PatientLevelPrediction: Theory and Strateg(y)us

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Patient-Level Prediction WG co-lead

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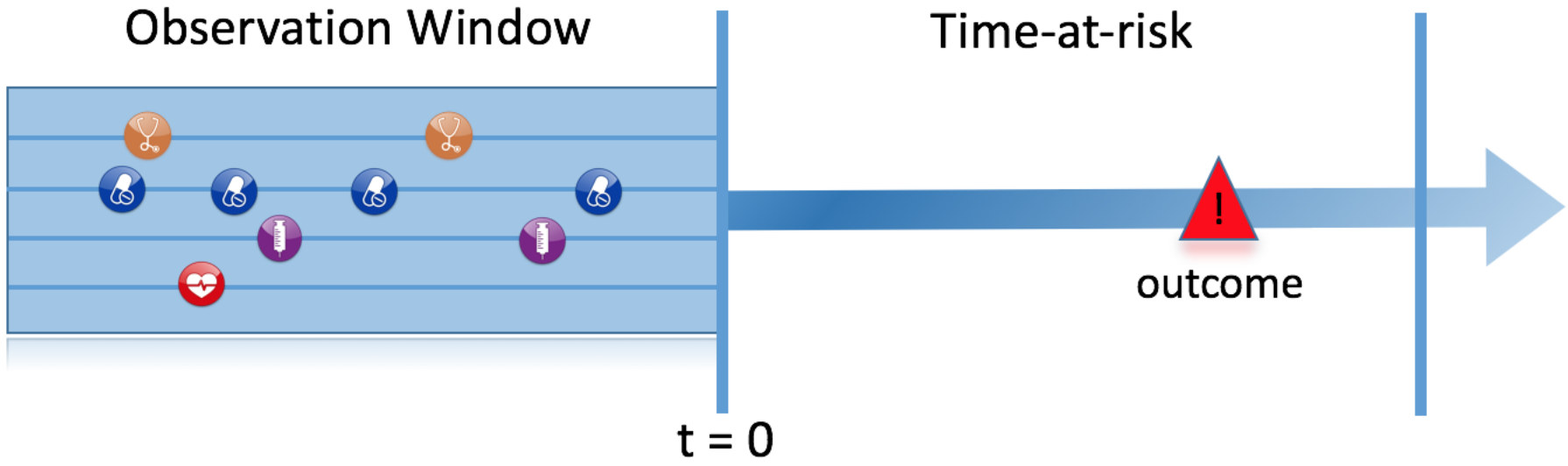
Problem definition



Among a population at risk, we aim to predict which patients at a defined moment in time (t=0) will experience some outcome (during a time-at-risk (1 year). Prediction is done using only information about the patients in an observation window prior to that moment in time.

Types of prediction problems in healthcare

Type	Structure	Example
Disease onset and progression	Amongst patients who are newly diagnosed with **<insert your favorite disease>**, which patients will go on to have **<another disease or related complication>** within **<time horizon from diagnosis>**?	Among newly diagnosed AFib patients, which will go onto to have ischemic stroke in next 3 years?
Treatment choice	Amongst patients with **<indicated disease> who are treated with either <treatment 1> or <treatment 2>**, which patients were treated with **<treatment 1>** (**on day 0**)?	Among AFib patients who took either warfarin or rivaroxaban, which patients got warfarin? (as defined for propensity score model)
Treatment response	Amongst patients who are new users of **<insert your favorite chronically-used drug>**, which patients will **<insert desired effect>** in **<time window>**?	Which patients with T2DM who start on metformin stay on metformin after 3 years?
Treatment safety	Amongst patients who are new users of **<insert your favorite drug>,** which patients will experience **<insert your favorite known adverse event from the drug profile>** within **<time horizon following exposure start>**?	Among new users of warfarin, which patients will have GI bleed in 1 year?
Treatment adherence	Amongst patients who are new users of **<insert your favorite chronically-used drug>**, which patients will achieve **<adherence metric threshold>** at **<time horizon>**?	Which patients with T2DM who start on metformin achieve >=80% proportion of days covered at 1 year?

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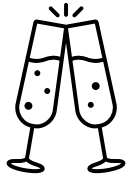
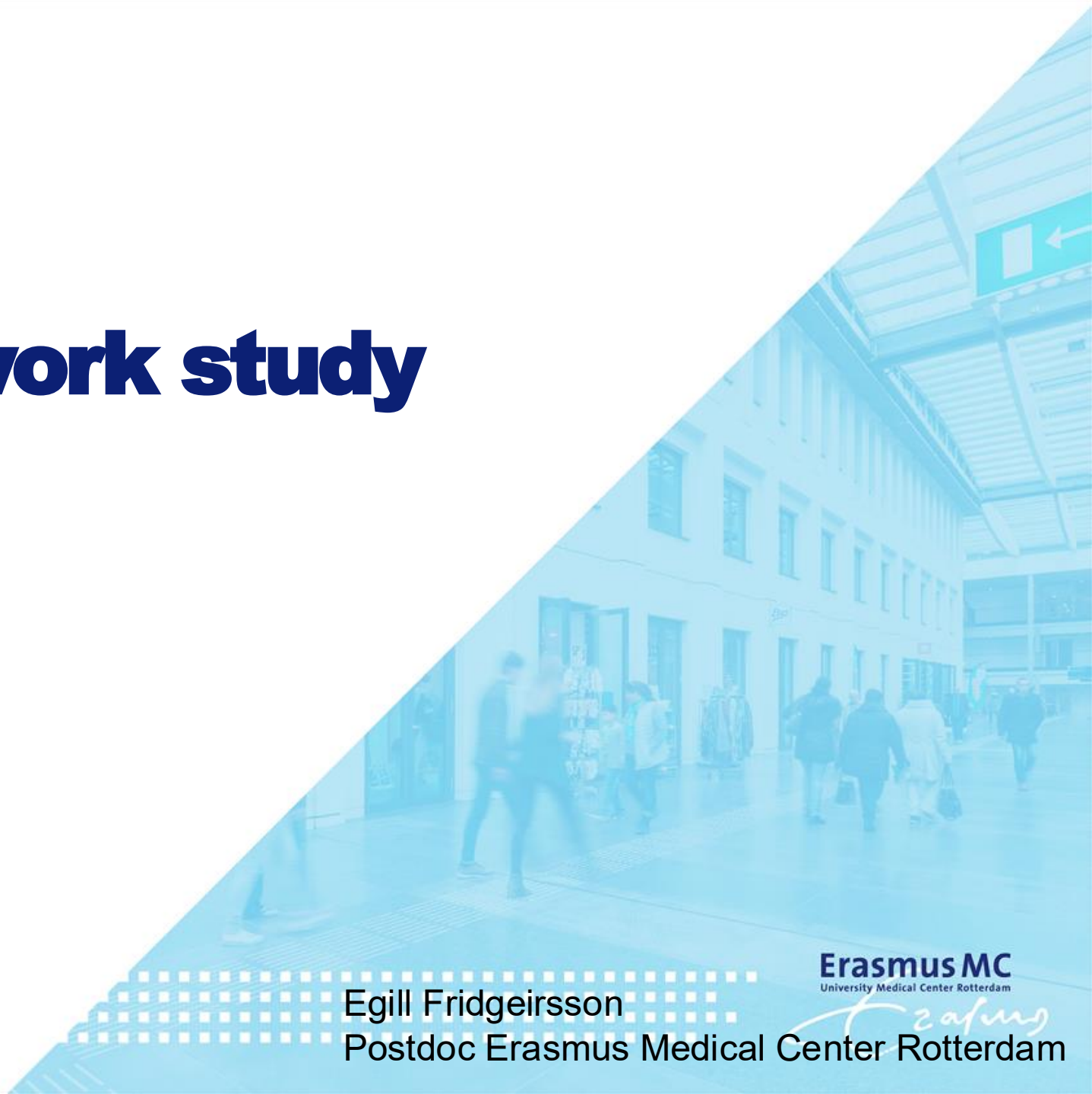
Covariates



Deep learning network study

- A strategus example



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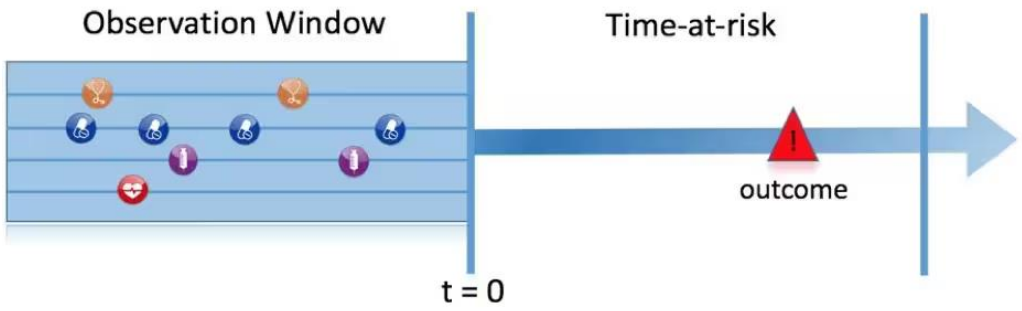
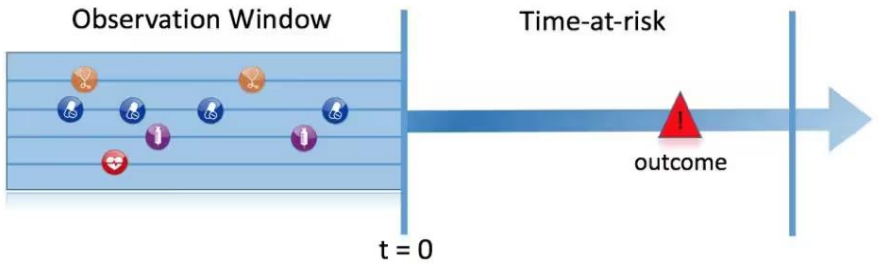
3 prediction problems

- Predict dementia in older patients (55 – 84 years) within 5 years from a visit
- Predict lung cancer in adults within 3 years in adults from a visit
- Bipolar transition within one year from diagnosis with major depression



```r
library(PatientLevelPrediction)

# dementia model design
modelDesign <- createModelDesign(
  targetId = 11931,
  outcomeId = 6243,
  populationSettings =
    createStudyPopulationSettings(minTimeAtRisk = 1,
                                  riskWindowEnd = 5*365),
  covariateSettings = FeatureExtraction::createCovariateSettings(
                                    useDemographicsGender = TRUE,
                                    useDemographicsAge = TRUE,
                                    useConditionOccurrenceLongTerm  = TRUE,
                                    useDrugEraLongTerm = TRUE,
                                    useCharlsonIndex = TRUE,
                                    longTermStartDays = -365,
                                    endDays = 0),
  preprocessSettings = createPreprocessSettings(),
  modelSettings = setLassoLogisticRegression(seed=1000)
  splitSEttings = createDefaultSplitSettings(splitSeed=
  )
```



3 different prediction problems

4 different models (LASSO, XGBoost, ResNet, Transformer)

Rest of settings same = 12 modelDesigns in our list

```
}
plpModuleSpecifications <- plpModuleSettingsCreator$createModuleSpecifications(
  modelDesignList = modelDesignList
)

# Create the analysis specifications ------------------------------------------
analysisSpecifications <- Strategus::createEmptyAnalysisSpecificiations() |>
  Strategus::addSharedResources(cohortDefinitionShared) |>
  Strategus::addModuleSpecifications(cohortGeneratorModuleSpecifications)
  Strategus::addModuleSpecifications(plpModuleSpecifications)

ParallelLogger::saveSettingsToJson(
  analysisSpecifications,
  file.path("deepLearningStudy.json")
)
```

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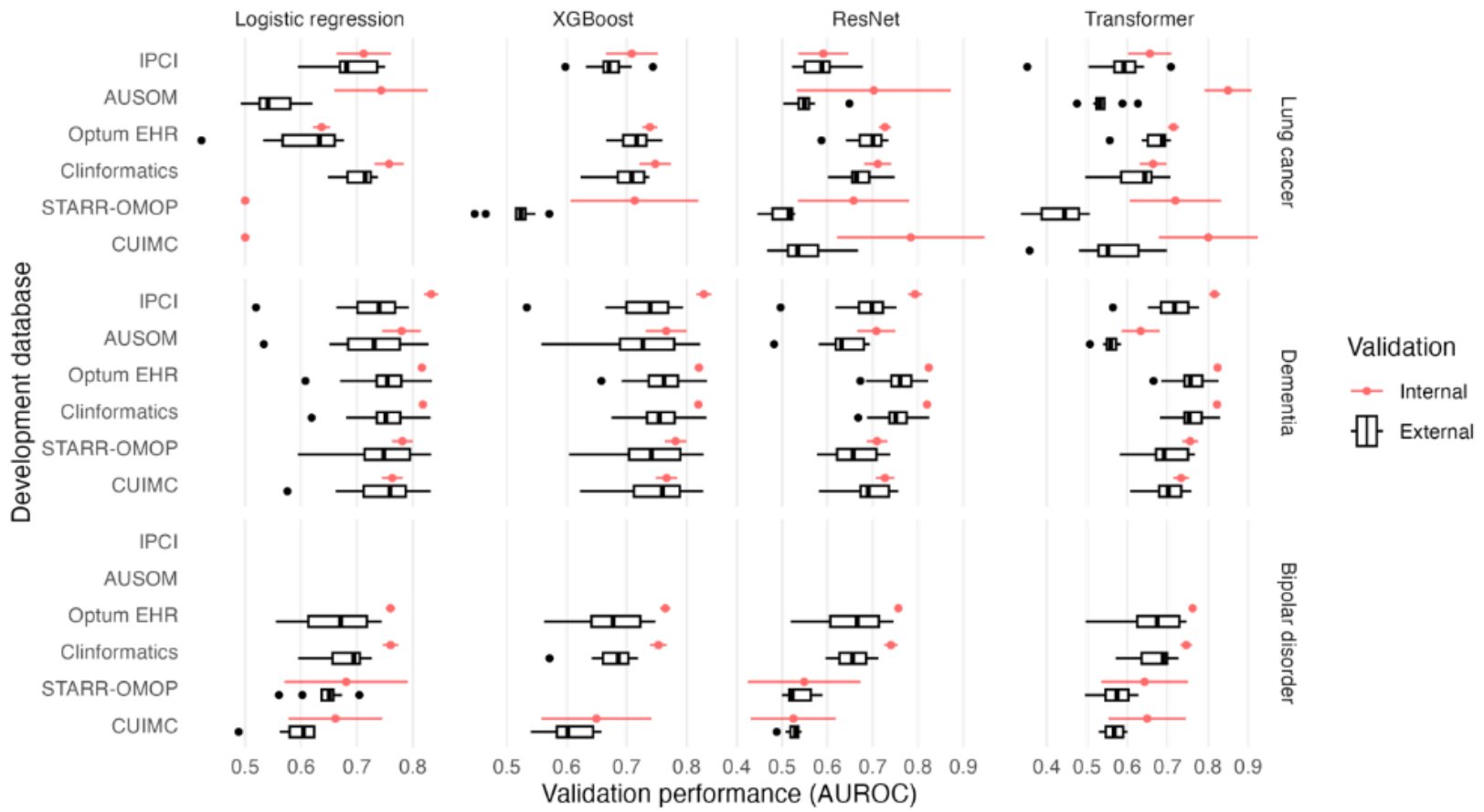

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