2023 INTERNATIONAL CONGRESS OF ACTUARIES

BRIDGE TO TOMORROW

28 MAY – 1 JUNE 2023 · SYDNEY

Actuaries Institute Australia

IAA AAI International Actuarial Association Association Actuarielle Internationale

Micro-reserving for Workers' Compensation claims

a case study from Kaggle

The "Actuarial Loss Prediction" Competition

- **Duration:** December 2020 to April 2021
- **Organizers:** Actuaries Institute of Australia, Institute and Faculty of Actuaries and Singapore Actuarial Society
- **Platform:** Kaggle
- **Objective:** Prediction of workers' compensation reserves on an individual claim basis, i.e., development of an individual claim reserving model for IBNeR (Incurred but not enough Reported)
- **Data:** Synthetically generated without reference to a specific jurisdiction or country. The dataset included, among other things, the insured person's anagraphic data, a description of the damage, and an initial estimate of the ultimate.
- **Evaluation of submitted solutions:** Mean squared error (MSE)
- **Our result:** 2nd place among the 140 participating teams/individuals

A quick overview of the data

- Details on the **insured person**:

Age	Gender	Marital Status	Dependent Children	Dependents Other
43	M	F	1	0

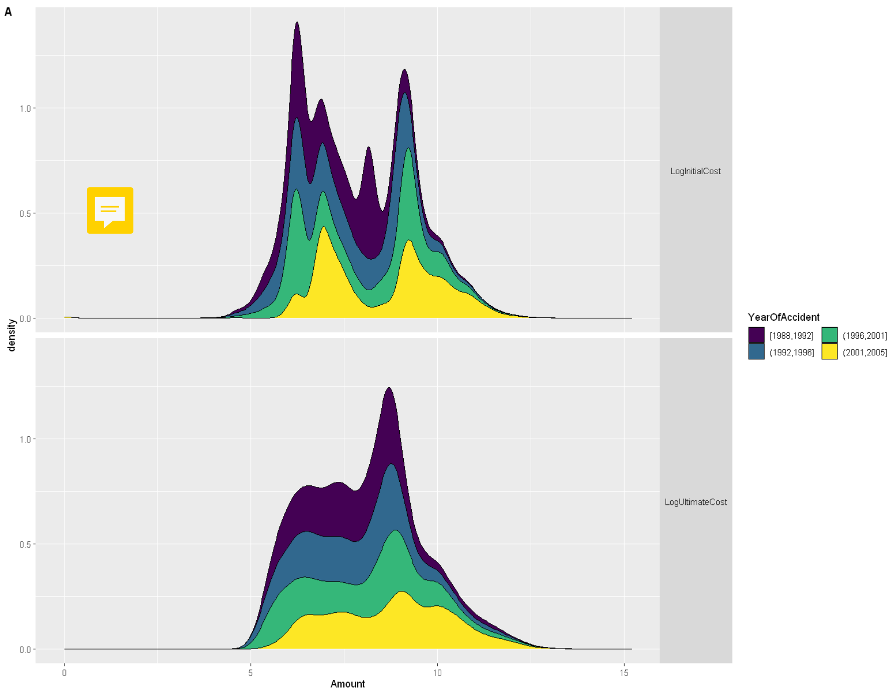
- Details on the **profession**:

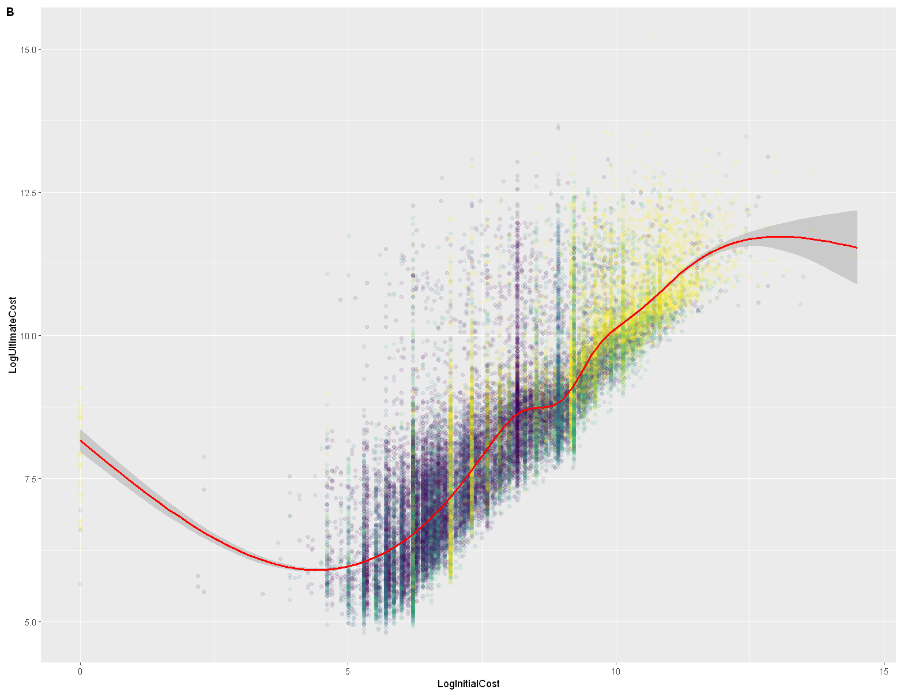
Weekly Wage	Part Time/Full Time	Hours Worked per Week	Days Worked per Week
43	M	F	1

- Details on the **claim**:

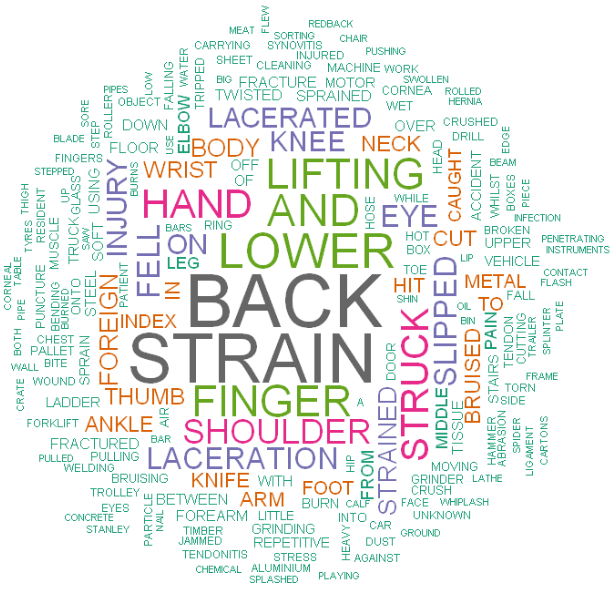
Date and Time of Accident	Date Reported	Claim Description	Initial Incurred Costs
43	M	CUT ON SHARP EDGE CUT LEFT THUMB	1

Initial vs. Ultimate Claim Cost





Claim Descriptions - Wordcloud



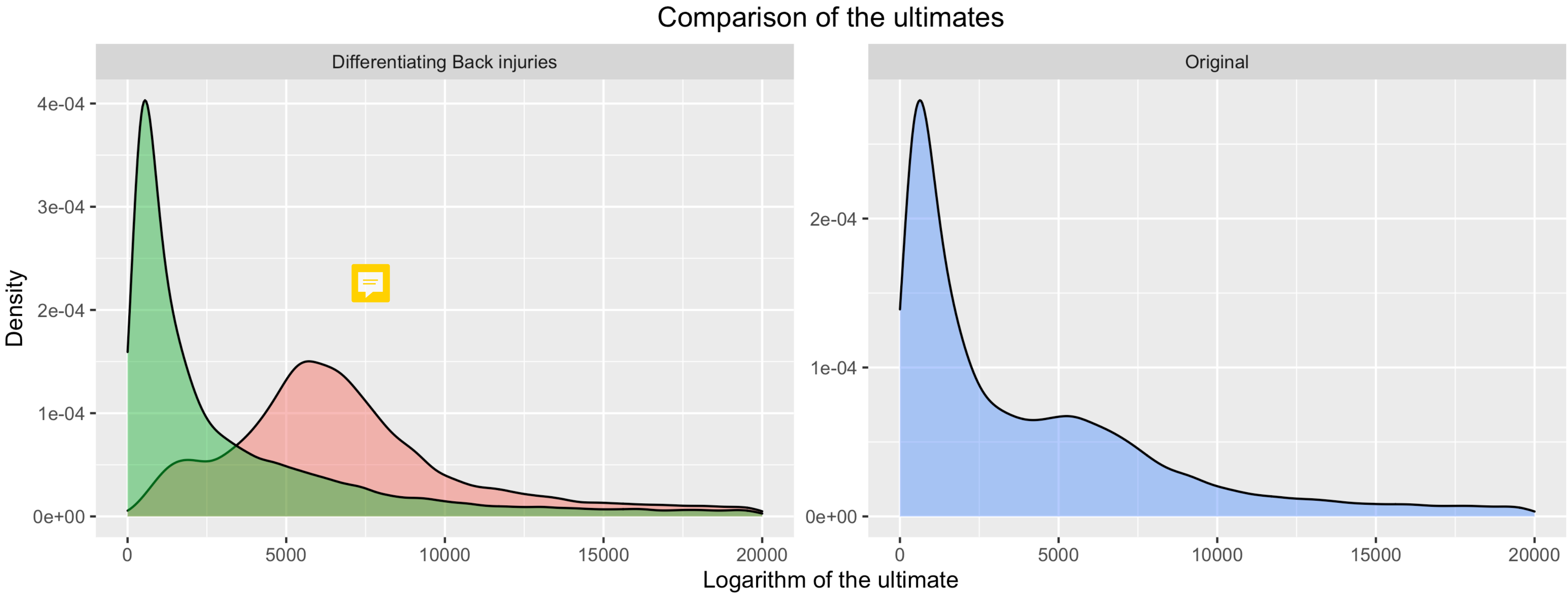
Remarks:

- Many different words
  Synovitis, Table, Particle, Ring...
- Body parts, types of accidents
  e.g. Back, Shoulder, Finger, Strain, Laceration

Important for the analysis:

- Remove stop words
  e.g. and, to, with, on
- Stem remaining words
  e.g. fall, falling, fell => fall
- Cluster the stemmed words
  e.g. eye, cornea => "eye" cluster

Claim Descriptions - Effects on the ultimate



Claim Descriptions - Analysis

The (synthetically generated) claim descriptions don't offer much grammatical structure, sometimes simply nonsensical, e.g. "TO RIGHT LEG RIGHT KNEE".

- Our approach to analysis:

– Remove stop words ("in", "on", ...);

– Lemmatization and stemming of words ("Feet" and "foot" are both mapped to "foot", "laceration" and "lacerated" to "lacer");

– Clustering of words according to context and ultimate;

– OHE for the most common words.

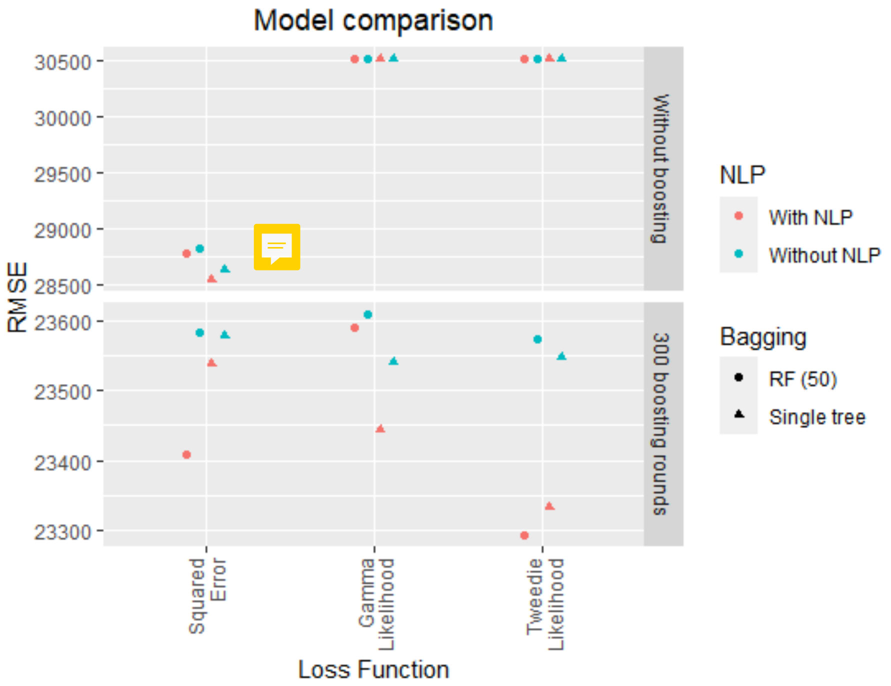
- In the end, we OHEncoded about 100 words and created 30 clusters.

Some details on our model

Our algorithm consisted of the following ensemble methods:
- **Boosting**: Gradient boosting with xgboost
- **Bagging**: Random forest as base learner
- **Voting**: Combination of models based on expert estimates

Adjusting the following model parameters significantly improved our position on the leaderboard:
- **num_parallel_tree**: Setting this parameter to a number greater than 1 allows the use of Random Forest as the base model;
- **monotone_constraints**: This parameter can be used, for example, to enforce a positive relationship between the number of children and the ultimate;
- **objective**: Setting to reg:gamma and reg:tweedie.

Model comparisons



Takeaways:

- Greatest impact is given by boosting
- Without boosting:
  - NLP does not influence the results
  - Distribution-based loss functions perform significantly worse
- Bagging does not consistently improve the result

Conclusion

Lessons learned:

- Feature engineering was more important than hyperparameter tuning;
- There is a Human Learning process which goes hand in hand with Machine Learning;
- Stacking models led to overfitting;
- Neural networks don't solve every problem.
- Large claims had a disproportionate impact on predictions. (MSE)

Thank you for your attention!