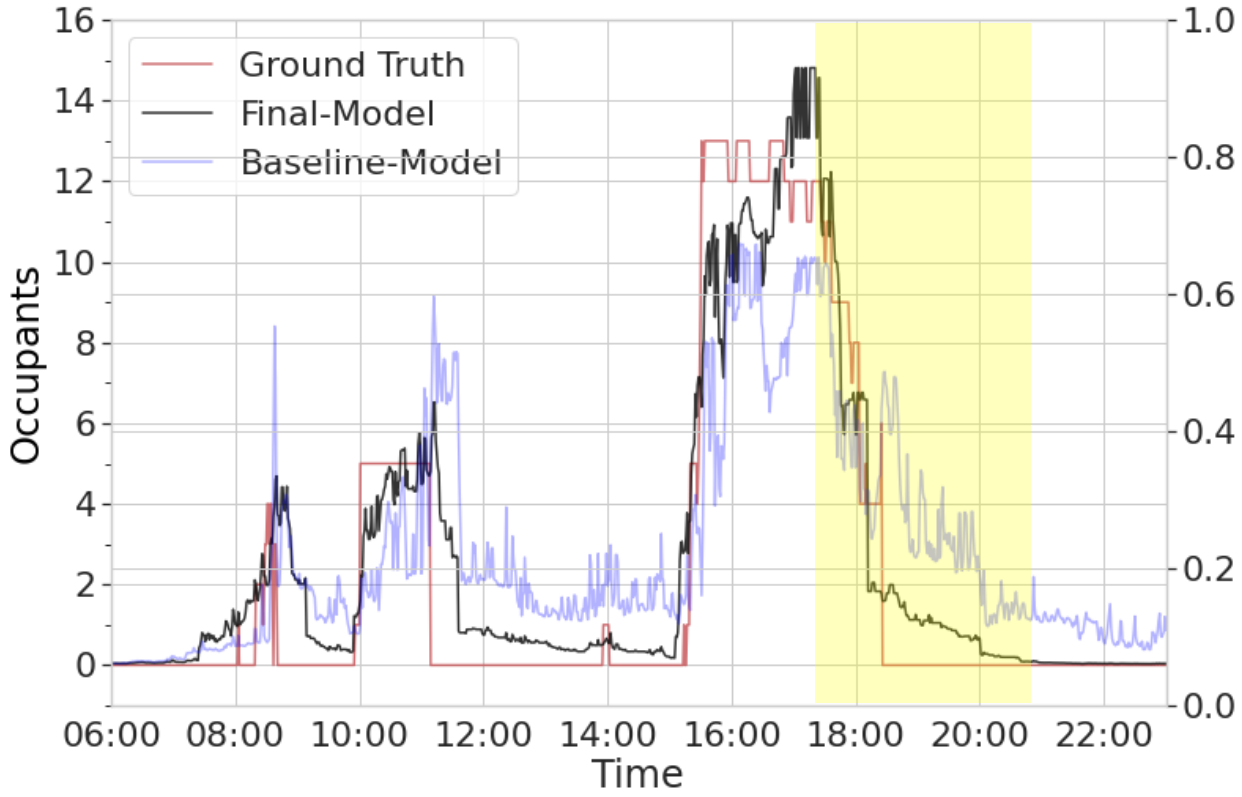
Developement



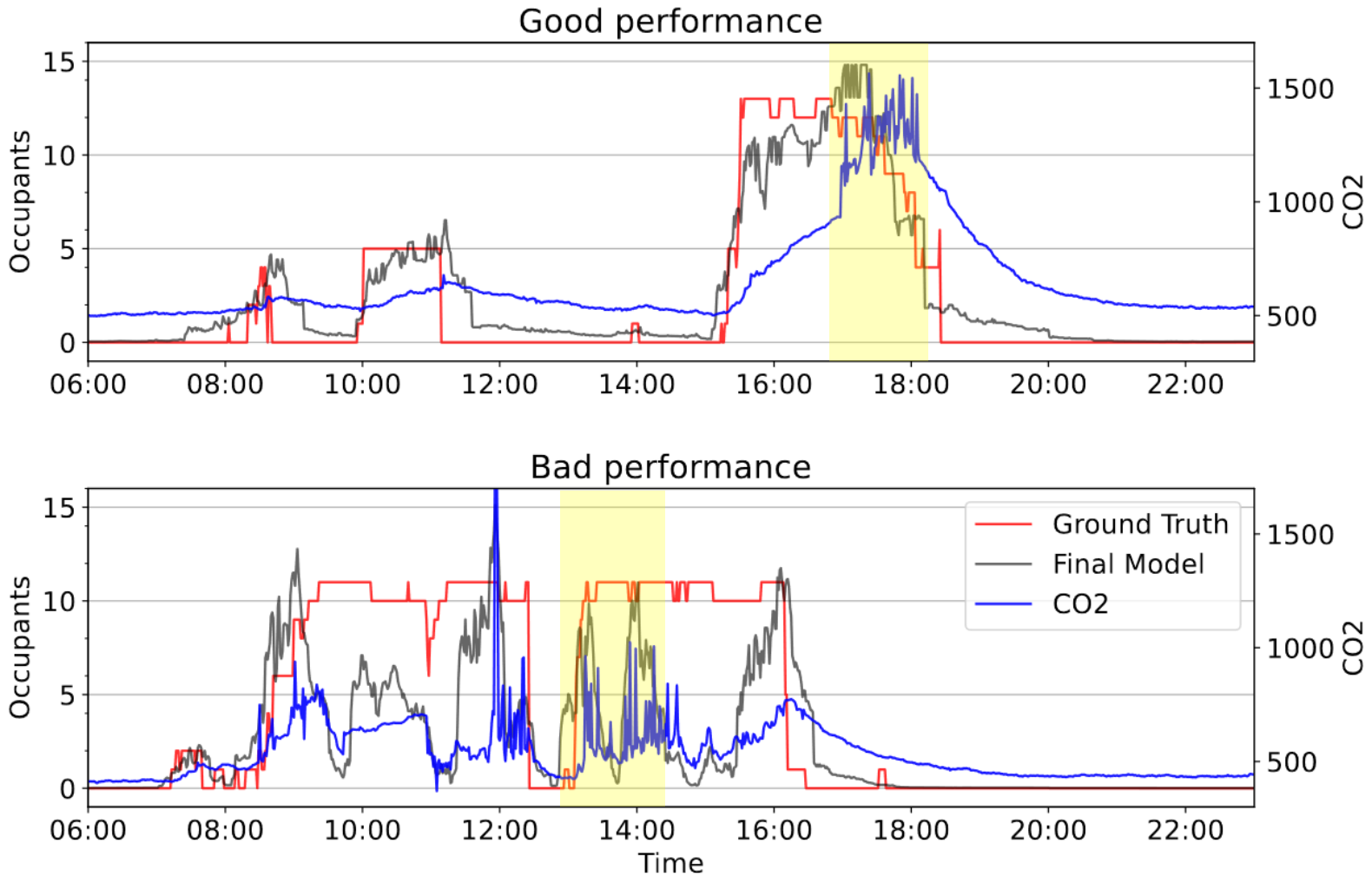


Performance Results

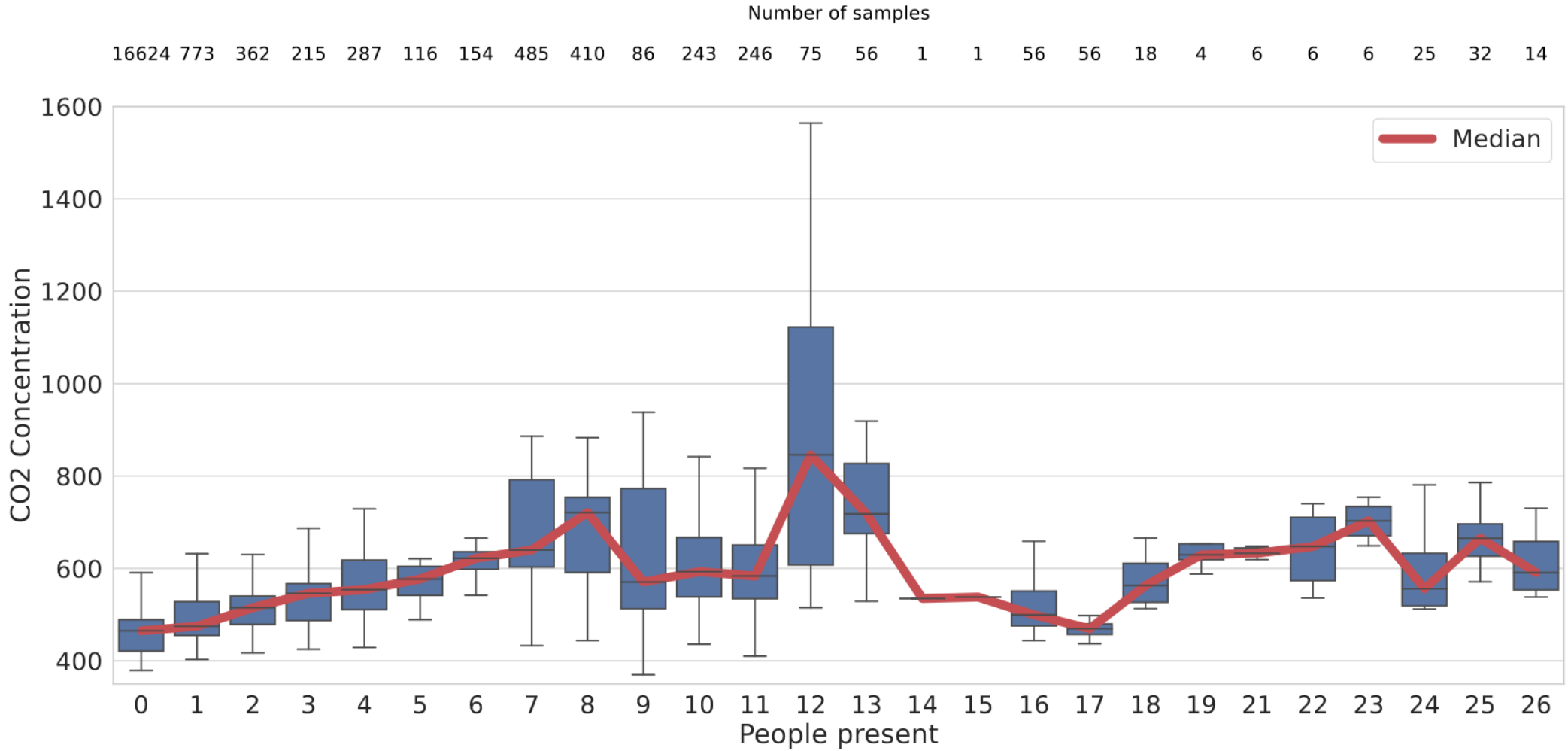
	White Box	Baseline Model	Final Model
R2	0.26	0.31	0.39
MAE	1.48	1.10	0.81
RMSE	2.78	2.67	2.52



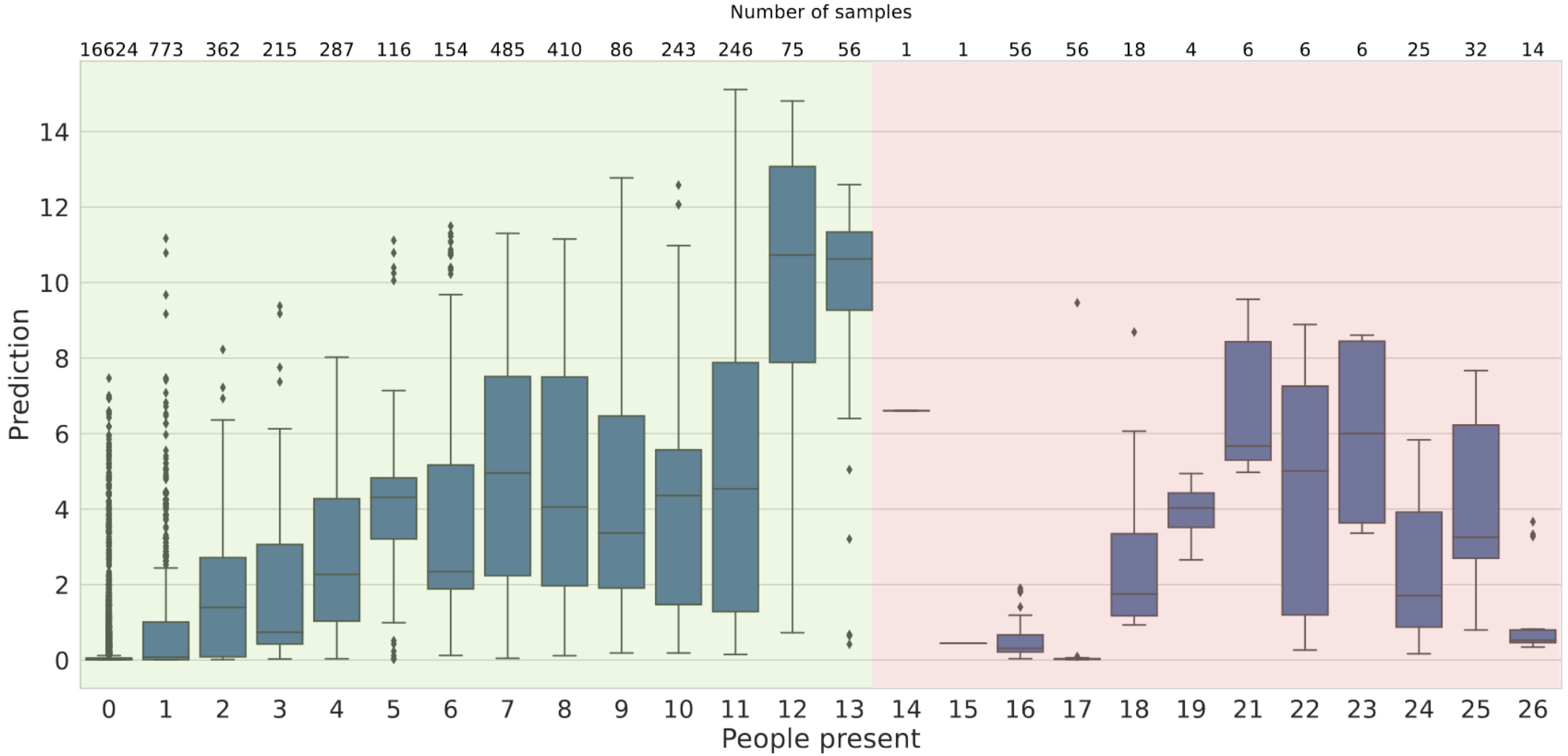
Prediction Quality



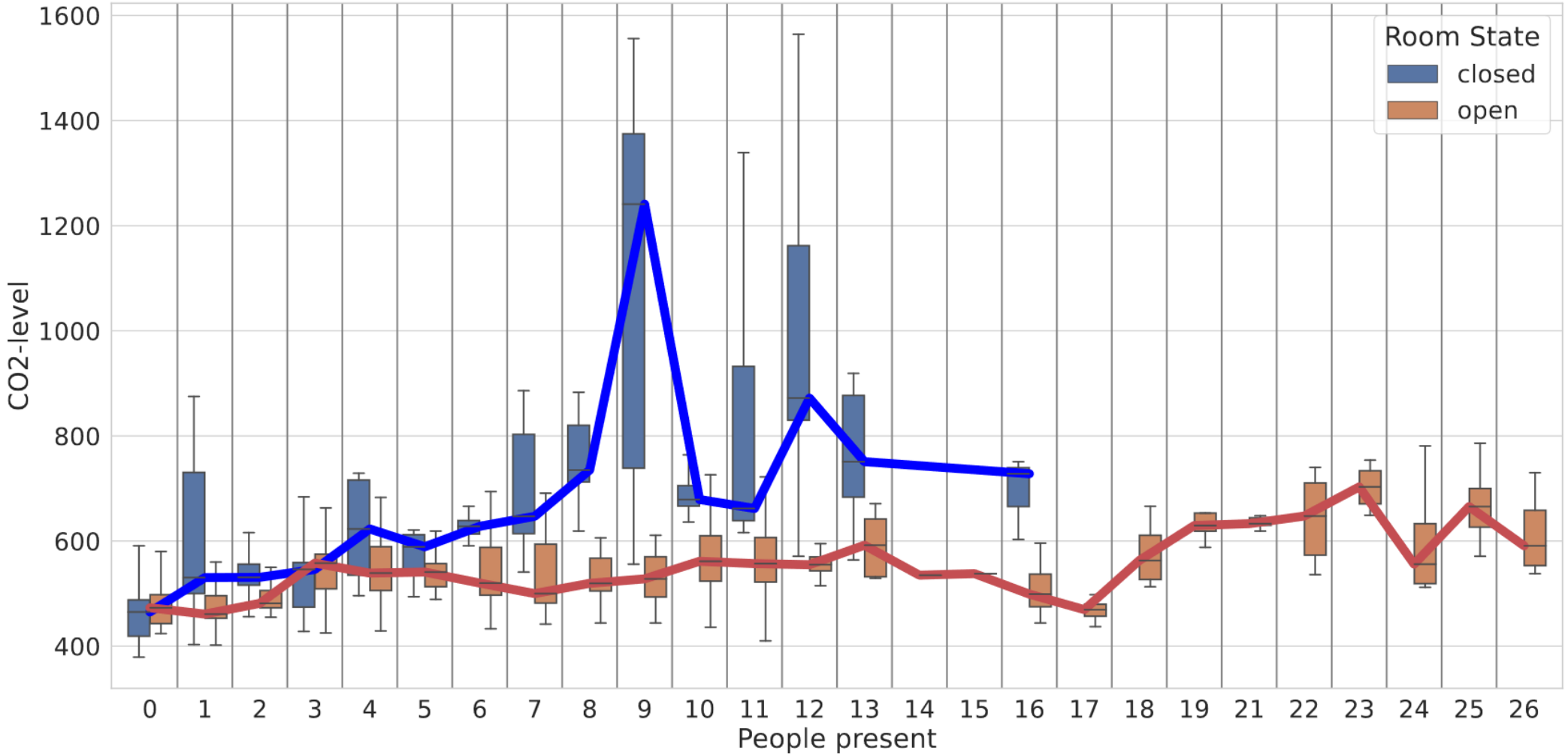
CO2 dependency



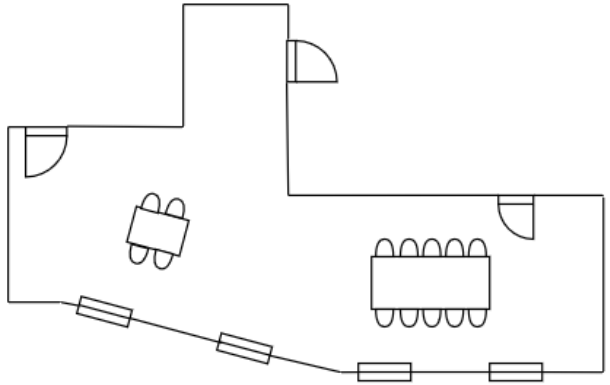
Distribution of Predicitons



Open or Closed System

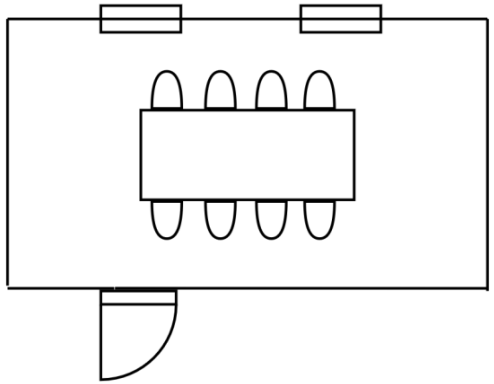


Different Domains



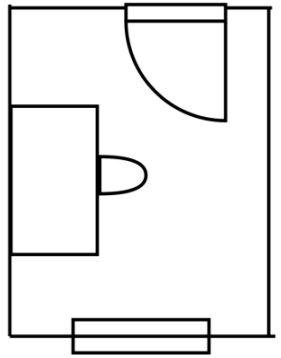
Room A
Big Open Workspace
3 Doors
4 Windows
70 Sensors

Model A



Room B
Small Meeting Room
1 Door
2 Windows
20 Sensors

Model B



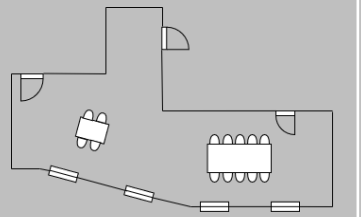
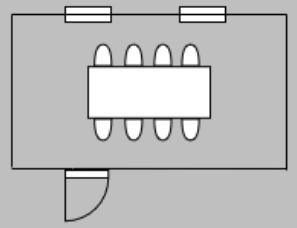
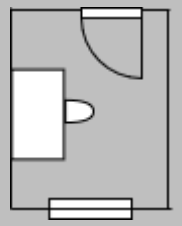
Room C
Small Office
1 Door
1 Window
9 Sensors

Model C

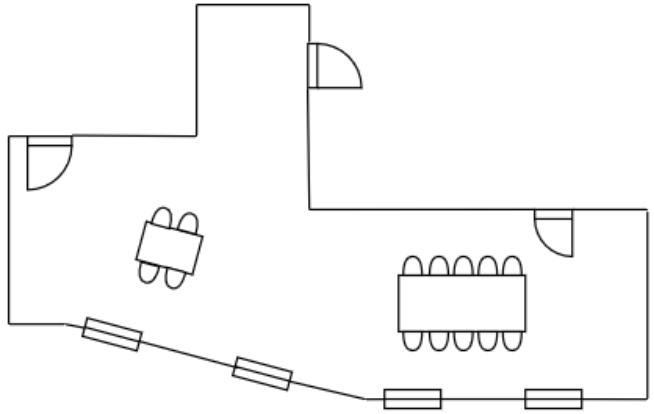
Model evaluated on different Rooms

$$R^2 = 1 - \frac{RSS}{TSS}$$

$RSS = sum\ of\ squares\ of\ residuals$
$TSS = Total\ sum\ of\ squares$

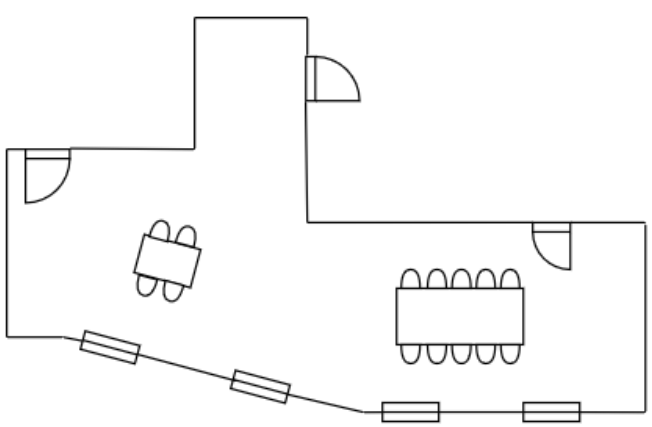
	Room A	Room B	Room C
			
Model A	0.36	0.57	-196.12
Model B	0.22	0.62	-128.68
Model C	-0.09	-0.16	0.52

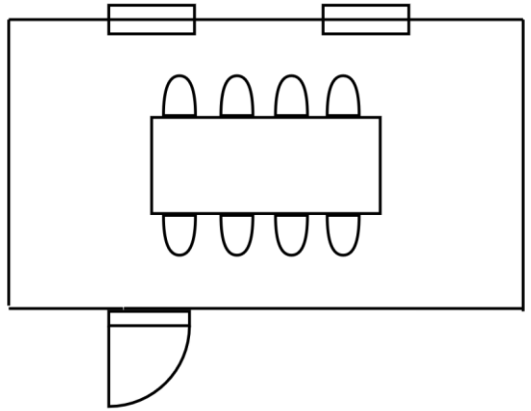
Conclusion and Outlook

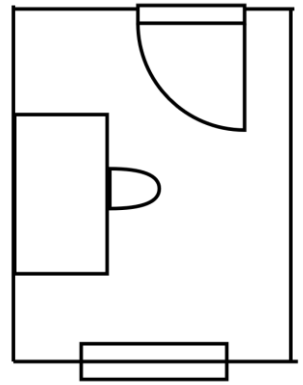


Model

Conclusion and Outlook



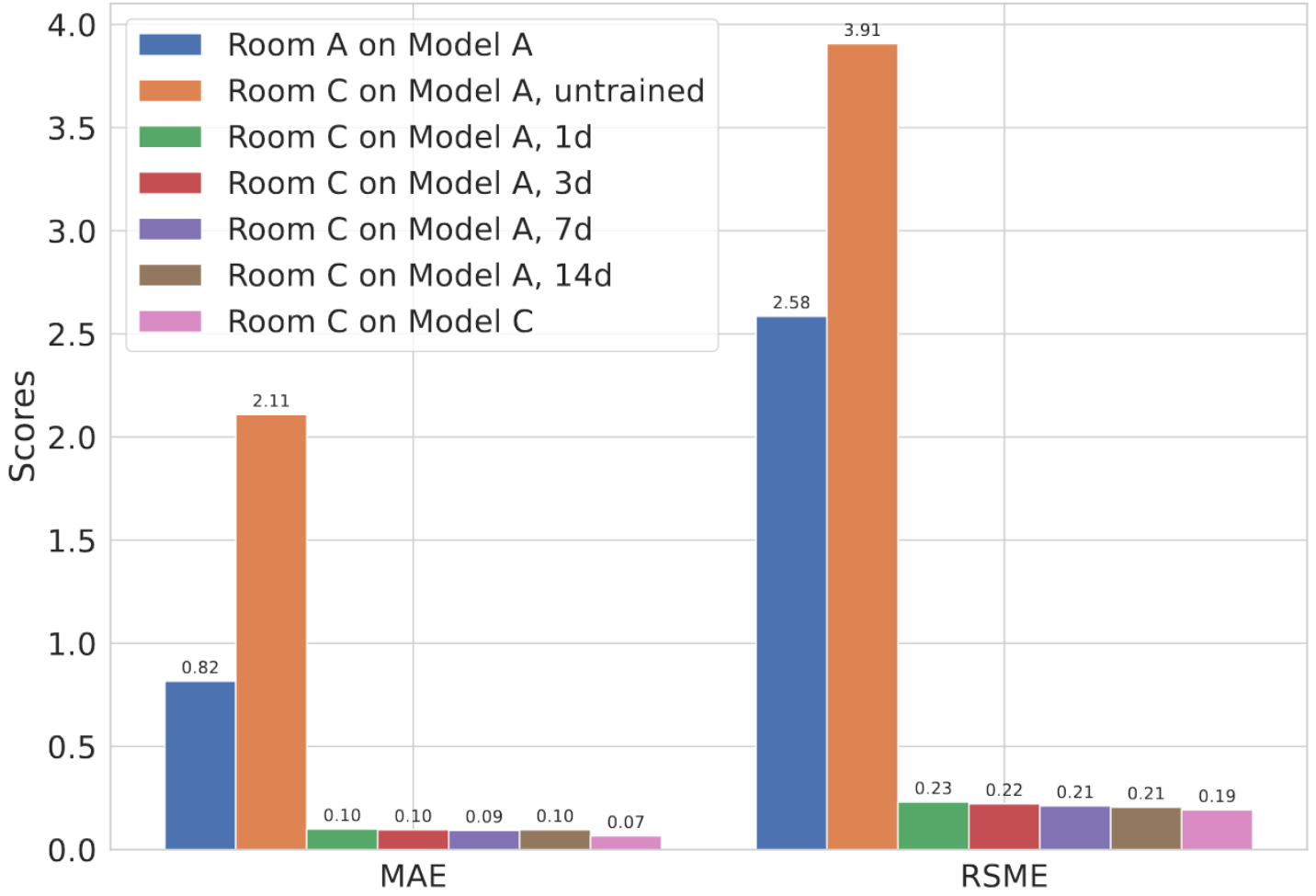




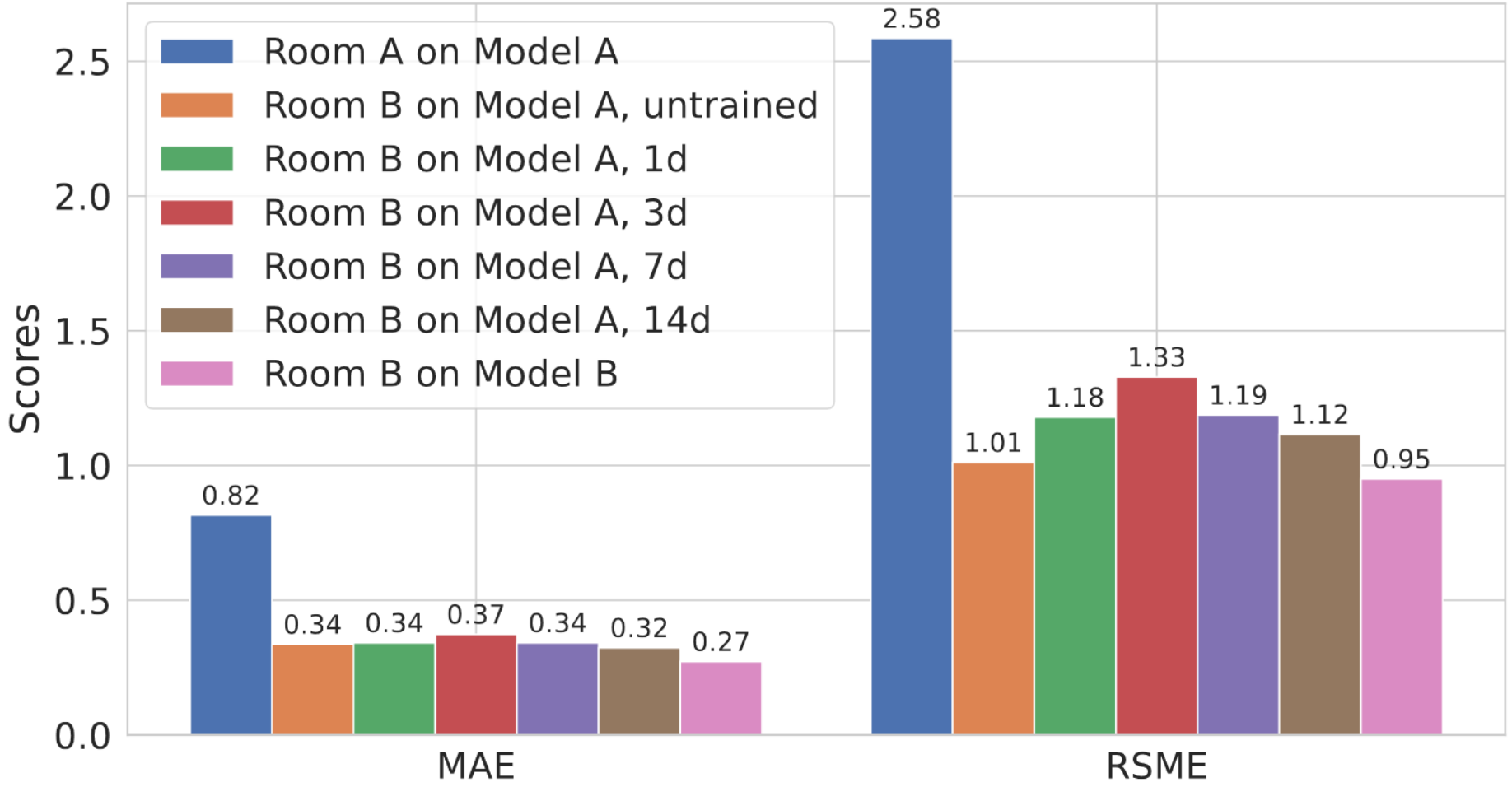
Domain-adapted Model

Appendix

Adaption to other rooms



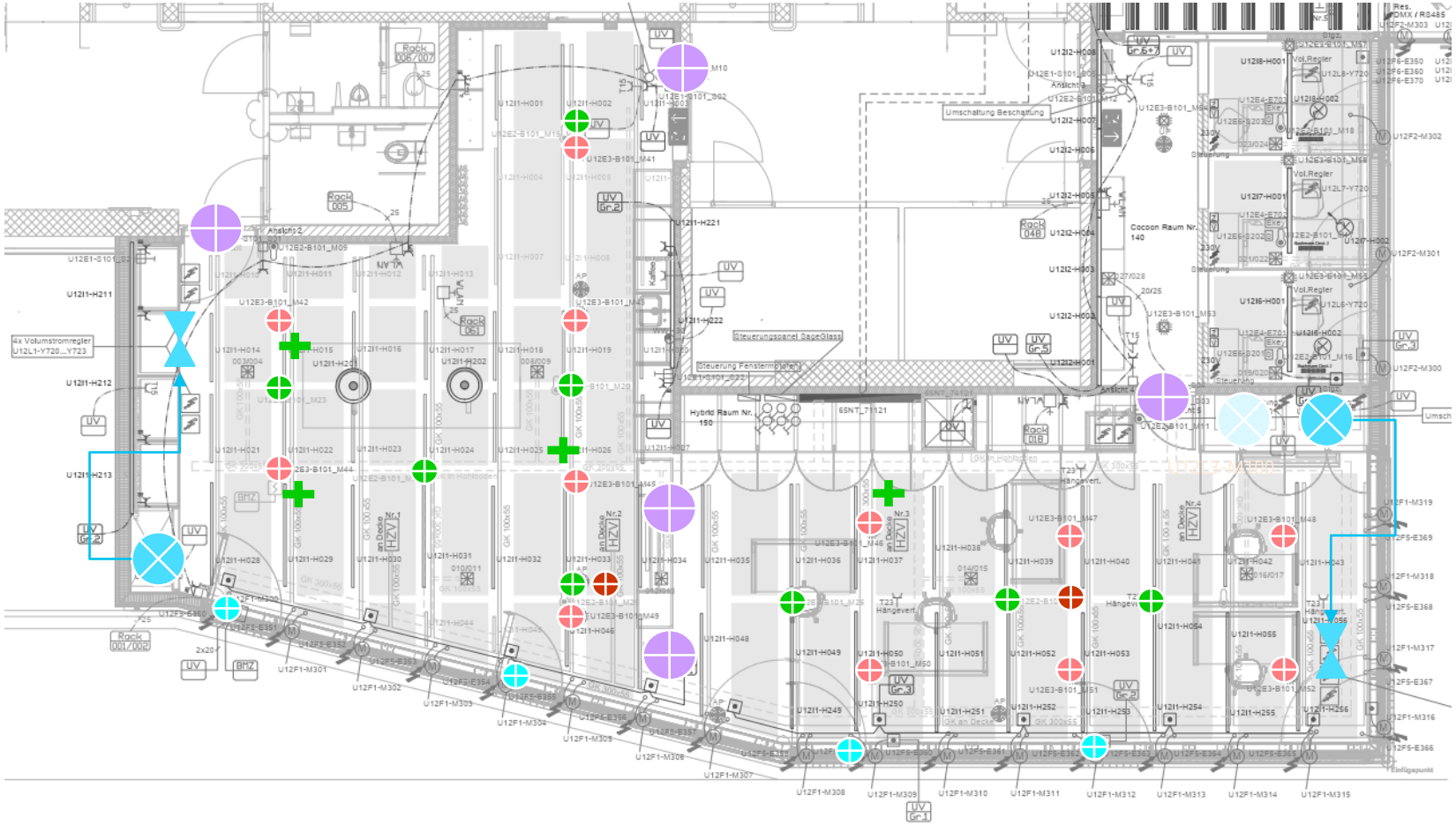
Adaption to other rooms



Model on different Rooms

	Room A		Room B		Room C	
	R^2	RMSE	R^2	RMSE	R^2	RMSE
Model A	0.36	2.58	0.57	1.01	-196.12	3.91
Model B	0.22	2.85	0.62	0.95	-128.68	3.17
Model C	-0.09	3.38	-0.16	1.55	0.52	0.19

Testbed at NEST in Dübendorf



- Window open/close
- People Count (Camera)
- Ceiling embedded
  Temperature, Humidity, CO2, ...
- Mobile
  Temperature, Humidity, CO2, …
- Ventilation Valve
- Presence
- Ventilation
- Presence/Light