

# Survival Analysis for Multiple Sclerosis: Predicting Risk of Disease Worsening

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# Related Work

Machine learning has been used in MS research, e.g., for patient stratification.

In terms of prognosis, studies focus on course prediction -- EDSS change and score, relapse occurrence and course type.

Related to this paper, time to event has also been a subject of research in MS.

# Task

Survival analysis task: how early is it likely for a worsening event to happen.

Worsening event definition according to the subtasks:

## Task 1a

EDSS value crosses the threshold of 3 at least twice within a one-year interval

## Task 1b

Considering first EDSS as baseline, happens when:

- baseline  $< 1$  and 1.5 point increase is first observed;
- $1 \leq \text{baseline} < 5.5$  and 1 point increase is first observed;
- baseline  $\geq 5.5$  and 0.5 point increase is first observed;

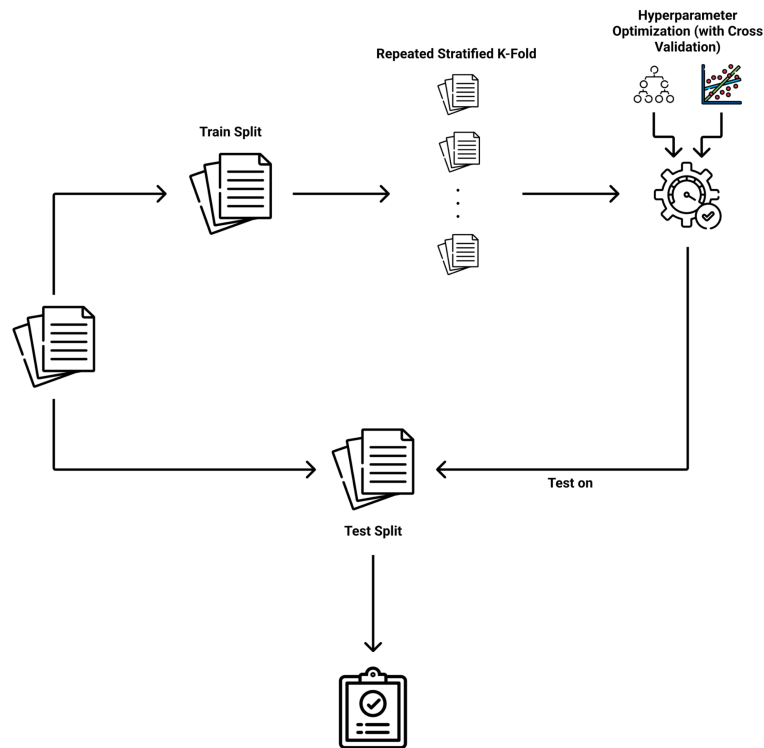
# Methodology



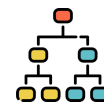
Brainteaser

Component	Feature	Type	Computed?
Static	Sex	Binary	
	Residence	Categorical	
	Age at Onset	Integer	
	Diagnostic Delay	Float	
	Spinal Cord Symptom	Boolean	
	Brainstem Symptom	Boolean	
	Eye Symptom	Boolean	
	Supratentorial Symptom	Boolean	
	Time since Onset	Integer	
	EDSS	EDSS as evaluated by clinician:	Float
	First assesment		✓
	Last assesment		✓
	Max value of assesments		✓
	Mean value of assesments		✓
	Min value of assesments		✓
	Std values of assesments		✓
	EDSS change		
Relapses	Delta time between Time 0 and Last relapse	Float	✓
	Relapse Count	Float	✓

# Methodology



## Models\*



Random Survival Forest and Gradient Boosting



Survival SVM



Cox Proportional-Hazards

\* Implemented by the sksurv Python package

# Results

## Task 1a

Model	Train C-Index	Test C-Index
CoxPHSurvivalAnalysis	0.775	0.790 [0.640; 0.941]
RandomSurvivalForest	<b>0.847</b>	<b>0.801</b> [0.678; 0.924]
FastSurvivalSVM	0.766	0.777 [0.626; 0.929]
FastKernelSVM	0.730	0.792 [0.649; 0.935]
GradientBoostingSurvivalAnalysis	0.604	0.760 [0.605; 0.916]

# Results

## Task 1b

Model	Train C-Index	Test C-Index
CoxPHSurvivalAnalysis	0.713	0.683 [0.581; 0.786]
RandomSurvivalForest	0.697	0.599 [0.494; 0.704]
FastSurvivalSVM	0.716	0.677 [0.575; 0.780]
FastKernelSVM	<b>0.727</b>	<b>0.690</b> [0.591; 0.788]
GradientBoostingSurvivalAnalysis	0.590	0.601 [0.489; 0.713]

## Discussion / Takeaways

Trial-and-tested survival analysis methods achieve good performance at MS worsening prognosis.

Even with simple preprocessing and temporal information processing. But ..

Task 1b harder task to solve, due to its complex event definition.



## THANK YOU. QUESTIONS?



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