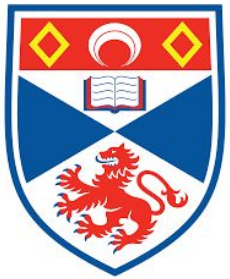
Analyses and Management of Healthcare Data for Cancer Care

Agastya Silvina



A Brief Overview

Front-End

Visualisation
Reporting Service
Dashboard

Back-End

Migration
API Gateway

Toxicity Predictor
(1,2,3,4,....)
ML, NLP, DL

PoC

Issues...
Issues...

Synthetic Data

IBM

Previous Projects

- Developed Patient timeline Visualisation, the SESO-Gateway
- The Oncology DB migration
- Designed and developed a reporting service for the Oncology DB

On Predicting the Outcomes of Chemotherapy Treatment in Breast Cancer

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Outline

- Project Overview
- Related Work
- Data Analysis
- Models Creation
- Result
- Conclusion

Project Overview

- Cancer is
  - a mutation caused by an abnormal reproduction of cells.
  - happens in in different organs (e.g., **breast**, lungs, bone, etc.)
- The treatments vary from surgery with **chemotherapy** and/or radiotherapy (i.e. usually take a long time and in sequence)
  - However some treatments are toxic and expensive
- We **compared several different techniques (Markov Model, HMM, RF, RNN)** applied to the same data set to **predict the toxicity outcome of different treatment options**

Related Work

- Many ongoing research looks at prediction of cancer treatment outcomes
  - Bayesian Logistic Regression (Subramani et al.)
  - Random Forest (Hui-Ling Chen et al.)
  - SVM (Nguyen et al.)
- We also consider **HMM** and **RNN** (common in different fields like NLP)

NHS

predict
breast cancer

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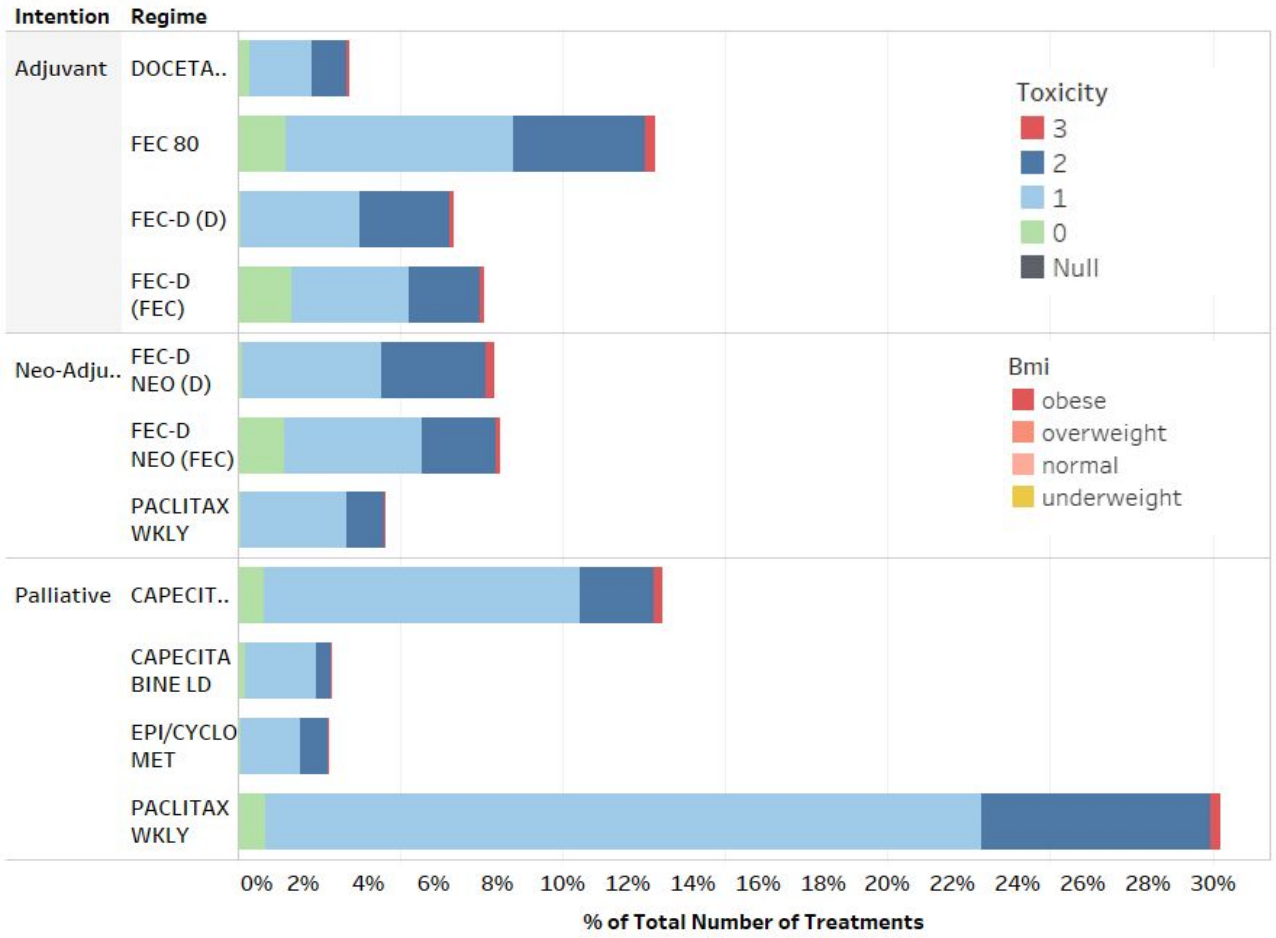
Data Analysis

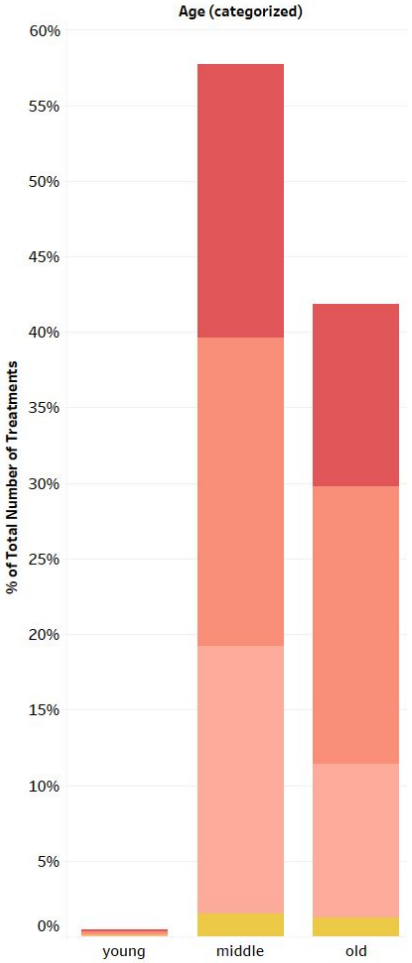
- We use data extraction from an oncology department in Scotland
  - 3 years (2014 - 2016)
  - Includes various observations concerning breast cancer treatments (e.g. **intention, regime, cycles**), recorded side effects (here, **toxicity level**), and patient characteristics (e.g. **age, BMI, performance status**).

Intention	Number of Treatments	Number of Patients
Adjuvant	1209	205
Neo-adjuvant	1855	382
Palliative	2752	213

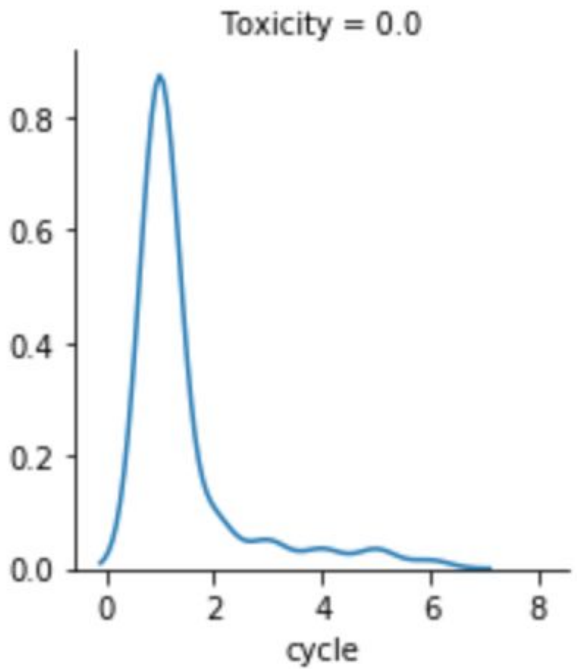
Toxicity proportion



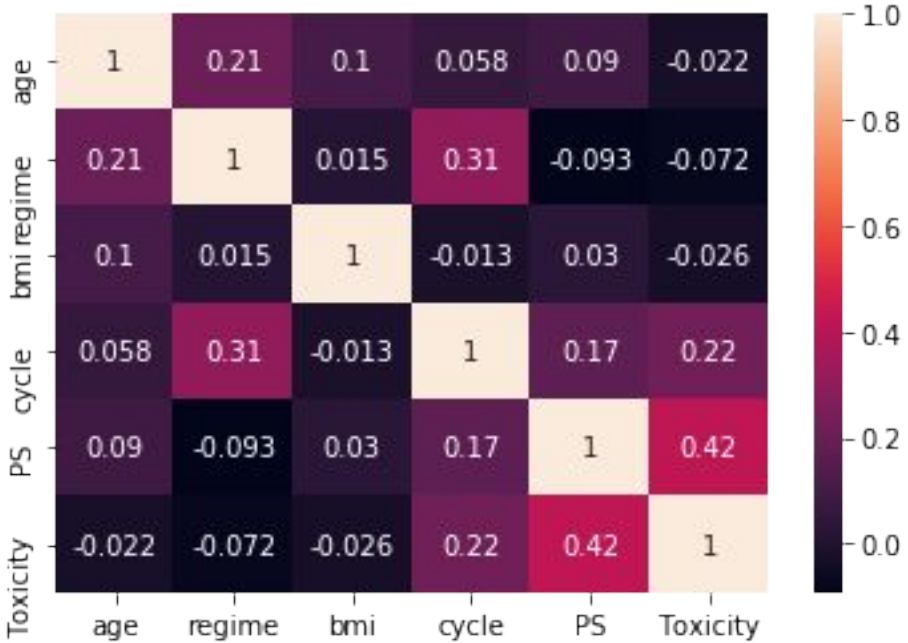
Age - BMI



Features correlation



Treatment cycle - toxicity (No toxicity)



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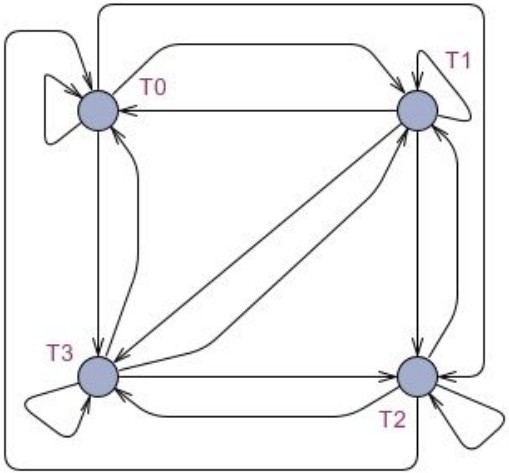
Markov Model (MM)



The transition probability matrix

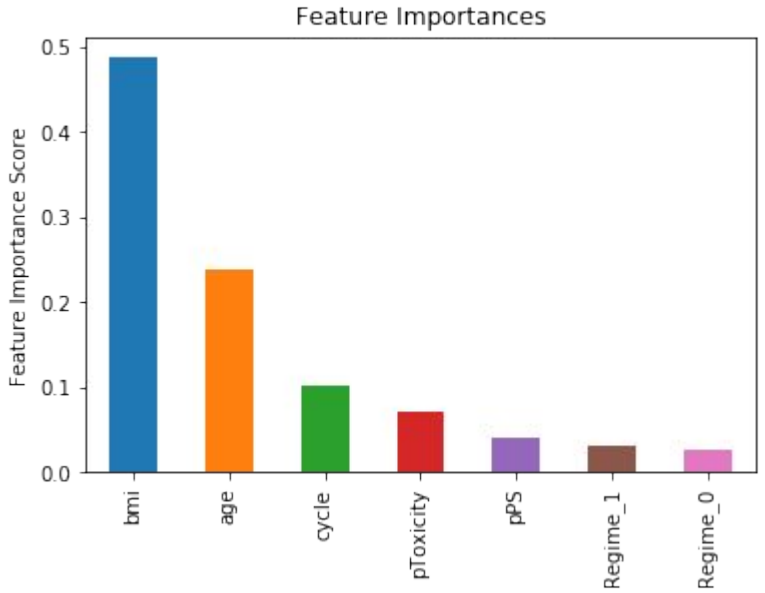
- A stochastic model with the assumption that a future state only depends on the current state.
- T0, T1, T2, T3 denote the toxicity state(i.e. No toxicity, Low, Medium, High)

Hidden Markov Model (HMM)

- Based on augmenting a Markov chain to observe the hidden states of events
- Our HMM components:
  - States: **T0, T1, T2, T3**
  - Transitions: from **T0 to T1**, from **T1 to T3**, etc
  - Observations: **cycle, age, BMI, regime** (categorised and coded)**.** For example, 1-2-3-1 denotes the observation for an overweight patient who gets the FEC-D (D) in their first cycle and is aged less than 50 years
  - Emissions: the probability of the observations generated from the toxicity state

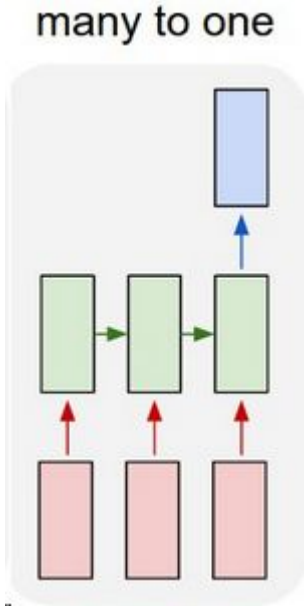
Random Forest

- An ensemble of decision trees for solving classification problems.
- We created three RF models for each treatment intention (i.e., adjuvant, neoadjuvant, palliative)
  - Predictors: **age, BMI, Regime, cycle, previous toxicity,** and previous performance status.
  - Outcome: **Patients' toxicity**



Recurrent Neural Network (RNN)

- A class of NN where connections between nodes form a directed graph along a temporal sequence.
- Implemented using **tensorflow LSTM** module.
- Used similar features as for our RF model. However, **we do not use** the previous **performance status** and **previous toxicity fields.**



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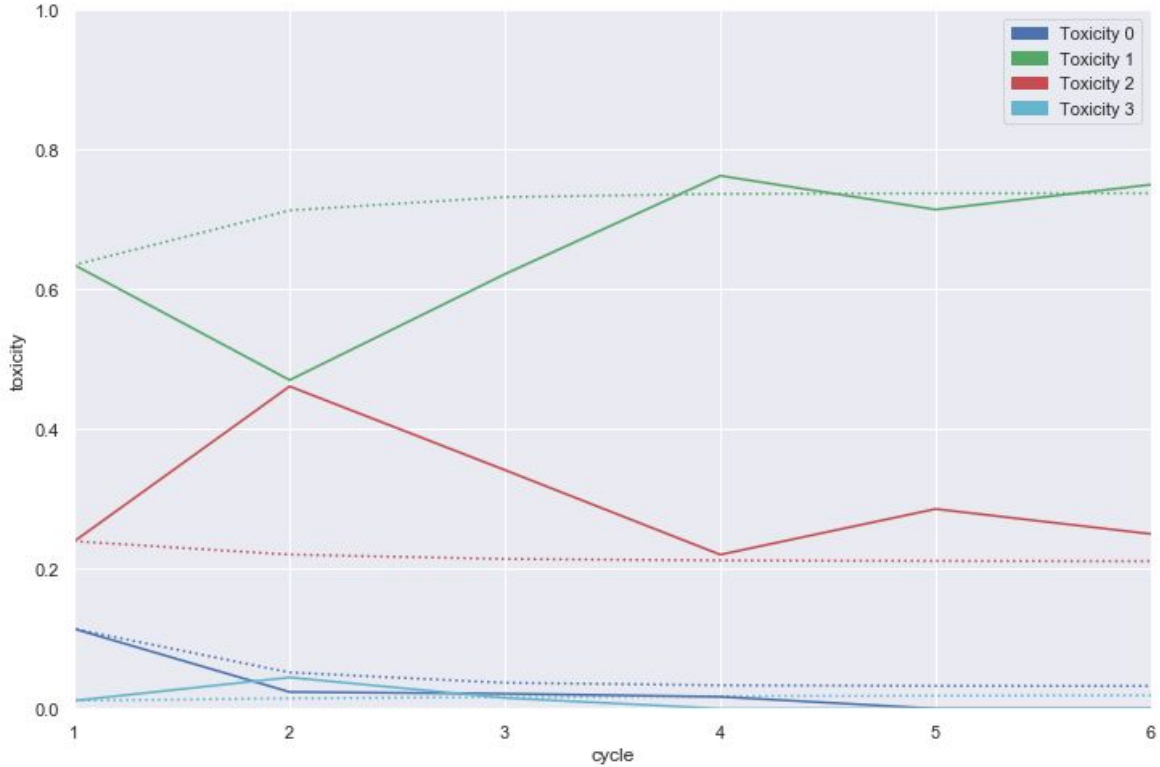
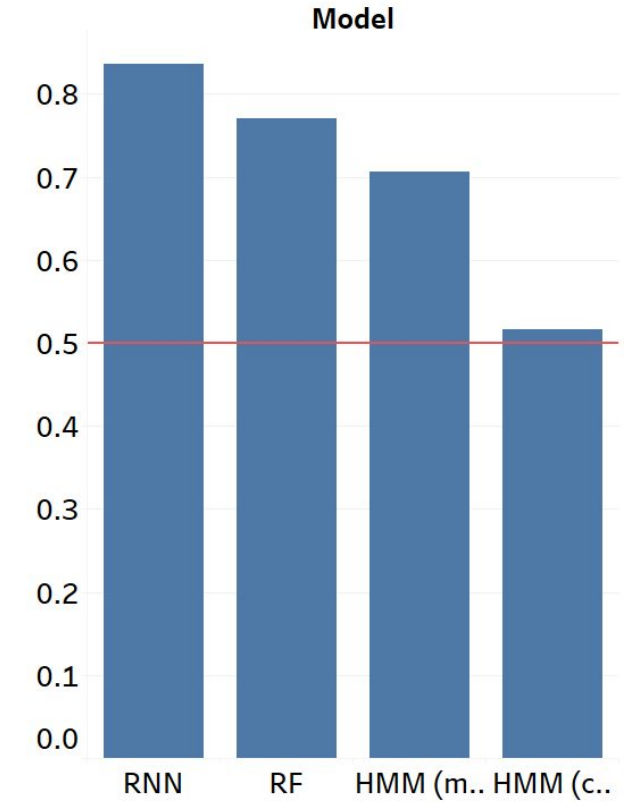
Markov Model



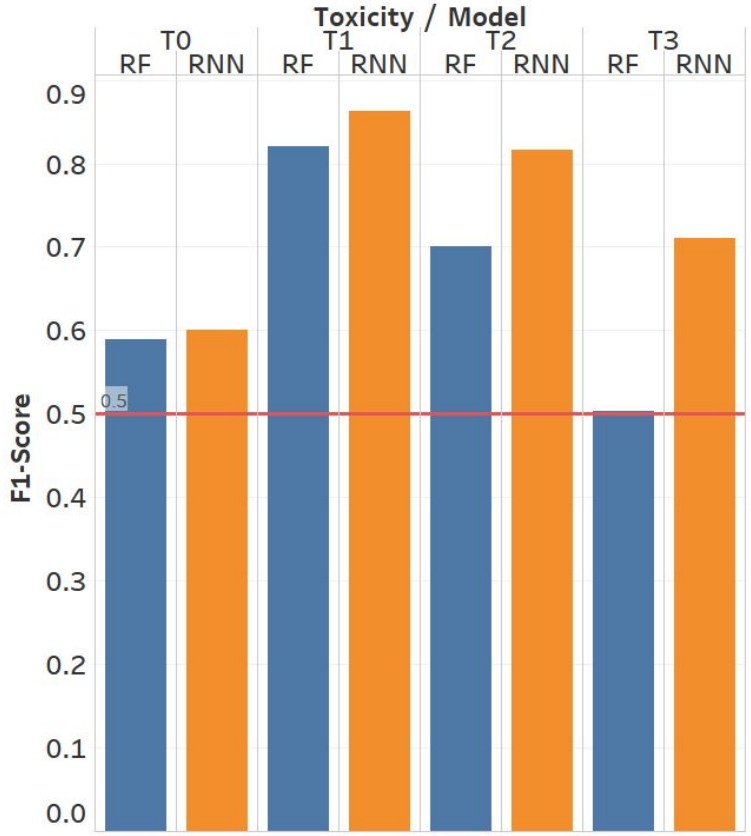
Palliative treatments distribution

Classifier

Accuracy



F1-Score



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Conclusion

- Our classifiers can predict the toxicity outcome of the chemotherapy outcomes with around **0.8 - 0.85** accuracy.
- The RNN model performed better than all other models because it considers all the patients' treatments
- In contrast to the MM, the classifiers are more tailored for an individual patient.
    - Both the MM and the classifiers are a complement to each other.

Future Work

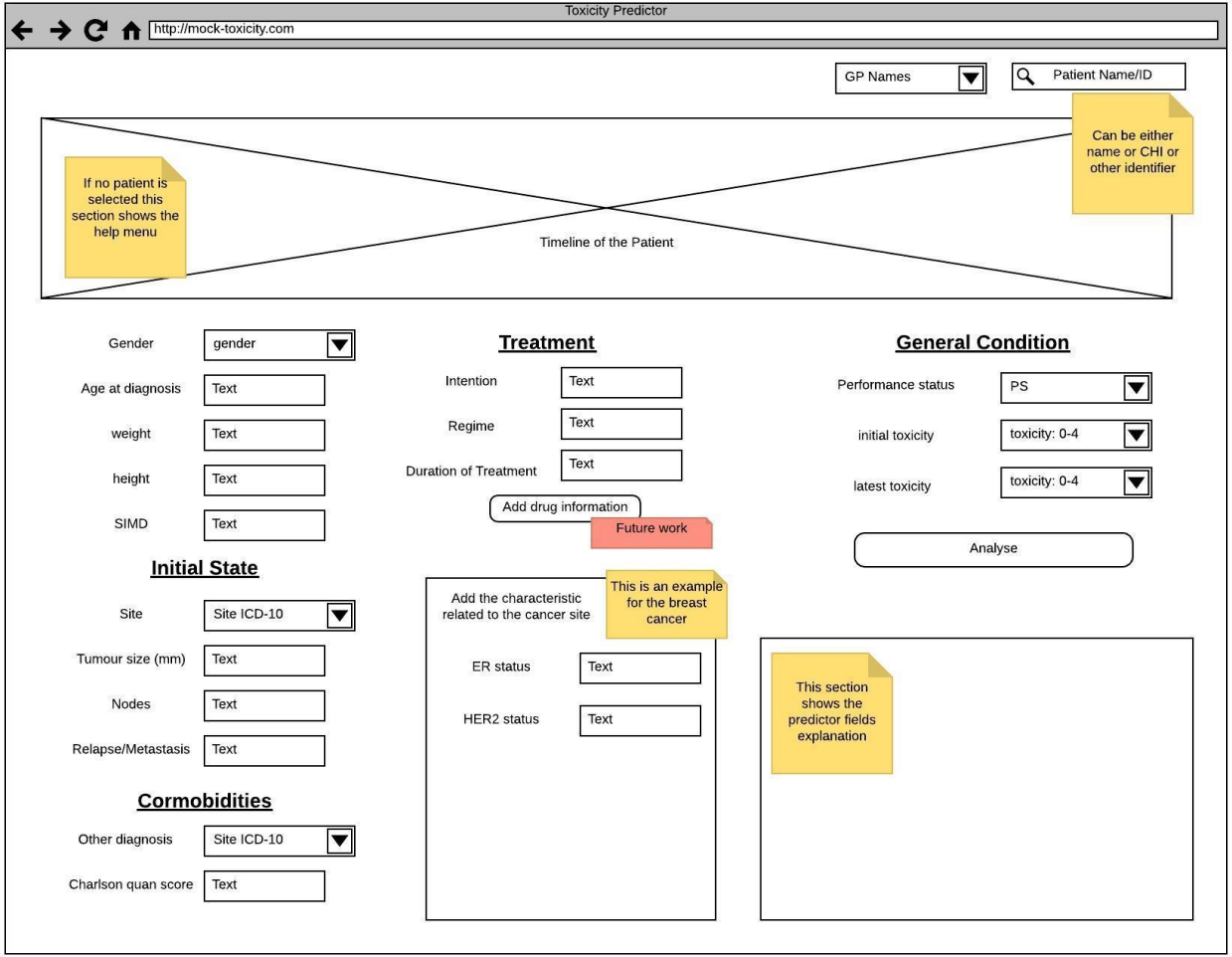
- Improve the accuracy further by integrating more data regarding the cancer characteristics and patients' comorbidity.
- Create a dashboard and/or reporting system which can be helpful to the physician as a second opinion to decide which regime is suitable for an individual patient.

Ongoing Work

Our aim is to use a **synthetic data** during the development of the Application.

DEMO
http://localhost:8000/

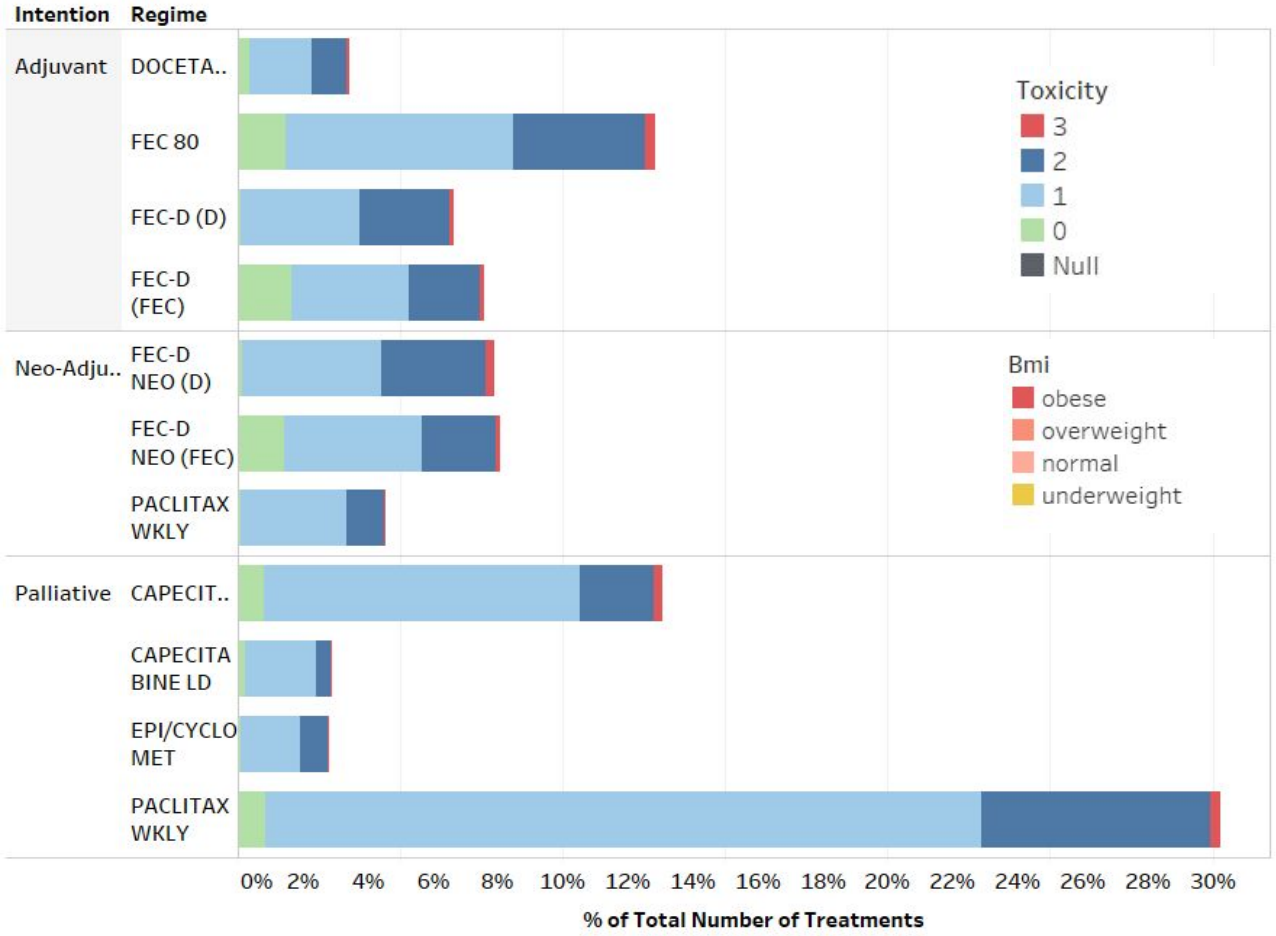
https://breast.predict.nhs.uk/tool



Issues

- **Missing Values**
  - Solution**:** regression, removing some instances
- **Class imbalance**
  - Solution: duplication for some classes
- **Overfitting**
  - Solution: Cross Validation, using more data

Toxicity proportion



And something like this occasionally happens as well….

```
import {EventEmitter, Injectable} from '@angular/core';
import { HttpClient } from '@angular/common/http';
import {TreatmentModel} from '../shared/treatment.model';

@Injectable()
export class TreatmentService {
  // TODO: DYNAMIC UPDATE THE URL FROM CONFIG
  private API_URL = 'assets/treatments.json';

  // EVEN THOUGH MY HEART SCREAMS AT THIS PUBLIC ELEMENT... I NEED TO EMIT THE MAP,
  // LETTING IT FREE TO THE OTHER MODULE...
  // BECAUSE IT'S MORE CONVENIENT... I KNOW SOMEDAY IT WILL COME BACK AT ME
  // BUT FOR NOW, LET'S JUST HOPE FUTURE AGASTYA HANDLE IT WELL.
  public treatmentMap = new Map<string, TreatmentModel>();
  private mapEmitter: EventEmitter<Map<string, TreatmentModel>> = new EventEmitter();

  constructor(private http: HttpClient) {}
```