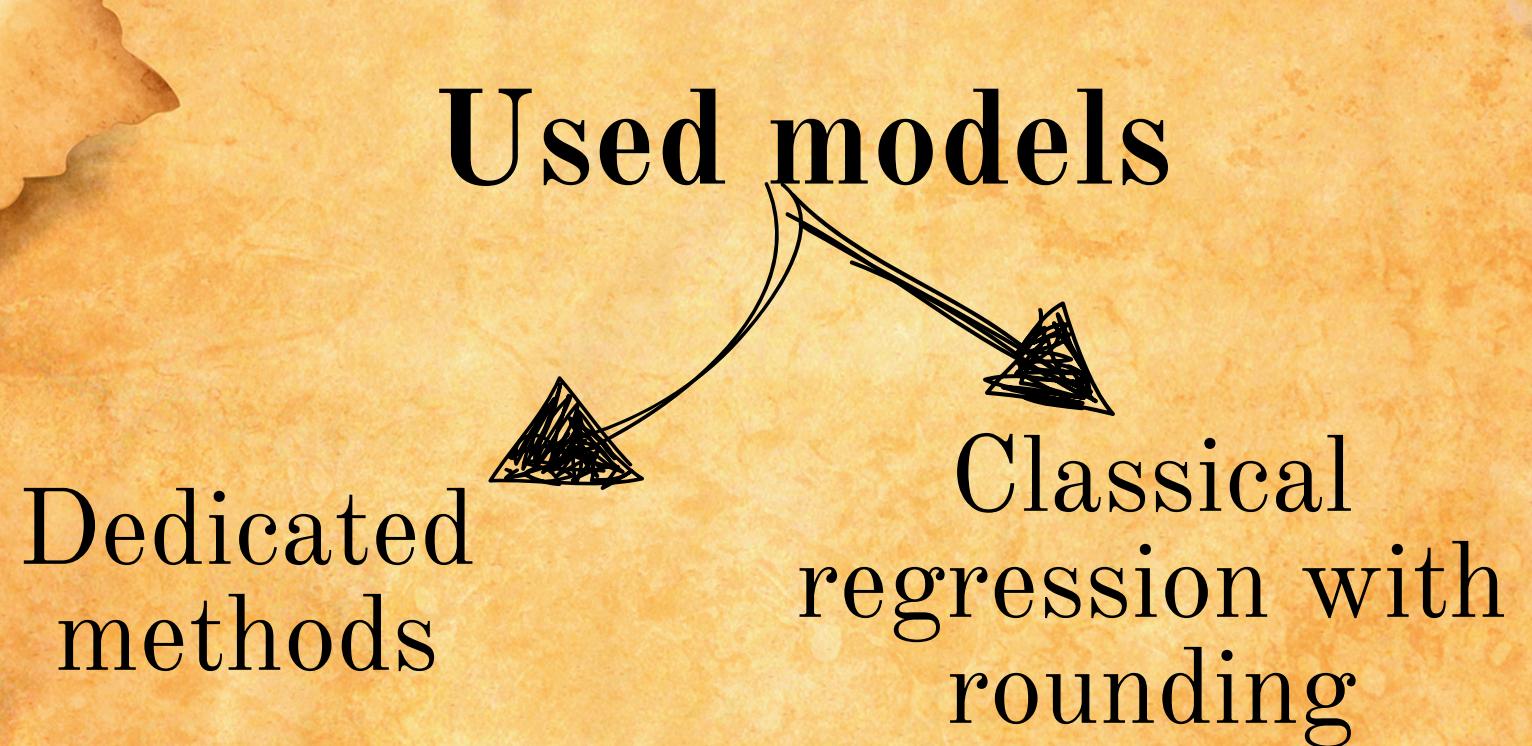


# Application of ML to support pen & paper RPG game design



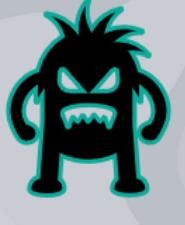
## Ordinal Regression

- Type of regression in which the goal is to predict a variable which is discrete and ordered.
- Our dependent variable: **LEVEL** (from -1 to 21)



### Metrics

- MAE
- RMSE
- Accuracy



### Models were tested using:

Set of 53 features

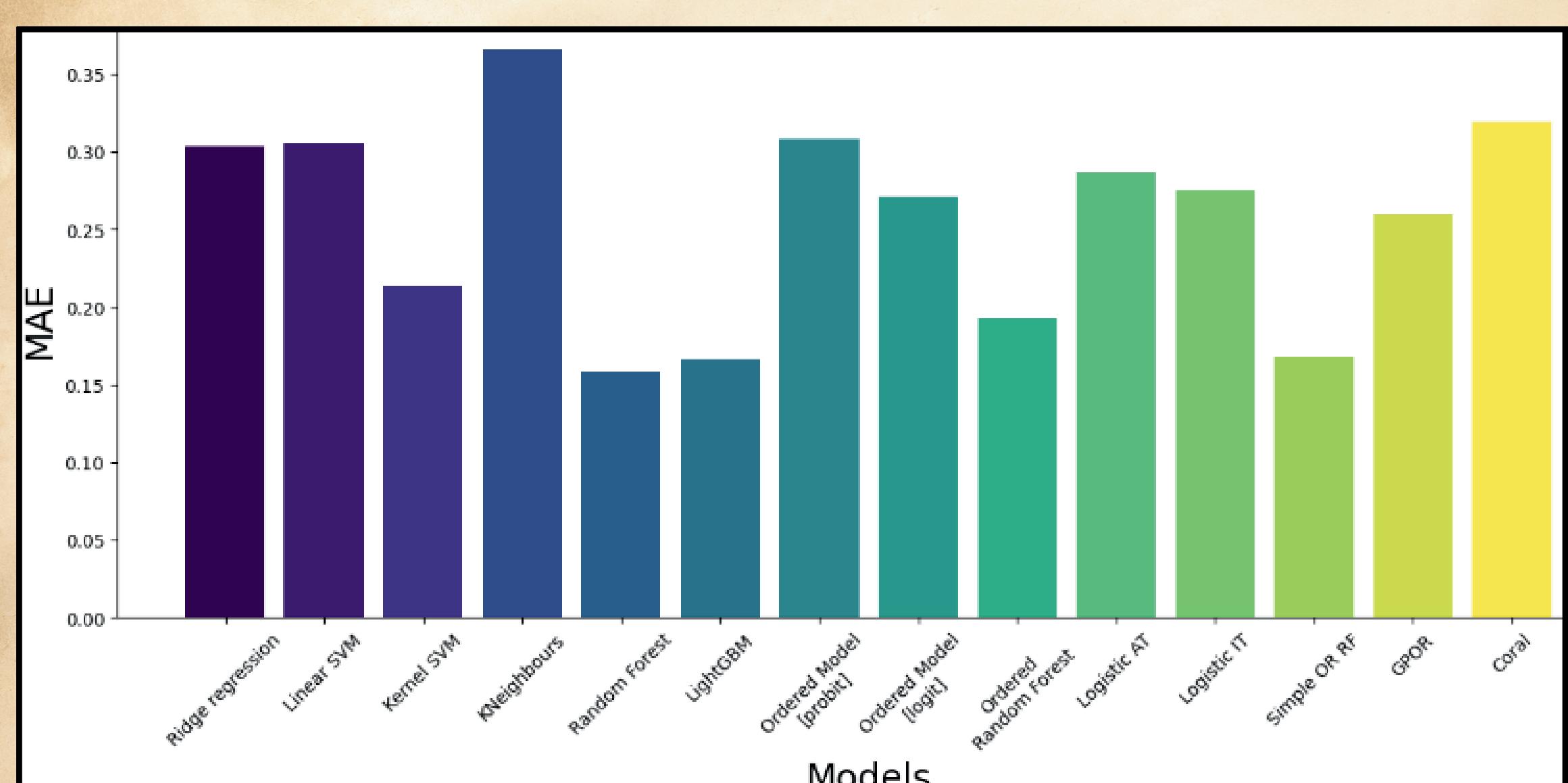
Chronological split

Monsters from books and scenarios

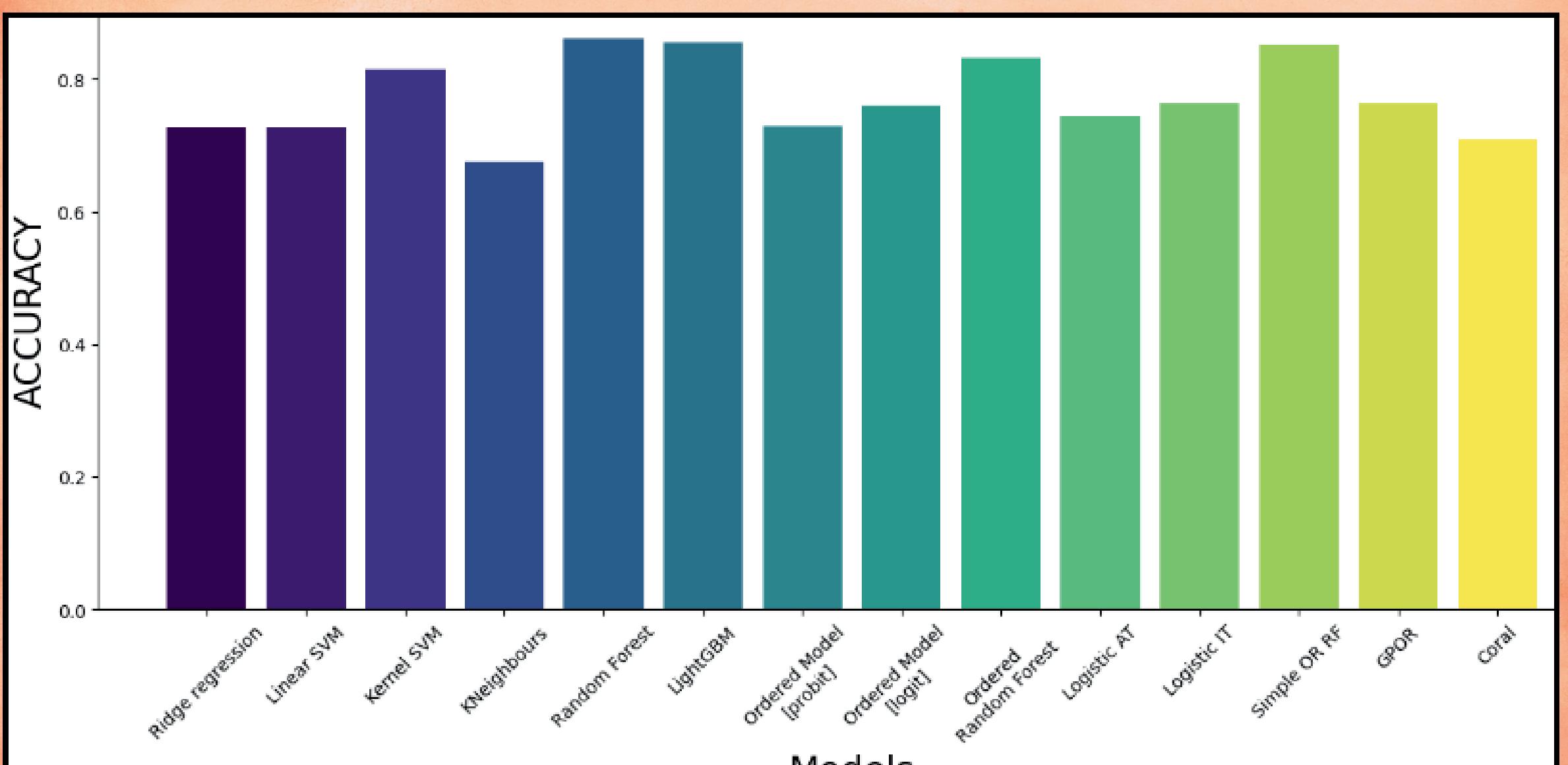
### Rounding

- Classical rounding
- Single best threshold for all levels
- Threshold tuning per level:
  - TPE algorithm
  - Shortest path for graph

### MAE



### Accuracy

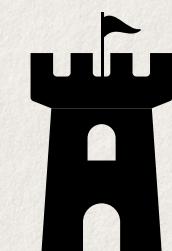


## WHAT ARE RPGS?

### Role-playing Game

a game played around a table or online in which a group of people create and play the part of characters in a story that develops as the game is played

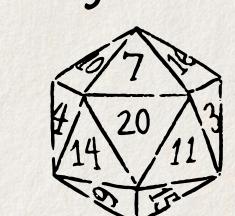
Cambridge Dictionary (02.2024)



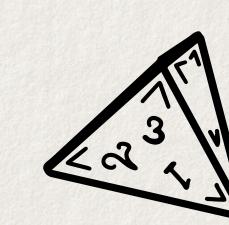
Takes place in an imaginary, fantasy world.



A group of people play as heroes of the story. Characters have statistics, e.g. strength or intelligence.



Adventures/gameplay is based on Game Master narration.



GOAL: Complete adventure scenario and achieve personal targets of heroes, e.g. kill dragon.

## FIGHT WITH MONSTERS!!!

Major part of game is fighting monsters, presented by GM.

Monsters have statistics similar to players, e.g. strength.

Number representing how hard it is to defeat the creature.



The fight should be challenging, but the victory has to be possible.



### Models

- Baseline: kNN - concept that is intuitive for humans
- Simple OR with Random Forest (RF) uses n-1 classifiers
- GPOR is a Gaussian Process model with ordinal likelihood
- CORAL is a method for OR with deep neural networks
- Ordered model based on logistic (logit) or normal distribution (probit)
- Ordered Random Forest is based on RF regression with ordered probabilities
- Logistic models implementing ordinal logistic model
  - All-Threshold
  - Immediate-Threshold
- SVM with RBF kernel

### Bul-Gae

AC 33; Fort +28, Ref +22, Will +25

Str +8, Dex +4, Con +7, Int +5, Wis +6, Cha +4

HP 255; Resistances cold 15, fire 15

Speed 40 feet

Melee jaws +27

Damage 2d8+12 piercing + 2d6 cold/fire



## RESULTS

- Best results for all metrics achieved by all RF-based models (RF, Ordered RF & Simple OR RF).
- Linear models give surprisingly good results.
- All models strongly outperform the human-inspired kNN baseline.
- LightGBM performs best with classical rounding due to its tendency to overfit.
- All models work great, with errors at most is 1-2 levels.
- Ordinal models do not have a better performance than classic regression with rounding.
- Best results: rounding with optimized graph-based thresholding.