Brainteaser

CLEF 2023

Notebook for the iDPP Lab on Intelligent Disease Progression Prediction

Baseline Machine Learning Approaches to Predict Multiple Sclerosis Disease Progression

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iDPP@CLEF 2023 – Aims and methods

Task 1
Predict risk of **disease worsening** in MS

Task 2
Predict **cumulative probability of worsening** in MS

Disease worsening is defined in two ways for as many sub-tasks

Sub-task a
The patient **crosses the threshold EDSS ≥ 3** at least twice within a one-year interval

Sub-task b
EDSS worsening with respect to the first recorded value according to current **clinical practice guidelines**

iDPP@CLEF 2023 – Aims and methods

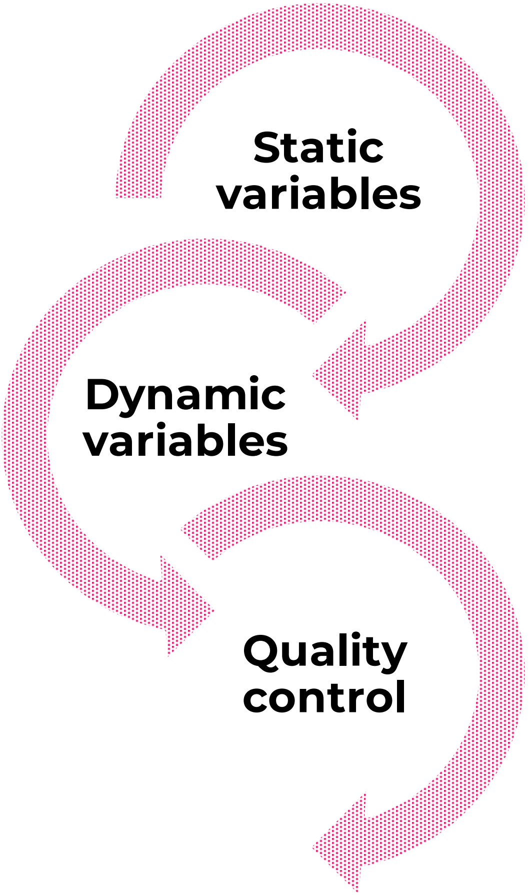
SURVIVAL ANALYSIS
(model time-to-event)

- ▷ Cox proportional-hazards model (Cox)
- ▷ Survival Support Vector Machines (SSVM)
- ▷ Random Survival Forest (RSF)

Outline

- ▷ **Preprocessing**
- ▷ **Model development framework**
- ▷ **Outcomes**
  - Models' outcome
  - Task 1 outcome
  - Task 2 outcome
- ▷ **Results**
  - Task 1 results
  - Task 2 results
- ▷ **Conclusion**

Preprocessing

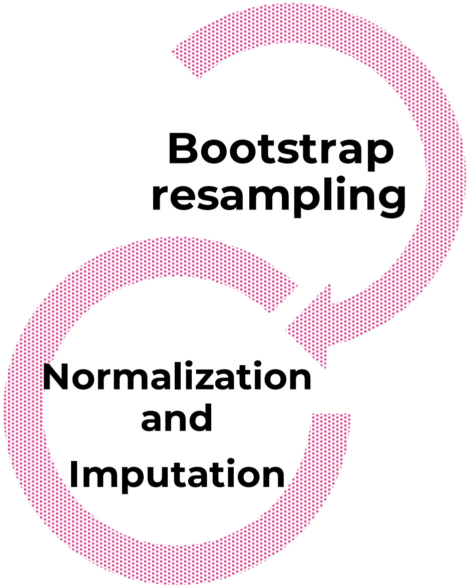


- ▷ ***Sex*** and ***centre*** mapped to binary variables
- ▷ **Residence** mapped to two dummy variables
- ▷ Only **Caucasian** subjects considered

- ▷ **EDSS:** min, max, first, and last values considered
- ▷ **Evoked potentials:** auditory, somatosensory, and visual
- ▷ **MRI measurements:** T1 gadolinium and T2 lesions for different anatomical regions, binary variables denoting presence or absence and numeric variable for maximum number of lesions

- ▷ All **variables** with more than **70%** missing removed
- ▷ No **subject** with more than **20%** missing

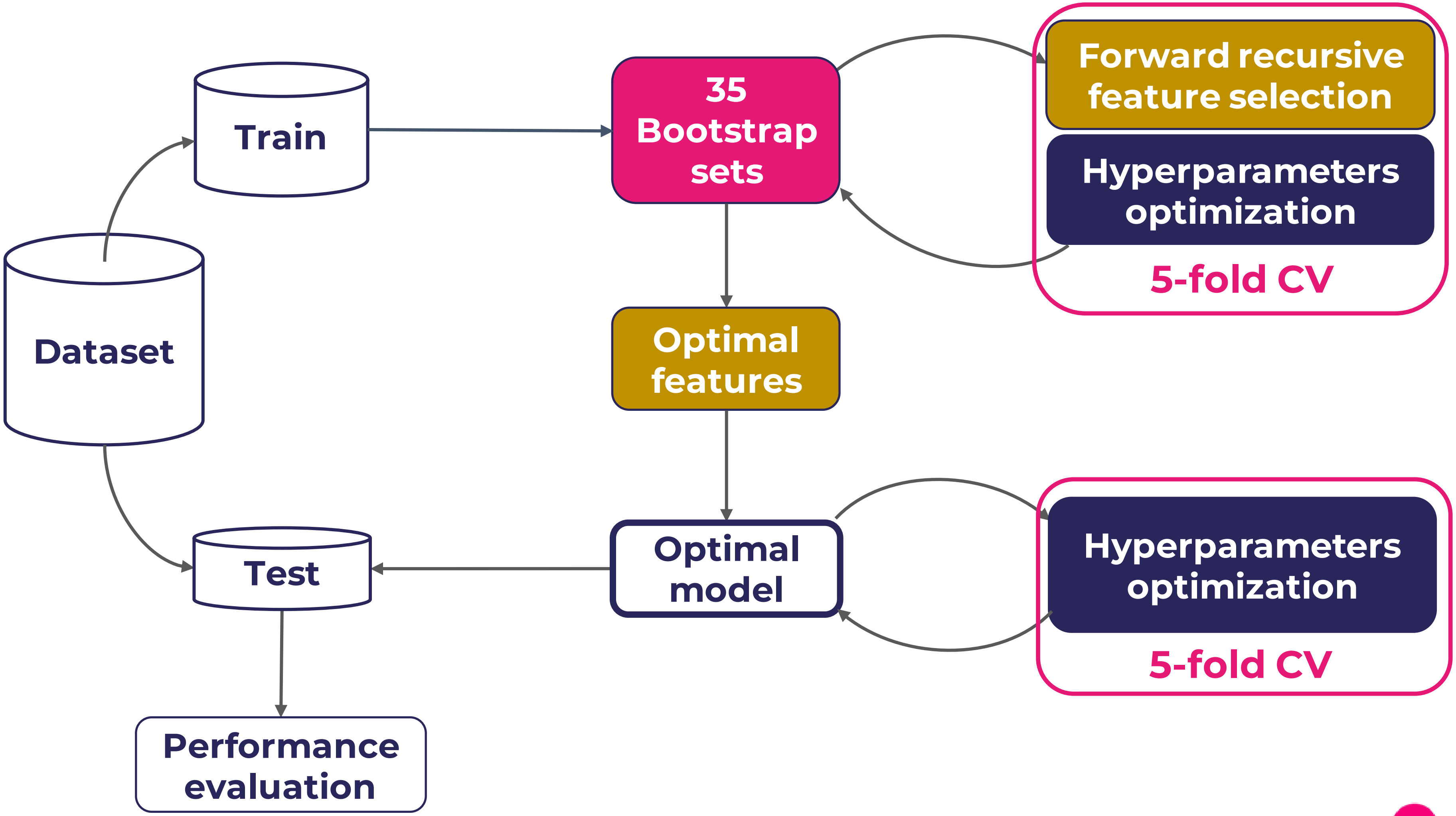
Preprocessing



- ▷ For **hyperparameters tuning** and **feature selection**
- ▷ **35 boots**: internal training set + validation set

- ▷ **Min max** scaling
- ▷ **MICE** imputation, 20 iterations

Model development framework



Dataset

Train

Test

35 Bootstrap sets

Forward recursive feature selection

Hyperparameters optimization

5-fold CV

Optimal features

Optimal model

Hyperparameters optimization

5-fold CV

Performance evaluation

Task 2 – Cumulative probability

Cox model

- Model outcome: **survival function**
- **Task 1:** $risk(t) = 1 - S(t)\ with\ t = 15\ years$
- **Task 2:** $risk(t) = 1 - S(t)\ with\ t \in (2,4,6,8,10)\ years$

SSVM

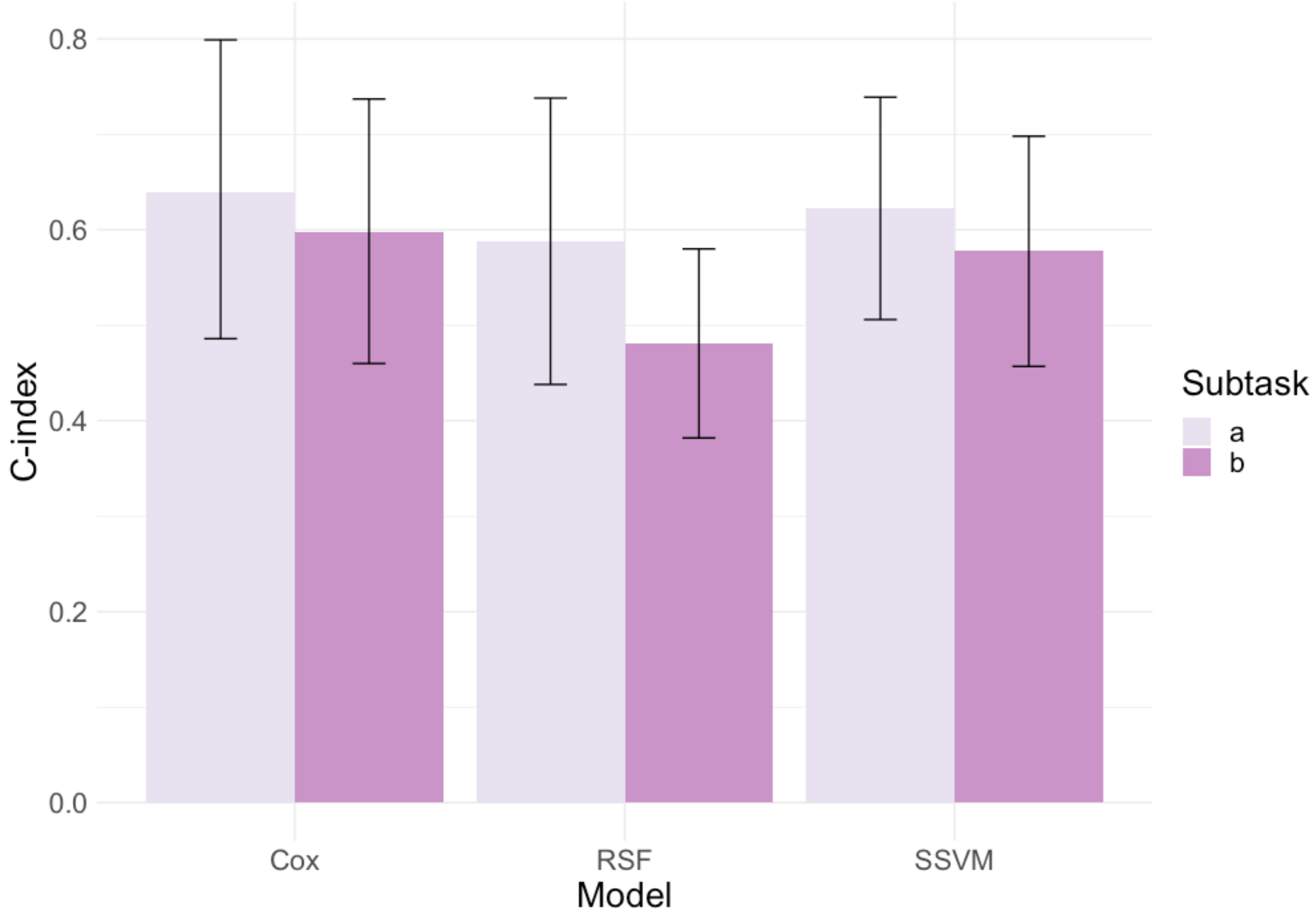
- Model outcome: **event time**
- **Task 1:** derived via Platt recalibration at 15 years
- **Task 2:** derived via Platt recalibration at (2,4,6,8,10) years

RSF

- Model outcome: **survival function**
- **Task 1:** $risk(t) = 1 - S(t) with\ t = 15\ years$
- **Task 2:** $risk(t) = 1 - S(t)\ with\ t \in (2,4,6,8,10)\ years$

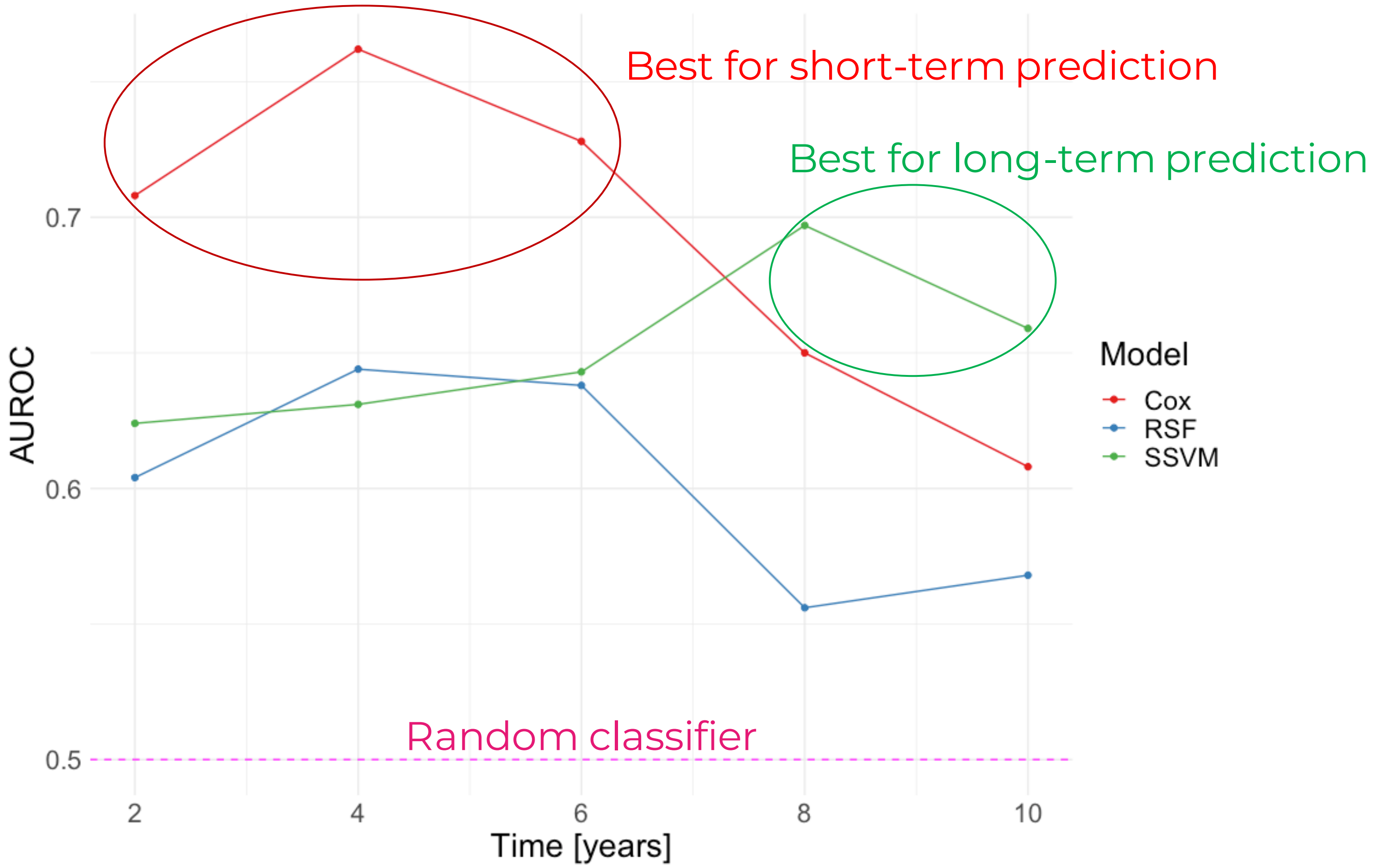
Results

Task 1: C-Index (CI)

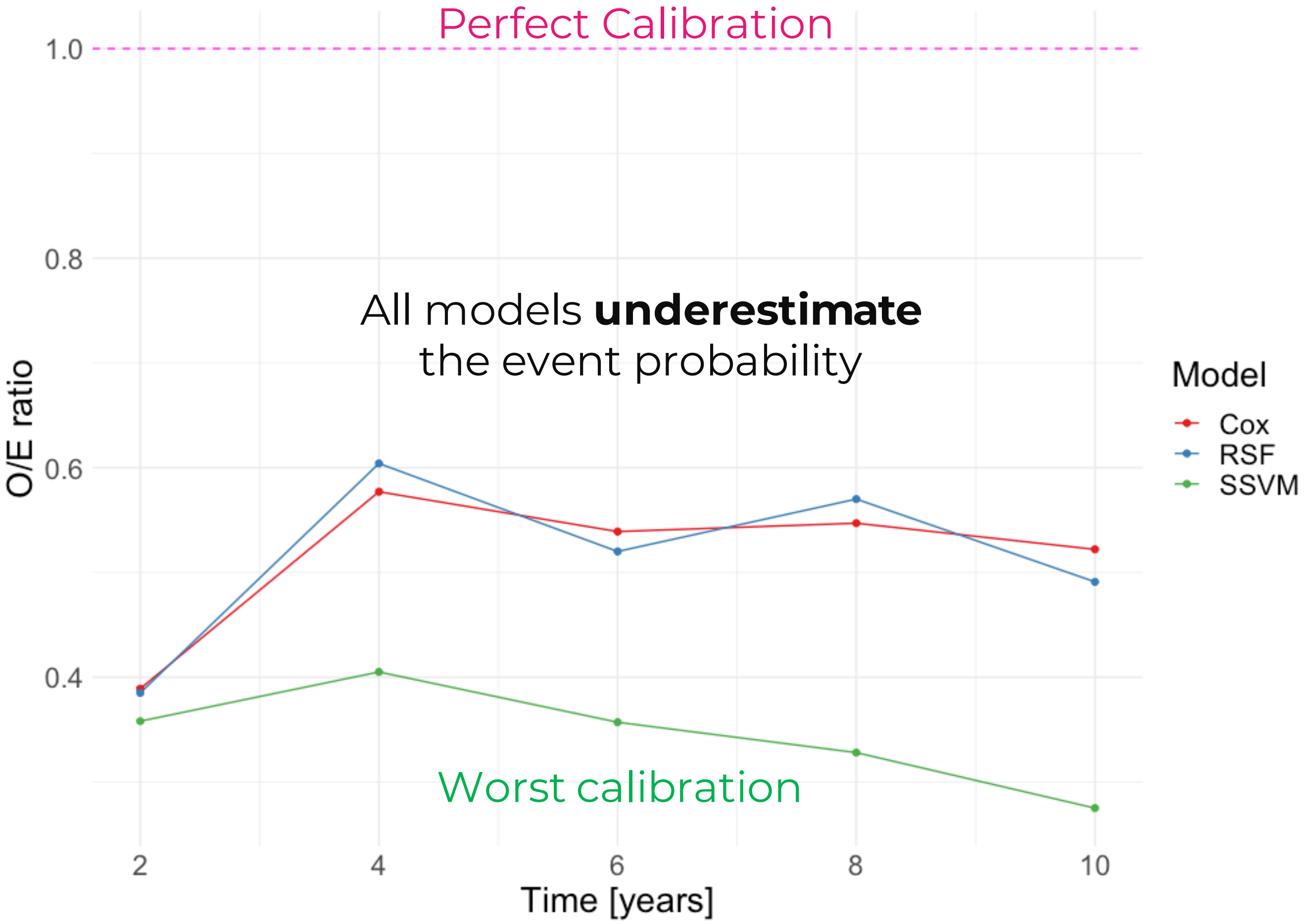


The **Cox model** achieves the **highest discrimination** in both sub-tasks

Task 2: sub-task a, AUROC

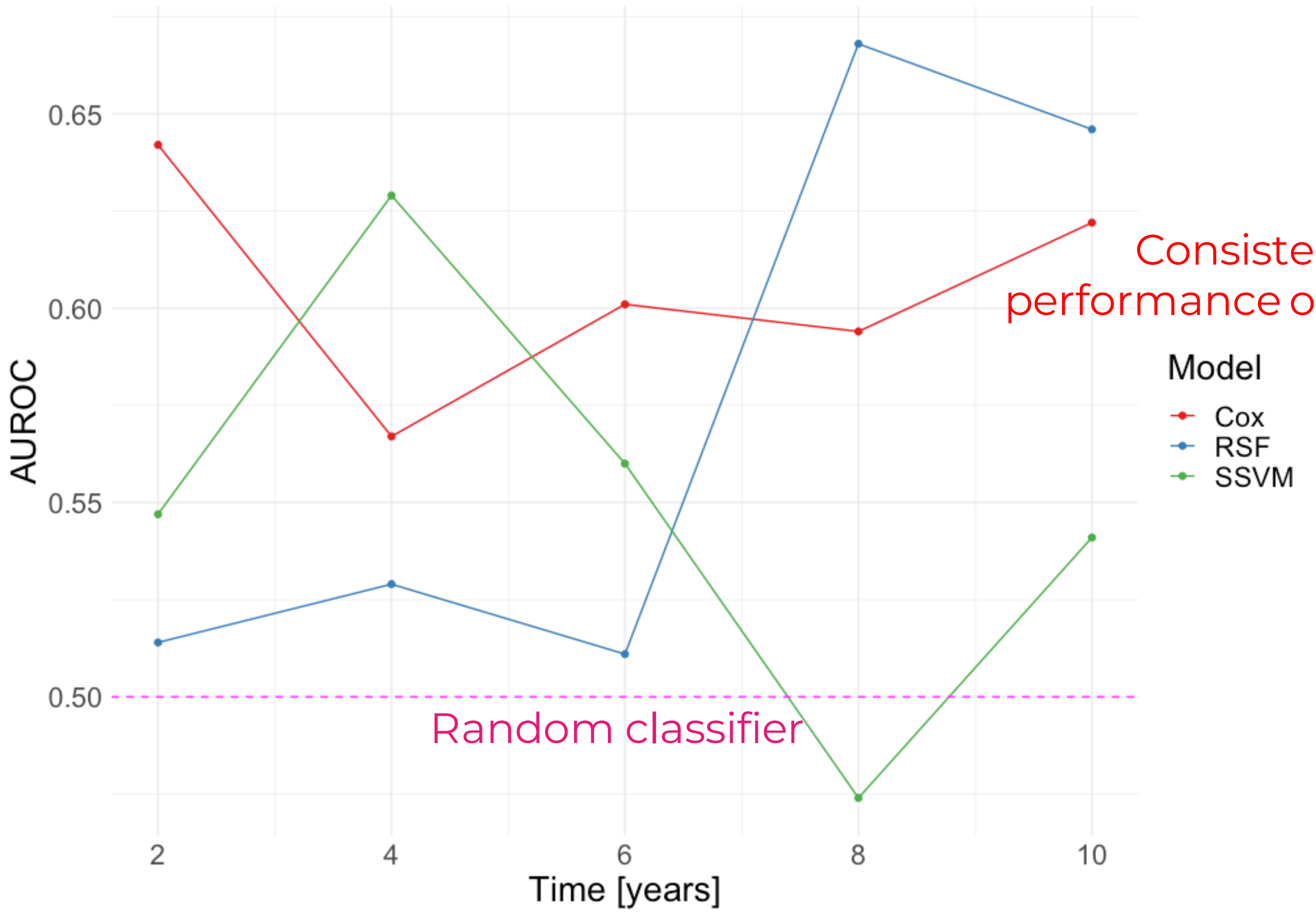


Task 2: sub-task a, O/E ratio



All models **underestimate** the event probability

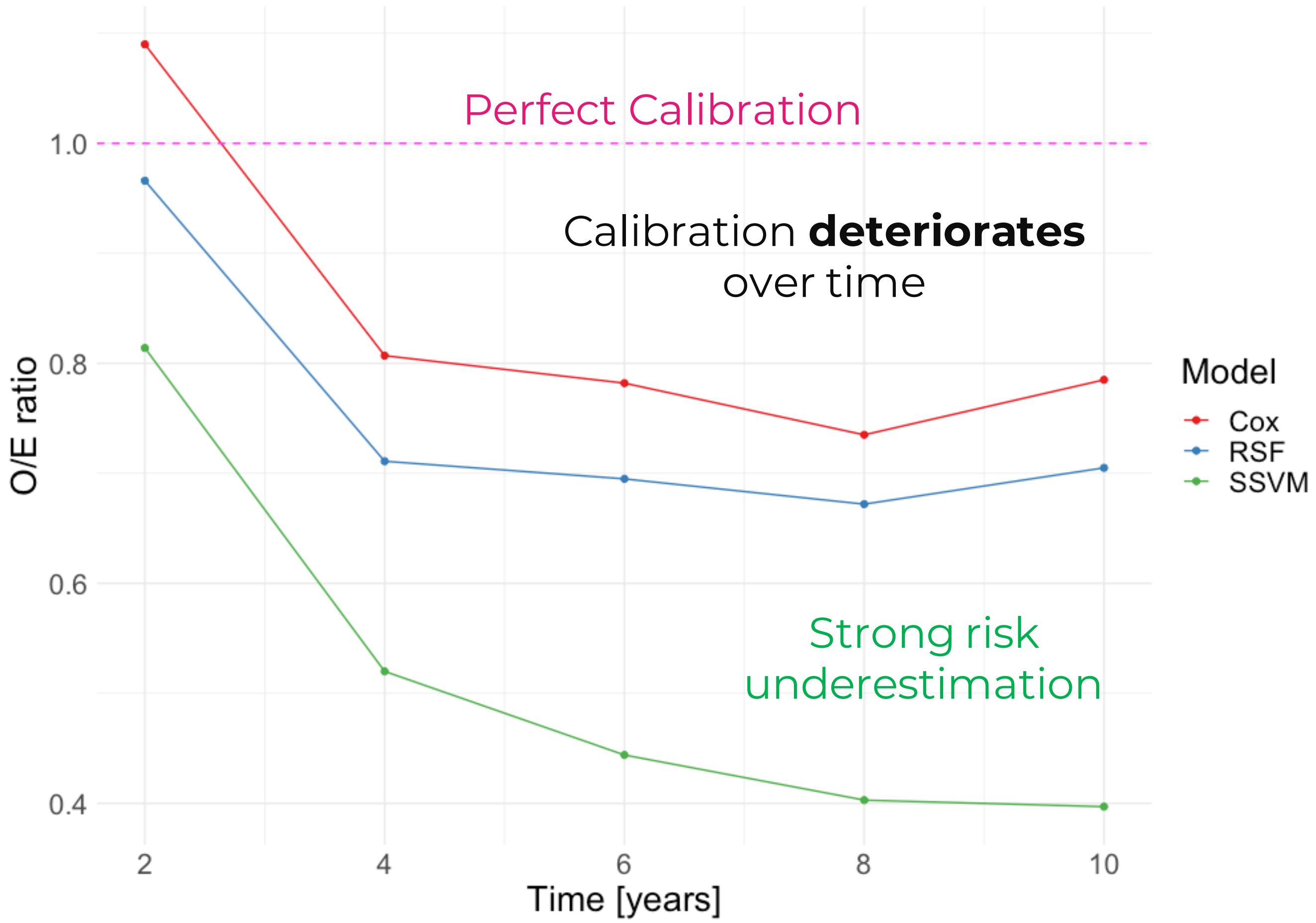
Task 2: sub-task b, AUROC



Consistent performance over time

Random classifier

Task 2: sub-task b, O/E ratio



Calibration **deteriorates** over time

Strong risk underestimation

Conclusion

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- **Task 1:** Poor discrimination across the board. Cox model is the best performing approach.
- **Task2:** Modest performance. Cox model is the best performing approach especially in terms of calibration.
- These results are **consistent** with what was previously observed in **similar studies.**
- Better results may be possible with **more sophisticated features extraction** processes concerning dynamic variables (i.e., **EDSS and MRI**)

Brainteaser

Thank You

Access the full text!

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