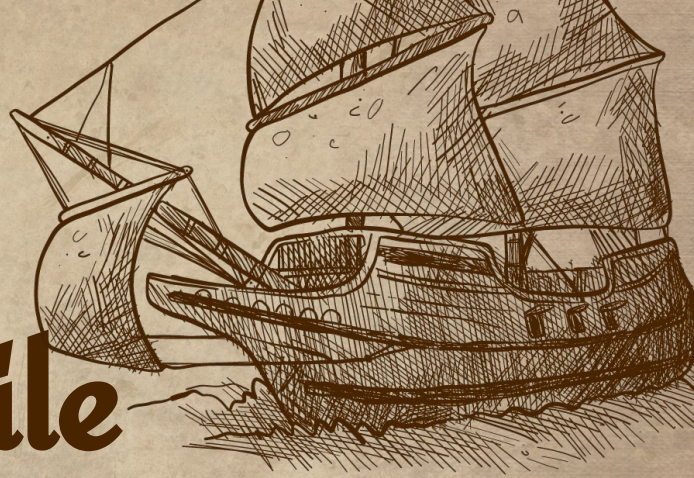
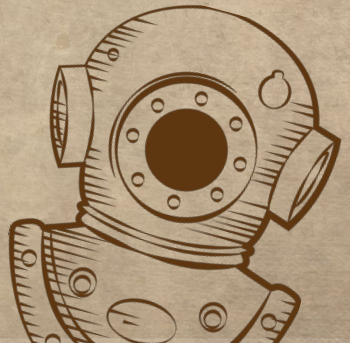


Path Of Exile Economy

A ML study on POE's Economy



0. Introduction

https://github.com/produdez/poe-economy/blob/main/Introduction.ipynb

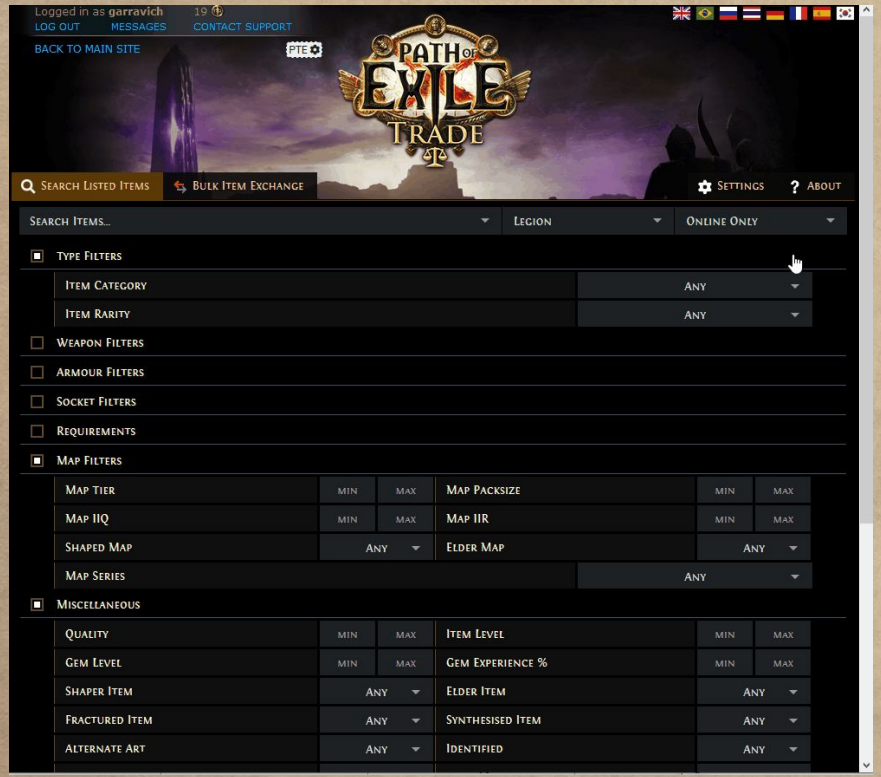
TOPIC INTRODUCTION

TLDR: run around killing stuff (Diablo)

Path Of Exile

Action RPG game developed by GGG, in the running from 2013 until now (2022)

Topic Introduction



The Economy

Free trade market for all items in game

Medium of Exchange

Chaos Orb

TOPIC INTRODUCTION

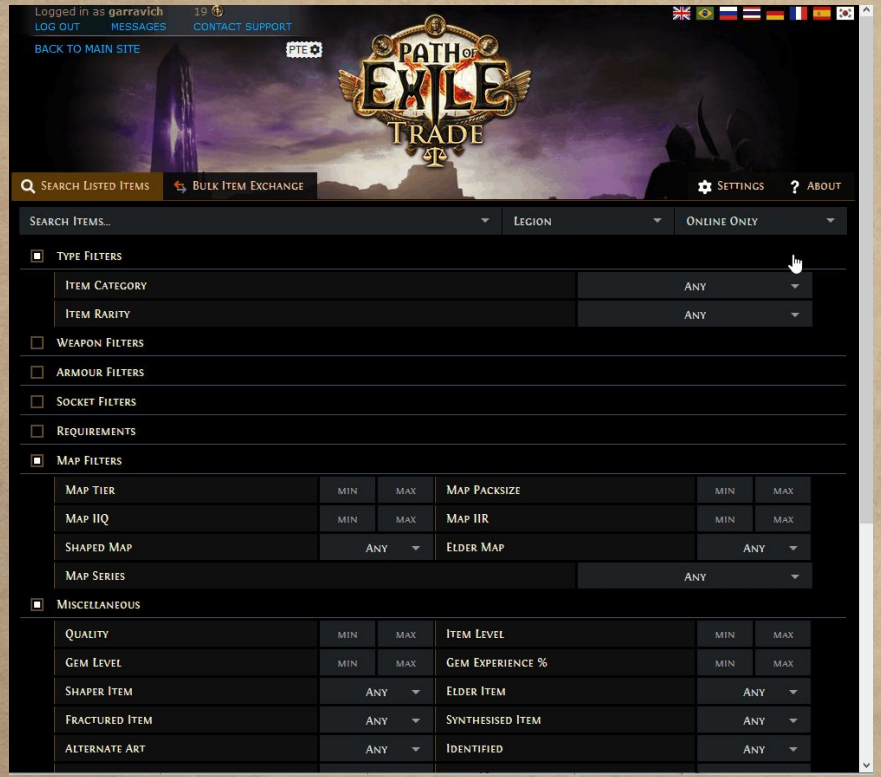


TABLE OF CONTENT

01 MOTIVATION

02 DATA

03 MACHINE LEARNING

04 COMPARISON

05 EXPANSION

06 CONCLUSION

1. Motivations

MOTIVATION

THE LEAGUE MECHANIC

period of gameplay of 3 months where the developer would usually introduce some new gameplay contents

List of challenge leagues

The challenge league currently running is the Scourge league.

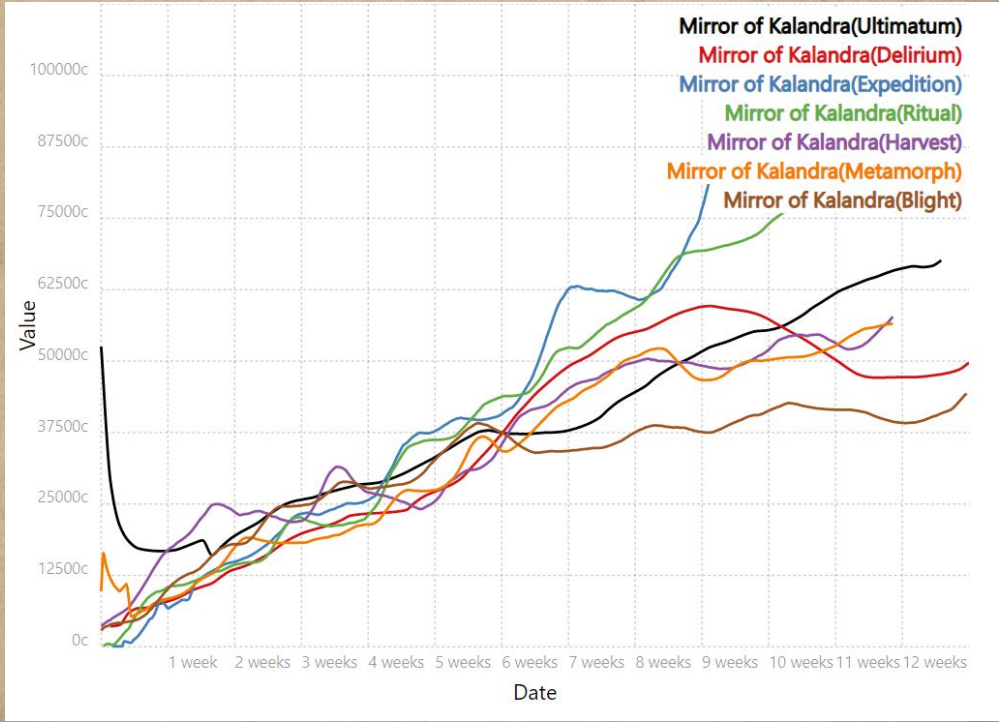
Expansion	release date	end date	release version
Scourge league	2021-10-22 8:00:00 PM		3.16.0
Expedition league	2021-07-23 8:00:00 PM	2021-10-19 8:00:00 PM	3.15.0
Ultimatum league	2021-04-16 8:00:00 PM	2021-07-19 10:00:00 PM	3.14.0
Ritual league	2021-01-15 8:00:00 PM	2021-04-12 9:00:00 PM	3.13.0
Heist league	2020-09-18 8:00:00 PM	2021-01-11 9:00:00 PM	3.12.0
Harvest league	2020-06-19 8:00:00 PM	2020-09-14 10:00:00 PM	3.11.0

35 leagues as of today

MOTIVATION

THE LEAGUE MECHANIC

Each league also reset the player's progress and wealth (all items)



Mirror of Kalandra's price

MOTIVATION

> "What if we can learn from this historical data and apply it to use in future leagues' prediction?"

— ME

MOTIVATION

01

This is only a study on economics

02

The project is a bit 'unpractical' and not related to VietNam in anyways

03

But it deals with a typical data in ML and is an interesting topic (for me)

2. Data

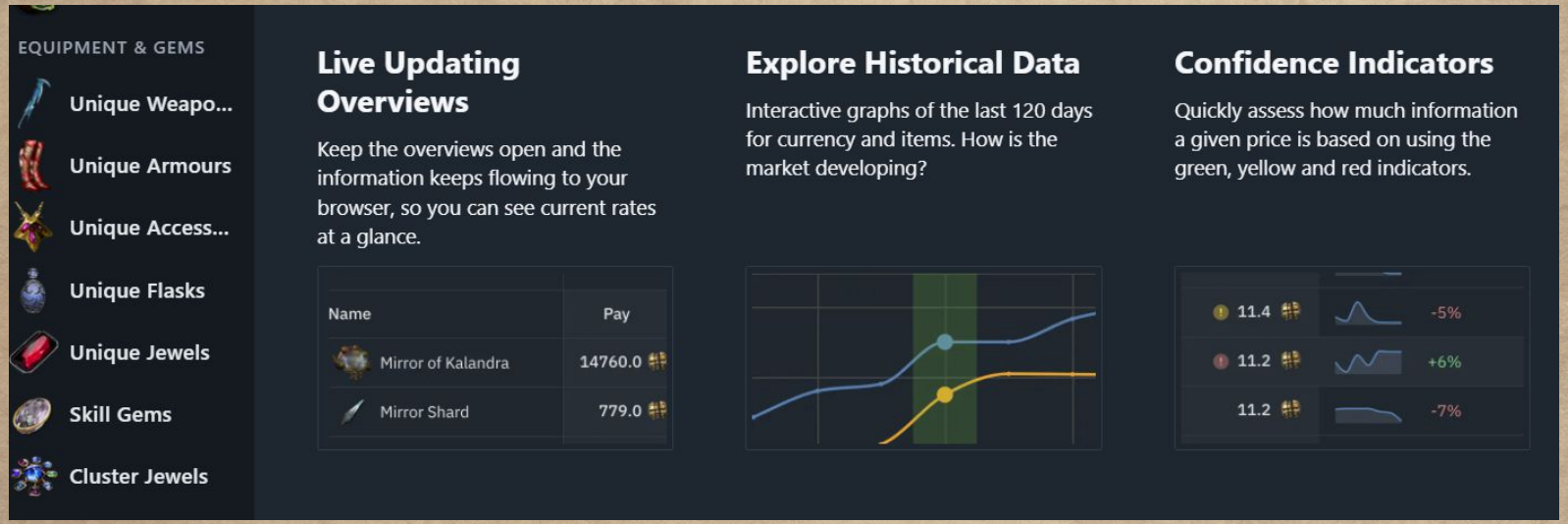
https://github.com/produdez/poe-economy/blob/main/RelatedAPIs.ipynb

https://github.com/produdez/poe-economy/blob/main/DataAcquisition.ipynb

https://github.com/produdez/poe-economy/blob/main/DataExploration.ipynb

https://github.com/produdez/poe-economy/blob/main/FeatureEngineering.ipynb

Data acquisition



poe.ninja

A market live data website

Has data dump each league for our usage

Data acquisition

- The data include all leagues from Essence to Scourge league
  - 19 Most recent leagues compare to the total 35 leagues

Raw Economy Data Dumps

This section contains raw dumps of economy data for past leagues for use in other community tools or to do interesting economy research.
Each league section contains a zip file consisting of the softcore and hardcore challenge leagues and the data from the softcore and hardcore permanent leagues in the same time span.
Each zip file contains a CSV file (semicolon seperated) for currency data points and item data points. These contain a line per item per day - so for example the Abyss CSVs contain about 9500 lines for currency and 225000 lines for items.
Example Exalted Orb data points from the Abyss currency CSV:

```
League; Date;       Get;            Pay;        Value;      Confidence
Abyss;  2017-12-09; Exalted Orb;    Chaos Orb;  26.16644;   High
Abyss;  2017-12-10; Exalted Orb;    Chaos Orb;  35.92556;   High
Abyss;  2017-12-11; Exalted Orb;    Chaos Orb;  43.5739;    High
Abyss;  2017-12-12; Exalted Orb;    Chaos Orb;  47.99698;   High
Abyss;  2017-12-13; Exalted Orb;    Chaos Orb;  45.45841;   High
Abyss;  2017-12-14; Exalted Orb;    Chaos Orb;  41.32816;   High
Abyss;  2017-12-15; Exalted Orb;    Chaos Orb;  42.48889;   High
Abyss;  2017-12-16; Exalted Orb;    Chaos Orb;  41.78923;   High
Abyss;  2017-12-17; Exalted Orb;    Chaos Orb;  41.5251;    High
```

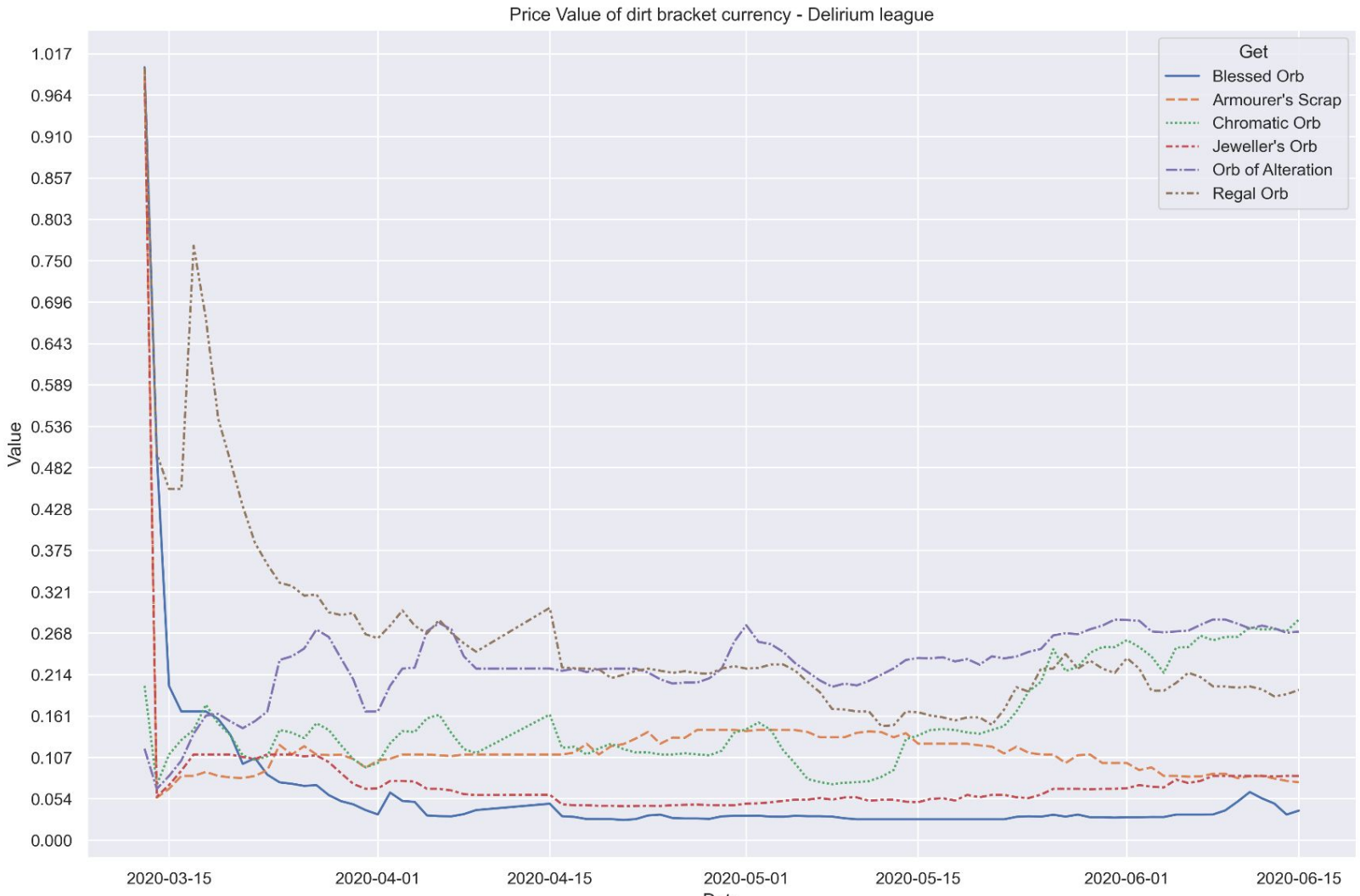
Data dump from poe.ninja

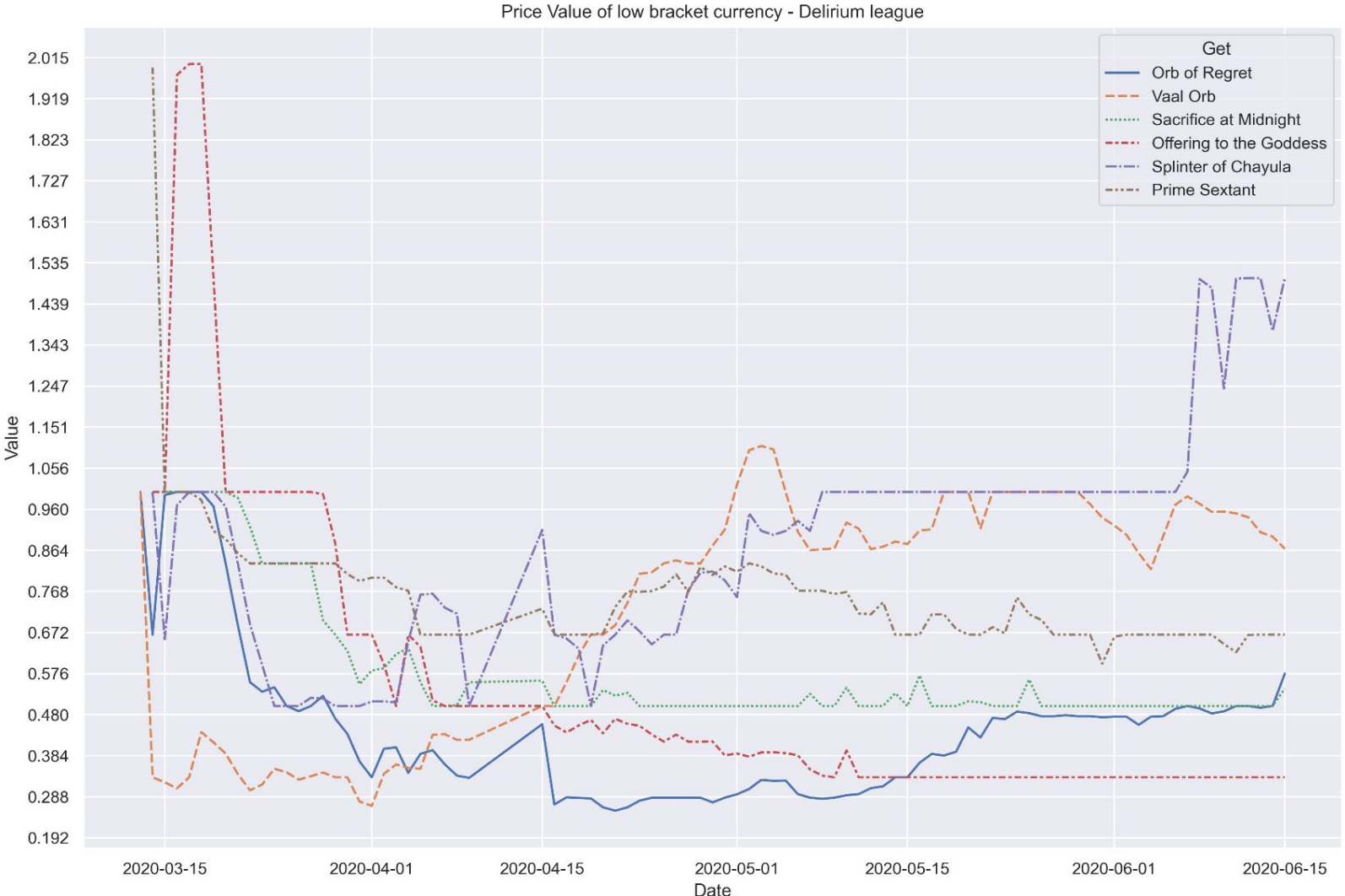
DATA EXPLORATION

Won't go detail into how the data dump is structure

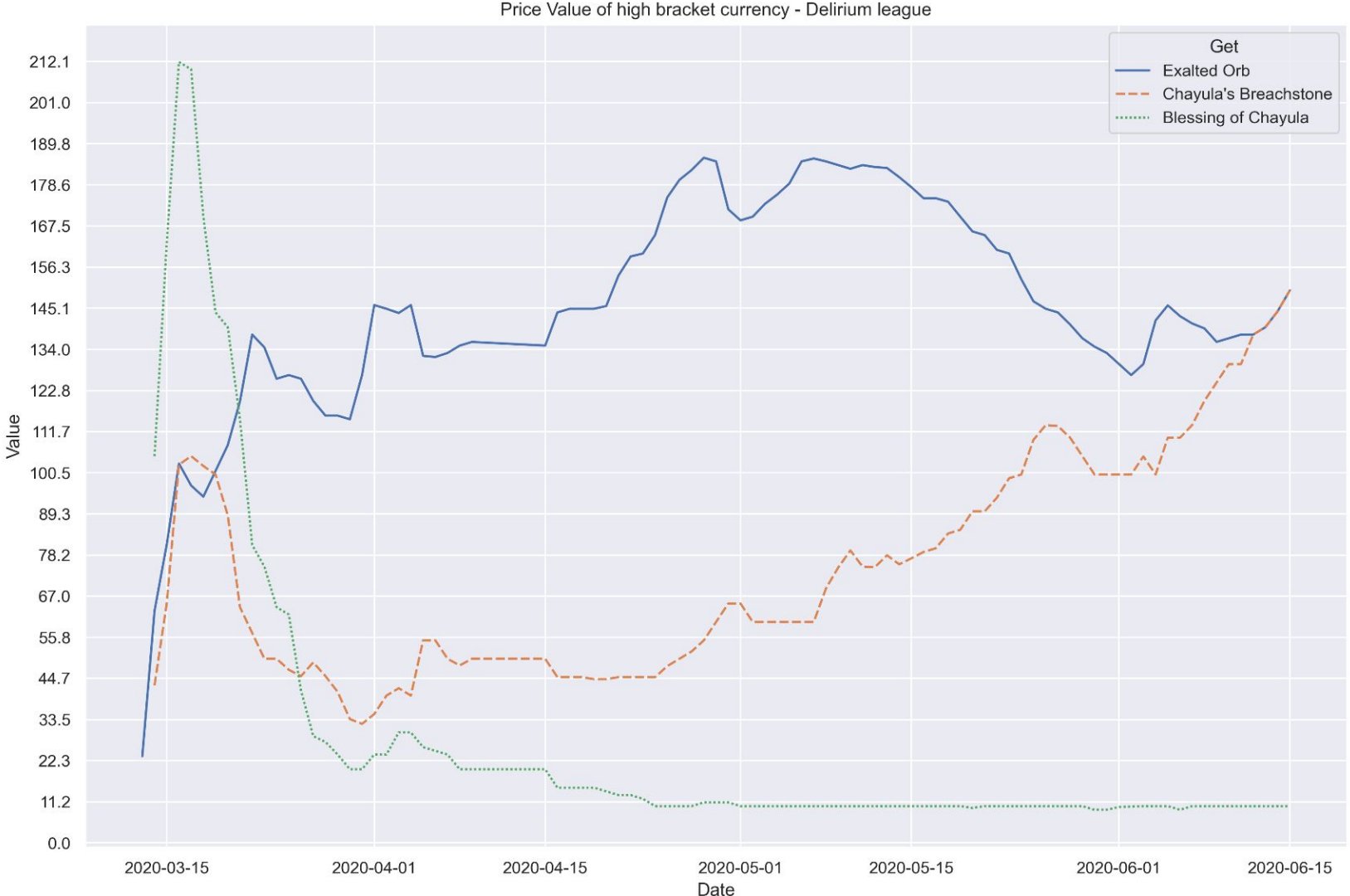
League	Day	Get	Pay	Value	Confidence
Abyss	2017-12-09	Exalted Orb	Chaos Orb	26.16644	High

DATA TREND BETWEEN BRACKETS


Price Value of dirt bracket currency - Delirium league
Value
1.017
0.964
0.910
0.857
0.803
0.750
0.696
0.643
0.589
0.536
0.482
0.428
0.375
0.321
0.268
0.214
0.161
0.107
0.054
0.000
2020-03-15
2020-04-01
2020-04-15
2020-05-01
2020-05-15
2020-06-01
2020-06-15
Get
Blessed Orb
Armourer's Scrap
Chromatic Orb
Jeweller's Orb
Orb of Alteration
Regal Orb

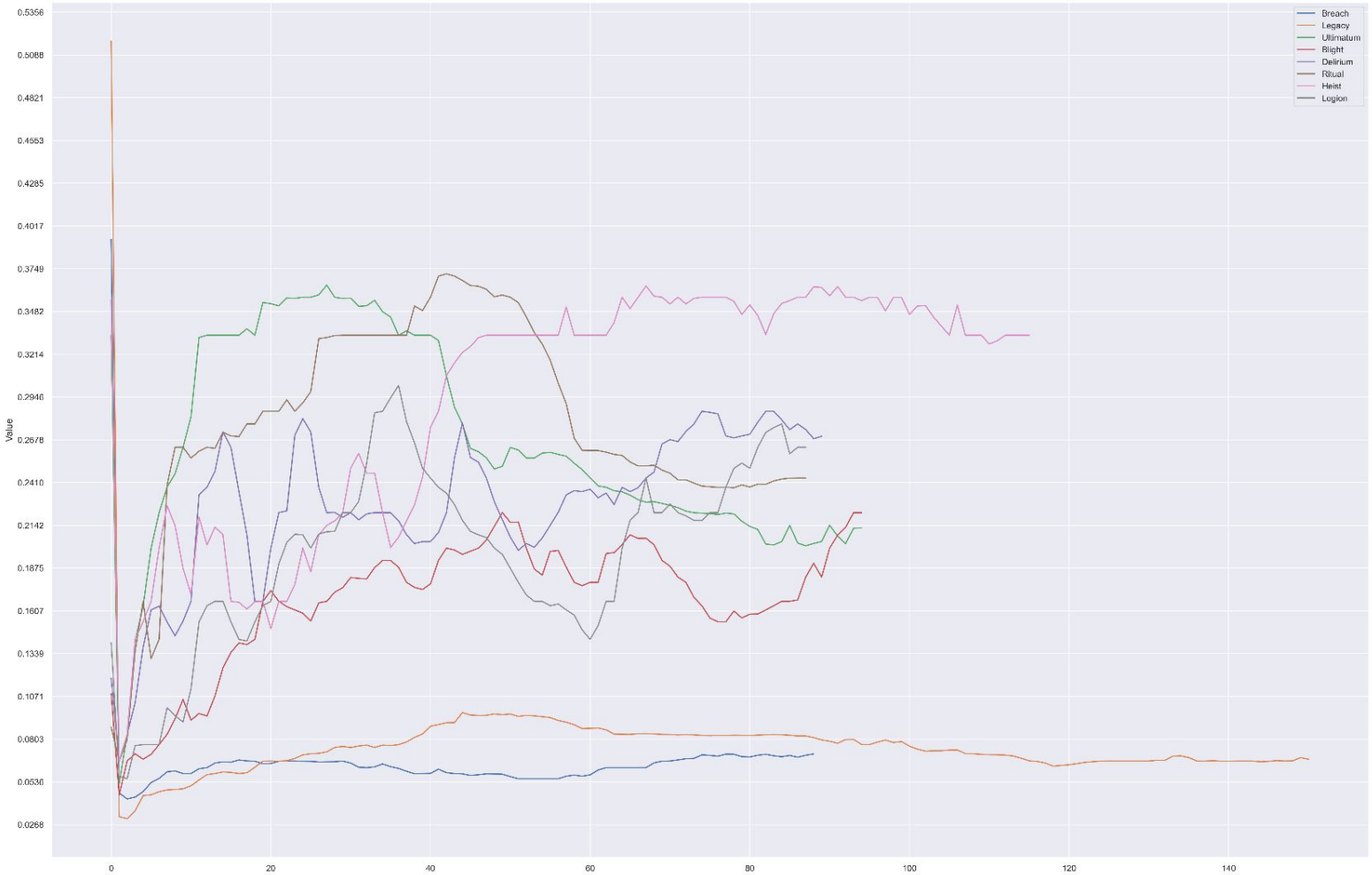

Price Value of low bracket currency - Delirium league
Get
Orb of Regret
Vaal Orb
Sacrifice at Midnight
Offering to the Goddess
Splinter of Chayula
Prime Sextant
Value
2.015
1.919
1.823
1.727
1.631
1.535
1.439
1.343
1.247
1.151
1.056
0.960
0.864
0.768
0.672
0.576
0.480
0.384
0.288
0.192
2020-03-15
2020-04-01
2020-04-15
2020-05-01
2020-05-15
2020-06-01
2020-06-15
Date

Price Value of medium bracket currency - Delirium league
Get
Divine Orb
Xoph's Breachstone
Mortal Grief
Mortal Ignorance
Awakened Sextant
Value
23.00
21.79
20.58
19.37
18.16
16.95
15.74
14.53
13.32
12.10
10.89
9.68
8.47
7.26
6.05
4.84
3.63
2.42
1.21
0.00
2020-03-15
2020-04-01
2020-04-15
2020-05-01
2020-05-15
2020-06-01
2020-06-15

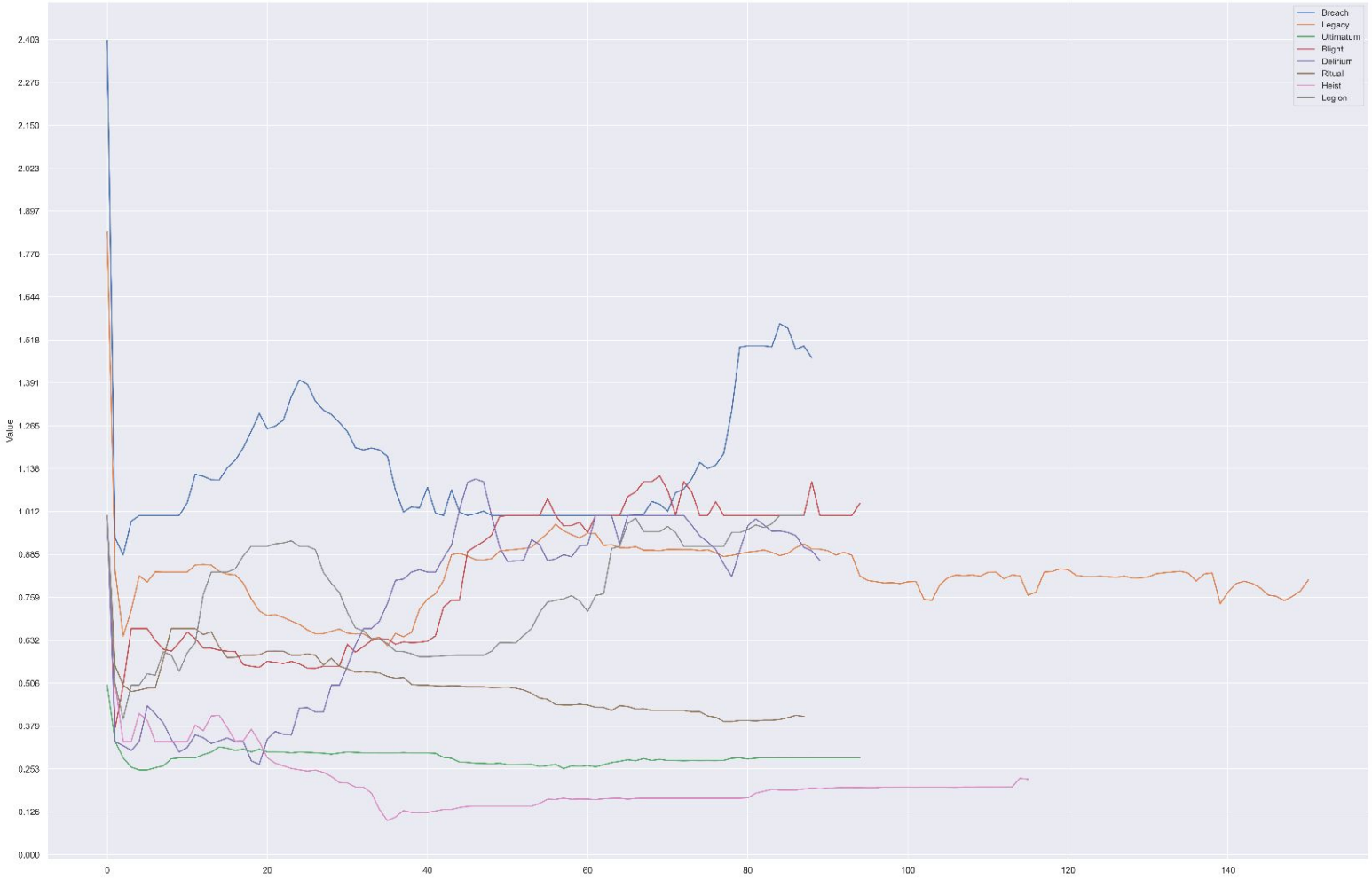

Price Value of high bracket currency - Delirium league
Get
Exalted Orb
Chayula's Breachstone
Blessing of Chayula
Value
212.1
201.0
189.8
178.6
167.5
156.3
145.1
134.0
122.8
111.7
100.5
89.3
78.2
67.0
55.8
44.7
33.5
22.3
11.2
0.0
2020-03-15
2020-04-01
2020-04-15
2020-05-01
2020-05-15
2020-06-01
2020-06-15
Date

DATA TREND BETWEEN LEAGUES

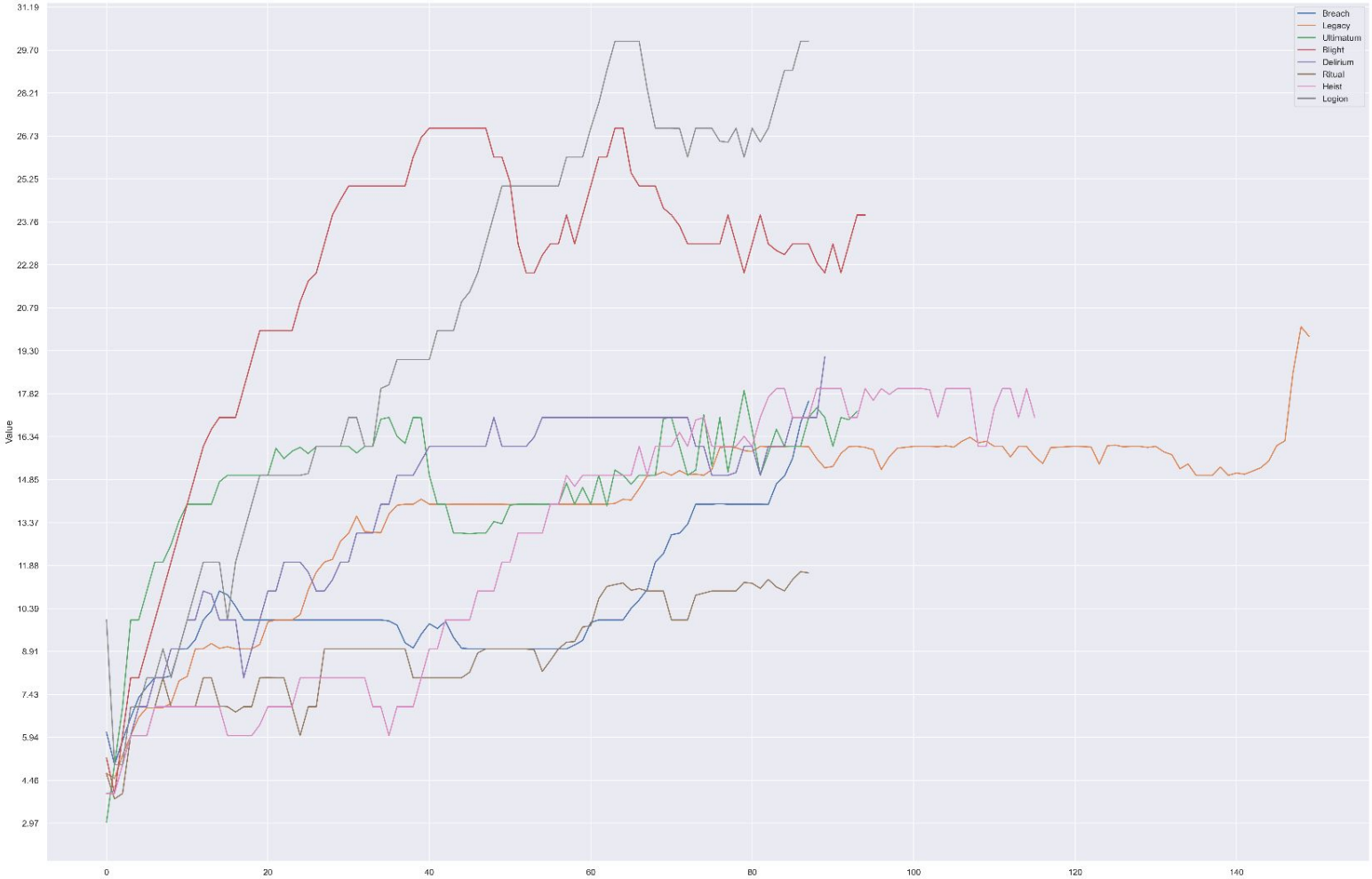
Orb of alteration



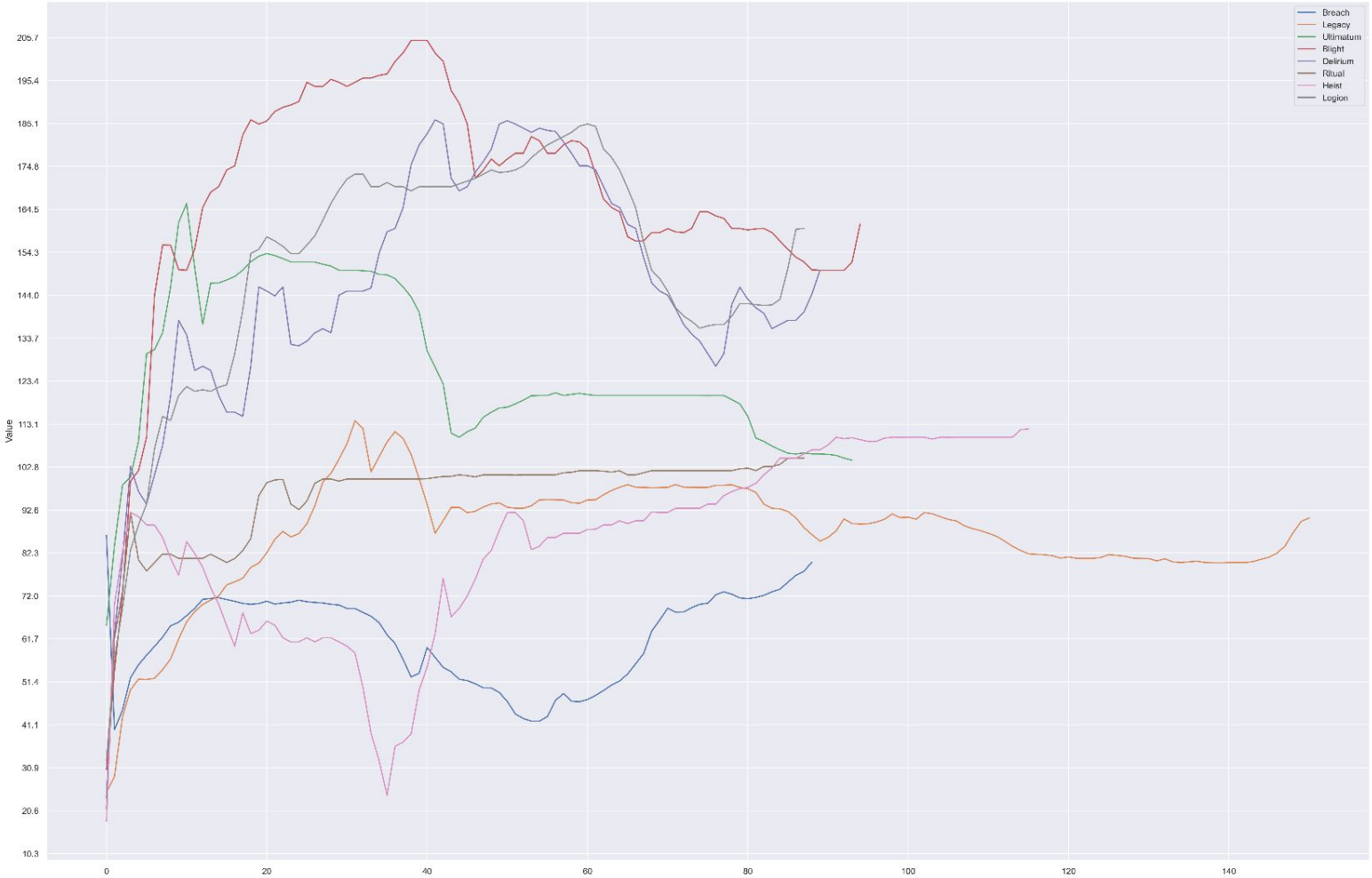
Vaal Orb


Breach
Legacy
Ultimatum
Blight
Delirium
Ritual
Heist
Legion
Value
2.403
2.276
2.150
2.023
1.897
1.770
1.644
1.518
1.391
1.265
1.138
1.012
0.885
0.759
0.632
0.506
0.379
0.253
0.126
0.000
0
20
40
60
80
100
120
140

Divine Orb


Breach
Legacy
Ultimatum
Blight
Delirium
Ritual
Heist
Legion
Value
31.19
29.70
28.21
26.73
25.25
23.76
22.28
20.79
19.30
17.82
16.34
14.85
13.37
11.88
10.39
8.91
7.43
5.94
4.46
2.97
0
20
40
60
80
100
120
140

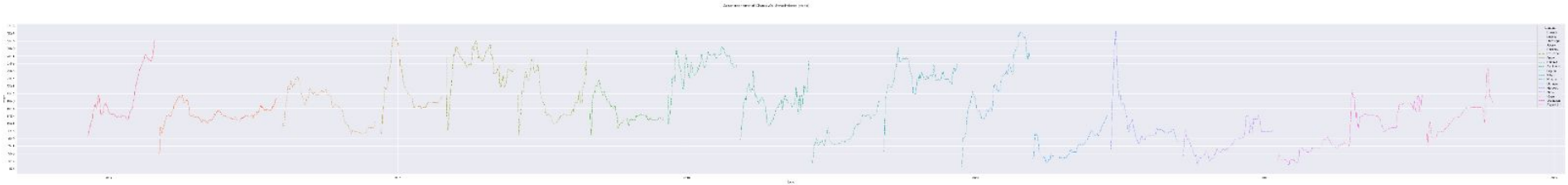
Exalted Orb


Breach
Legacy
Ultimatum
Blight
Delirium
Ritual
Heist
Legion
Value
205.7
195.4
185.1
174.8
164.5
154.3
144.0
133.7
123.4
113.1
102.8
92.6
82.3
72.0
61.7
51.4
41.1
30.9
20.6
10.3
0
20
40
60
80
100
120
140

TREND GRAPH

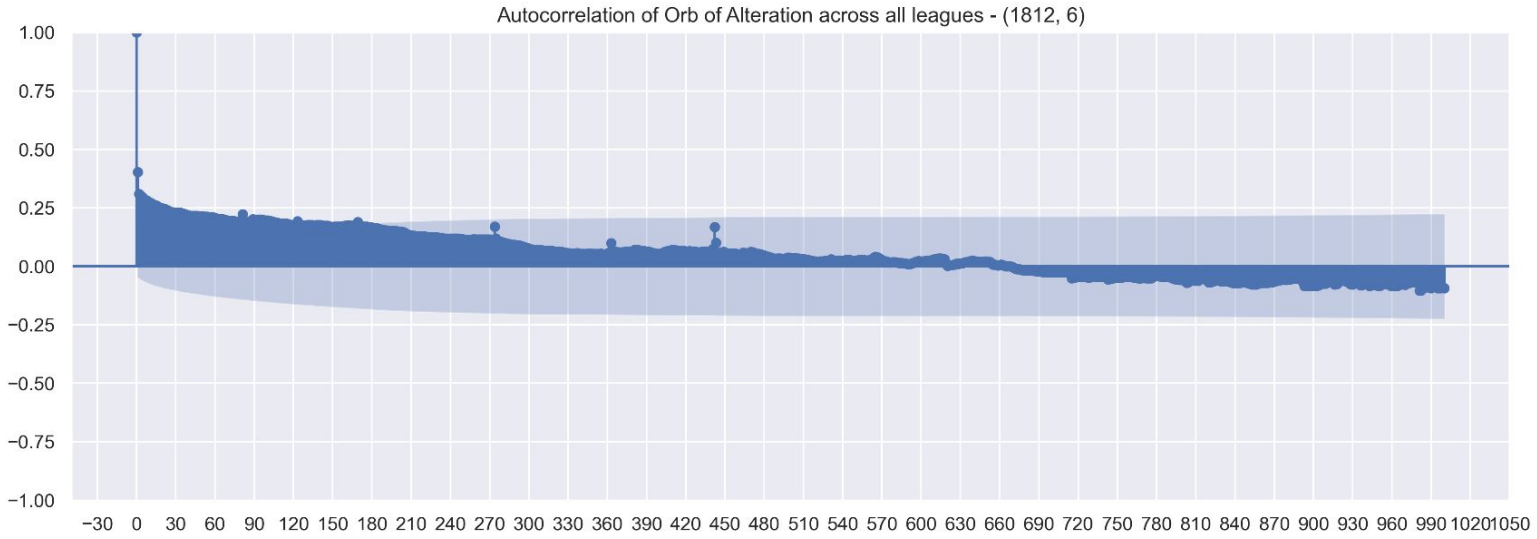
The North Hemi spheare
The South Hemispheare
THE OCEANE
THE PACIFICKE SEA
The straits of Magellan
THE WESTERNE OCEAN
INDIAN SEA
ARABIAN AND
TICKE SEA
MEDITERRANEAN SEA
NORT
SOUTH AMERICA
BRASIL OR PERU
PERU

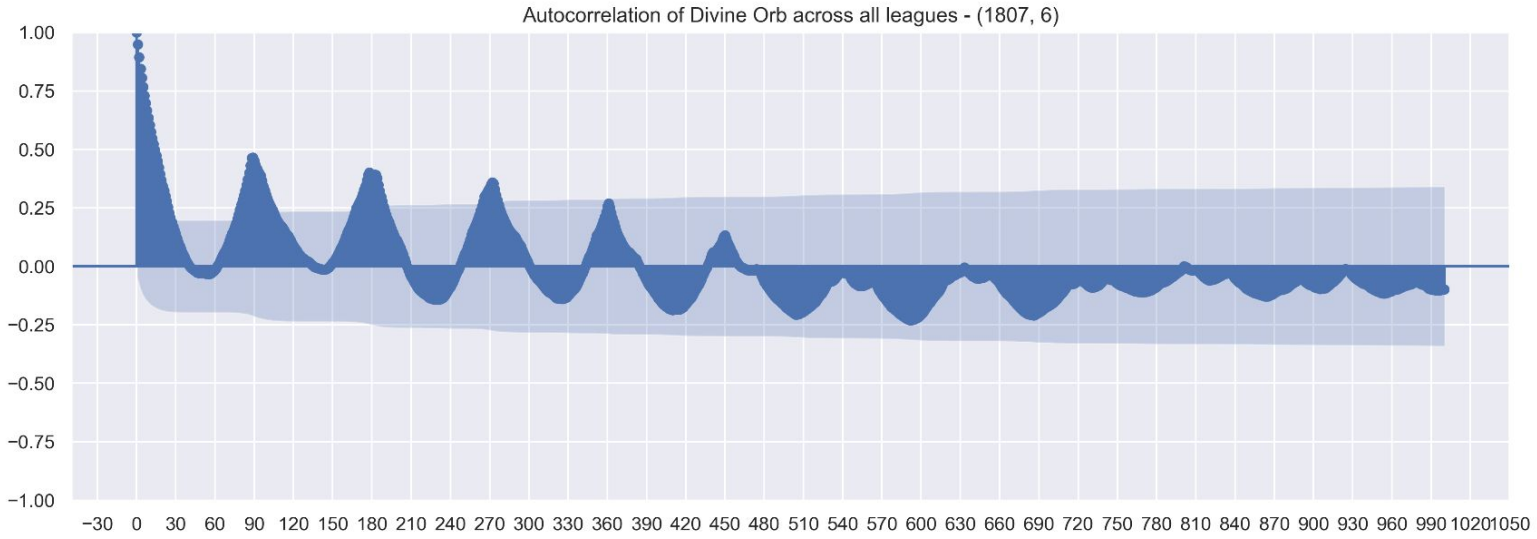
Can't show due to size

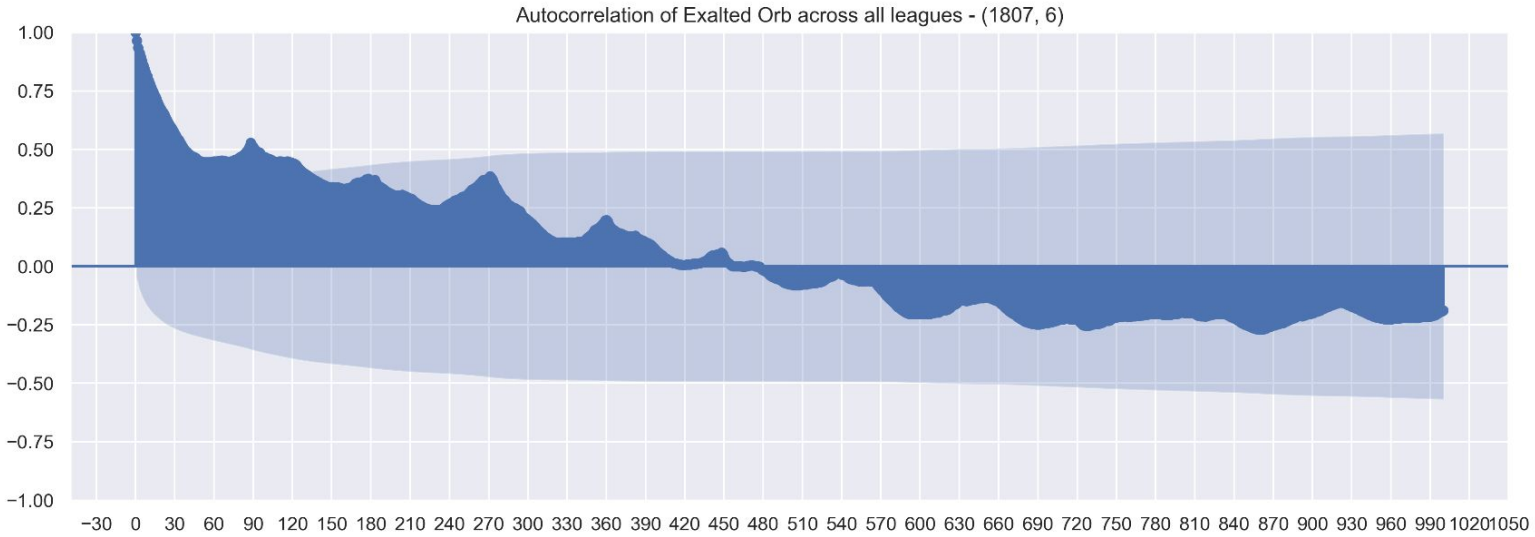


Does not show any clear trend

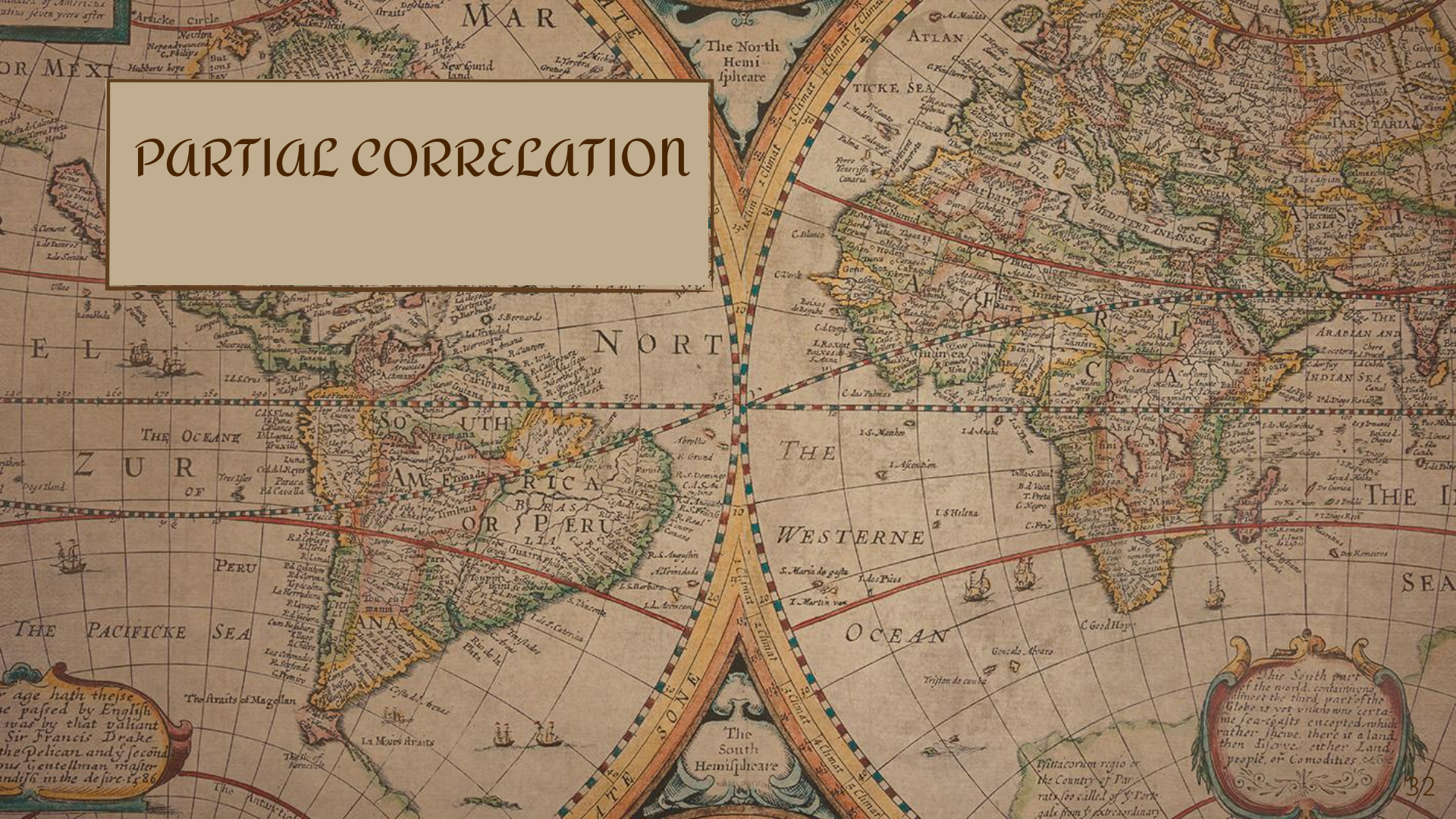
CORRELATION


Autocorrelation of Orb of Alteration across all leagues - (1812, 6)
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−30 0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510 540 570 600 630 660 690 720 750 780 810 840 870 900 930 960 990 1020 1050

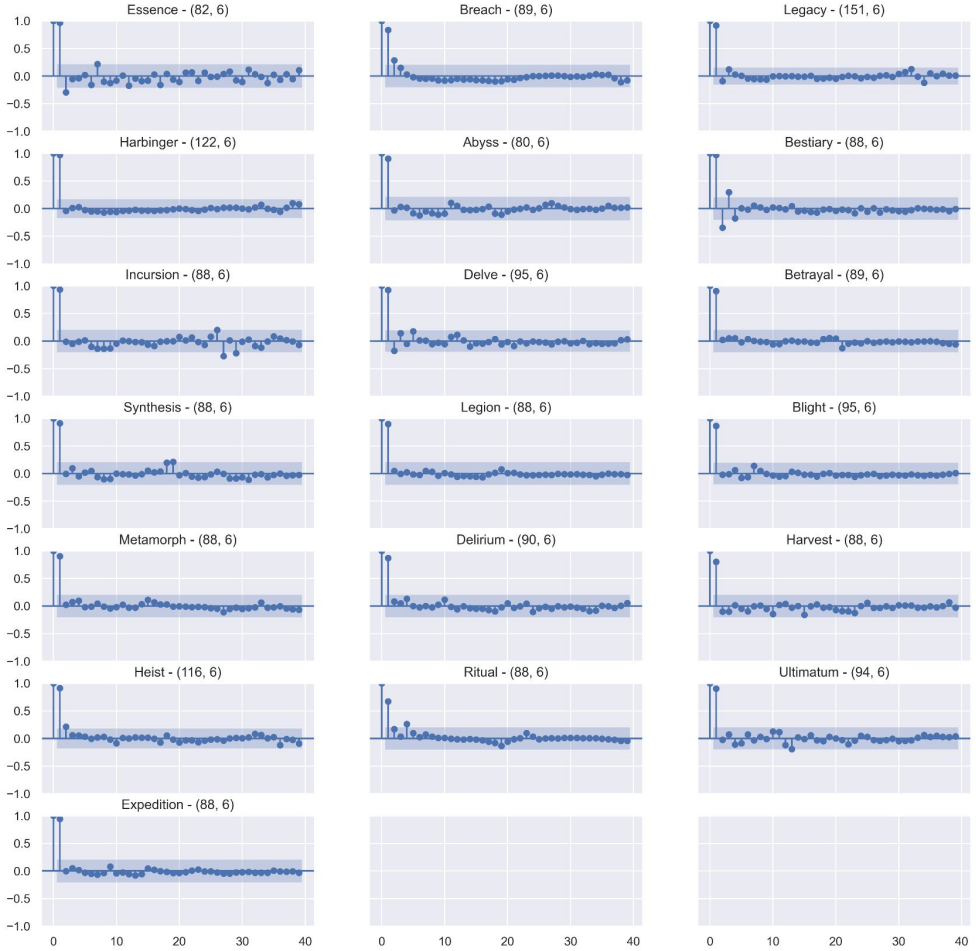

Autocorrelation of Divine Orb across all leagues - (1807, 6)
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−30 0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510 540 570 600 630 660 690 720 750 780 810 840 870 900 930 960 990 1020 1050


Autocorrelation of Exalted Orb across all leagues - (1807, 6)
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−30 0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480 510 540 570 600 630 660 690 720 750 780 810 840 870 900 930 960 990 1020 1050

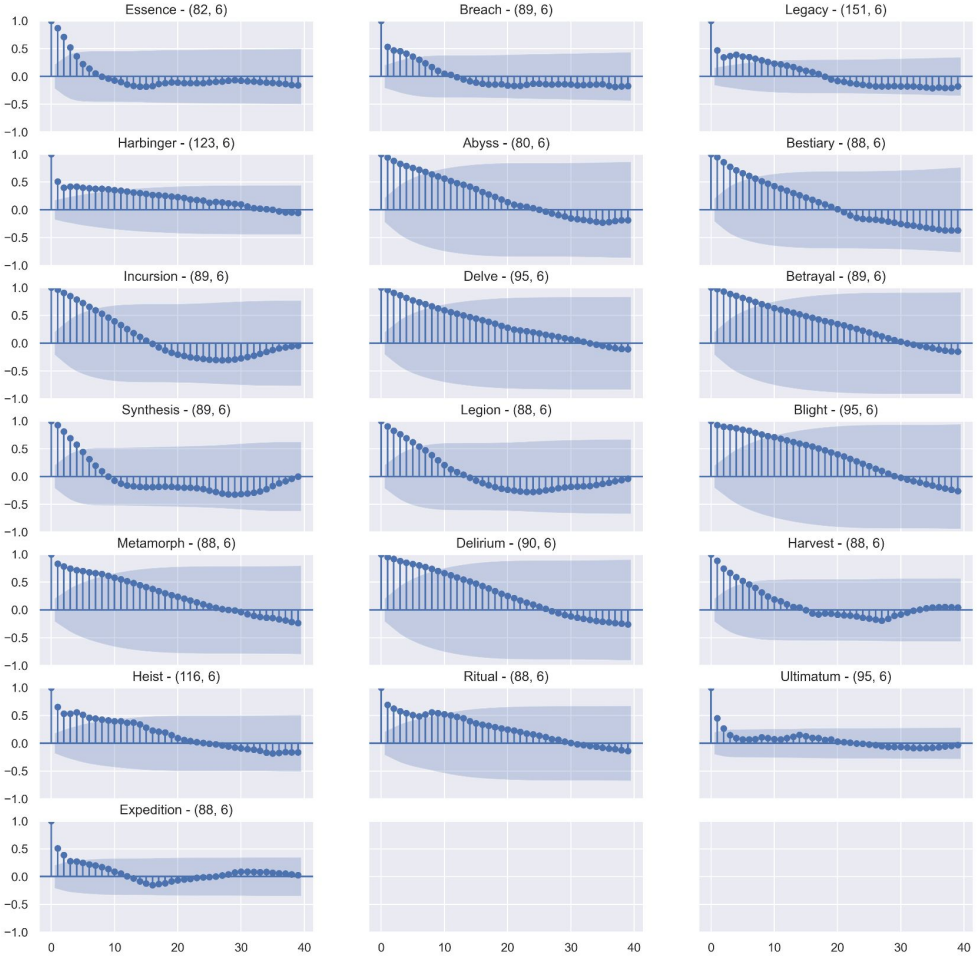
PARTIAL CORRELATION



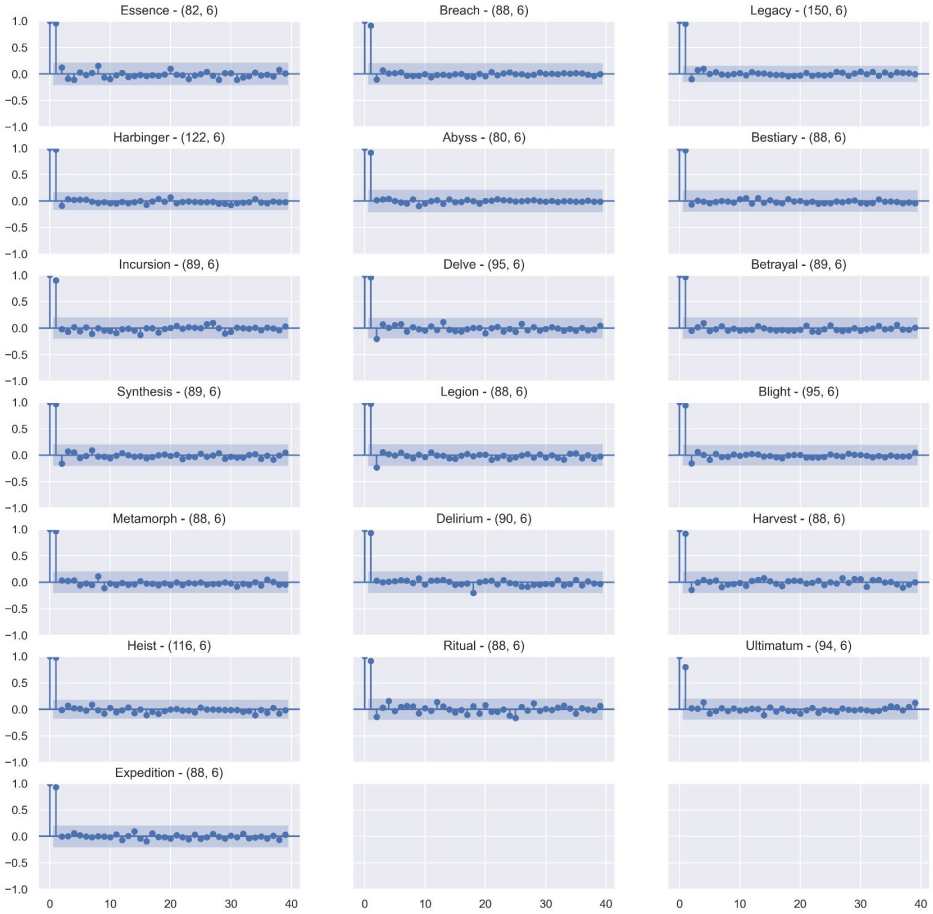
Partial Autocorrelation for Exalted Orb in each leagues



Autocorrelation for Vaal Orb in each leagues



Partial Autocorrelation for Divine Orb in each leagues



3. Machine Learning

https://github.com/produdez/poe-economy/blob/main/Sampling-Preprocessing.ipynb

https://github.com/produdez/poe-economy/blob/main/FeatureEngineering.ipynb

https://github.com/produdez/poe-economy/blob/main/Modeling.ipynb

OBJECTIVE

- Focusing on **Exalted Orb** as the **MAIN** learning object
- 5-steps prediction model
- Compare different models
- Apply model to other learning objects

PREPROCESSING

- Label encode ‘Confidence’ feature
- Some checks
- Remove data inconsistencies (Nul)

FEATURE ENGINEERING

- Add time based features:
  - LeagueDay
  - DayOfWeek
  - Month
- 4 Lag Features
- Expanding and Rolling Features
  - Rolling min, max, mean
  - Expanding min, max, mean
- Make multi-step target for training: 5 steps
- Split all previous leagues as training and the last as validation

MODELING

- **Regressor Chain** with **Random Forest** estimator (Best Models)

X:

- LeagueDay
- DayOfWeek
- Month
- Lag 1 2 3 4
- Rolling min max mean (window 5)
- Rolling min max mean (window 15)
- Expanding min max mean

Y:

- Step 1
- Step 2
- Step 3
- Step 4
- Step 5

RESULT

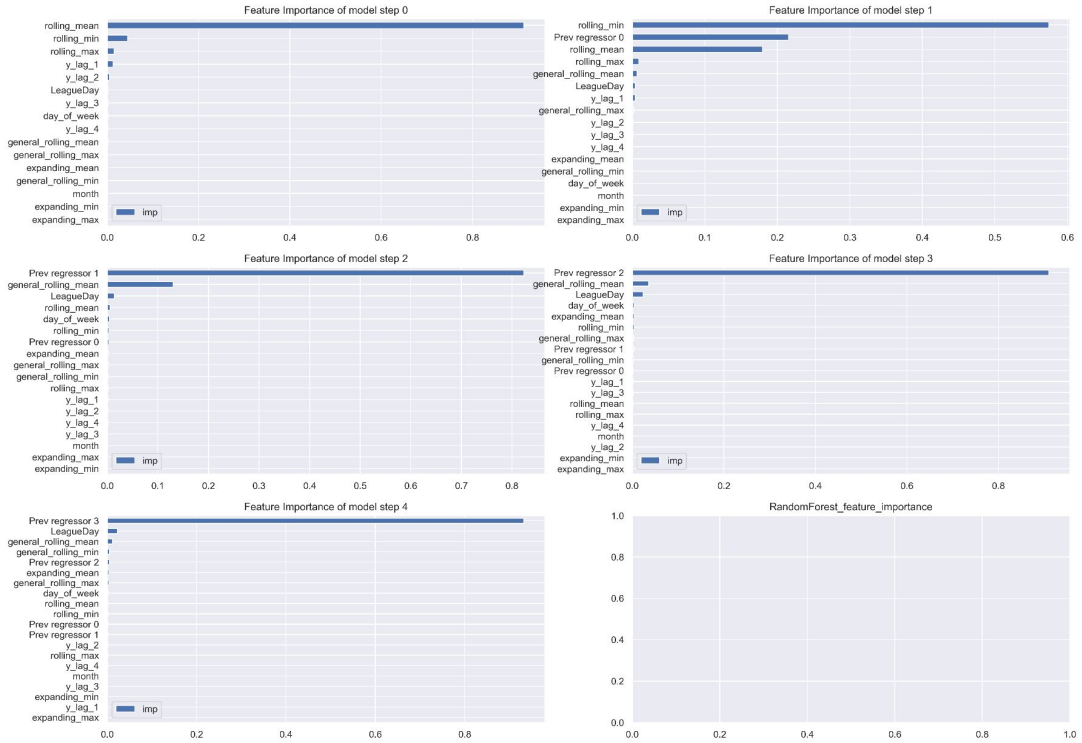
Training:

- MSE: 33.234
- MAPE: 0.024

Validation:

- MSE: 168.946
- MAPE: 0.076

FEATURE IMPORTANCE



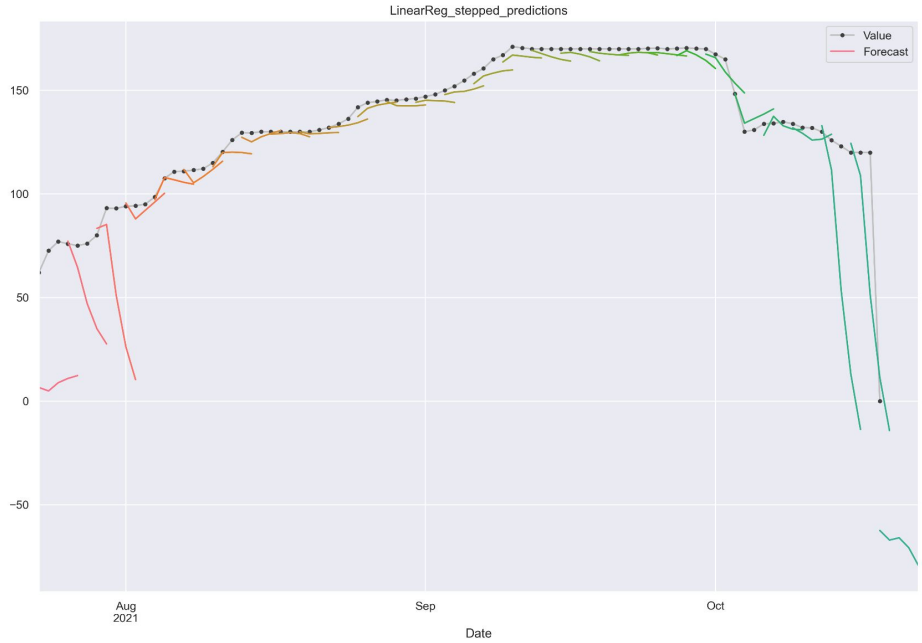
4. Comparison

https://github.com/produdez/poe-economy/blob/main/Comparison-Conclusion.ipynb

REGRESSOR CHAIN

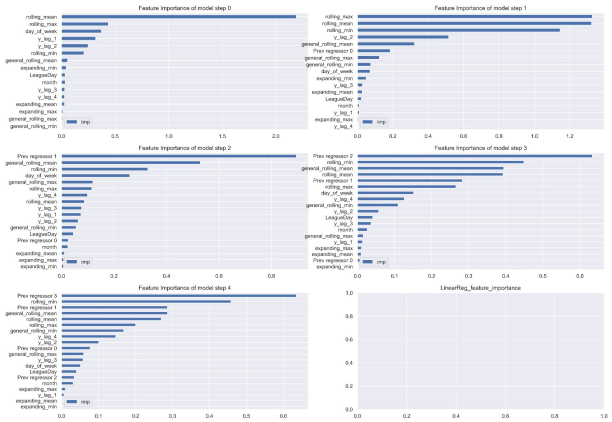
COMPARISON

- **Regressor Chain** with **Linear Regression** estimator



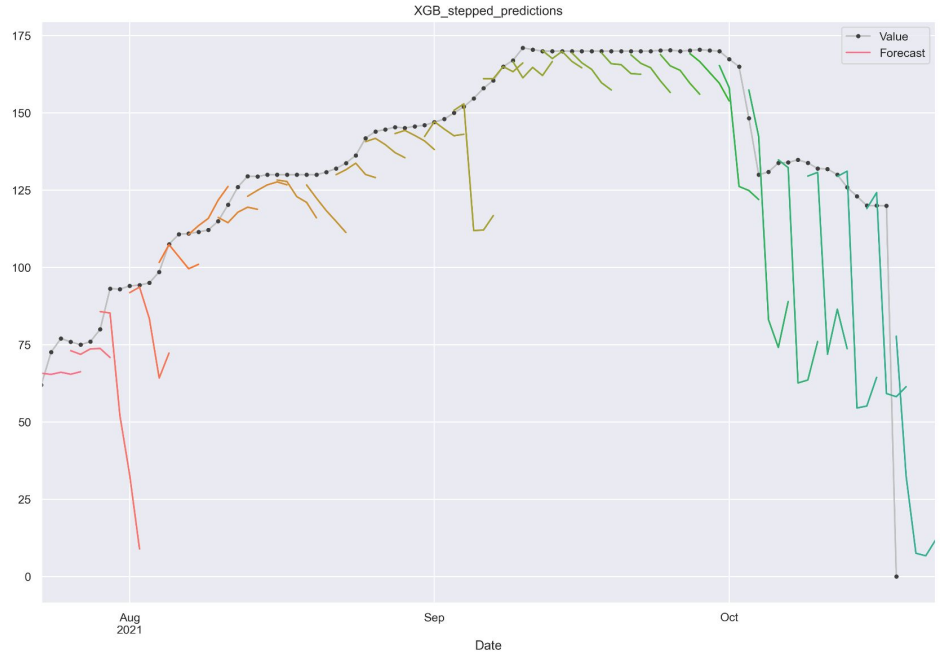
Training:
- MSE: 106.38
- MAPE: 0.08

Validation:
- MSE: 641.39
- MAPE: 0.84



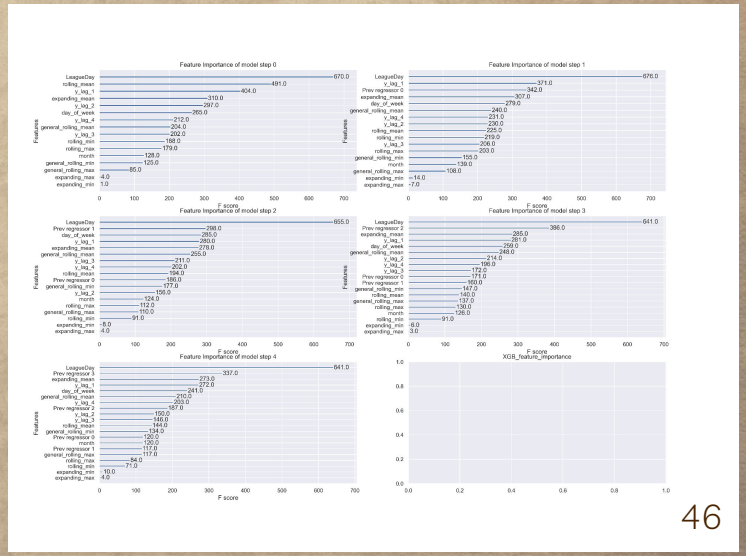
COMPARISON

- **Regressor Chain** with **XGB** estimator



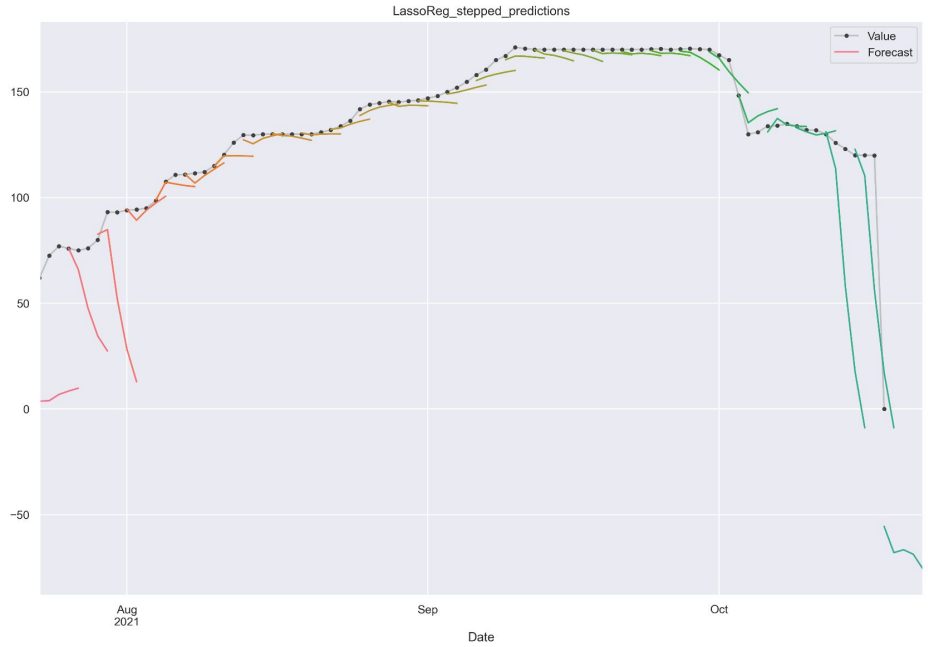
Training:
- MSE: 7.53
- MAPE: 0.01

Validation:
- MSE: 507.65
- MAPE: 0.20



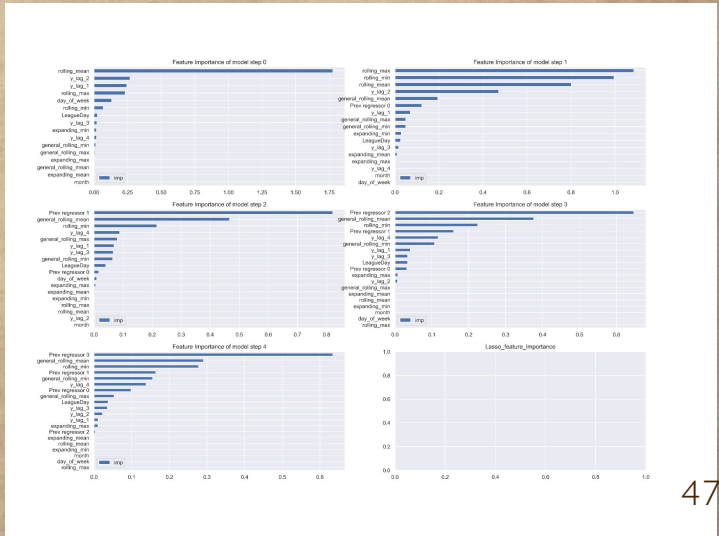
COMPARISON

- **Regressor Chain** with **Lasso** estimator



Training:
- MSE: 107.39
- MAPE: 0.074

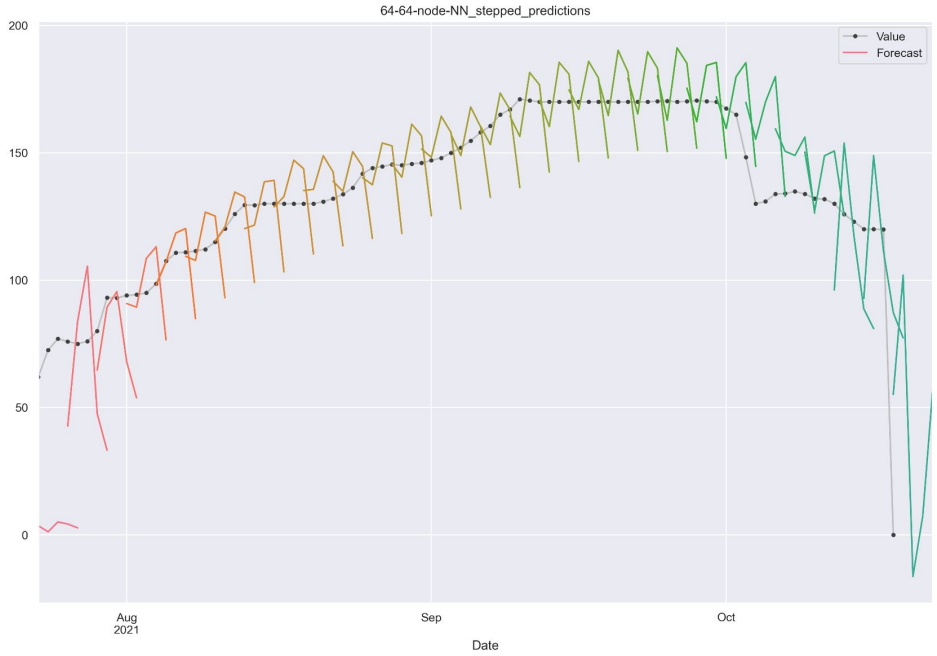
Validation:
- MSE: 608.02
- MAPE: 0.586



FULLY CONNECTED NEURAL NETWORK

COMPARISON

- **64-64-5 Neural Network** estimator

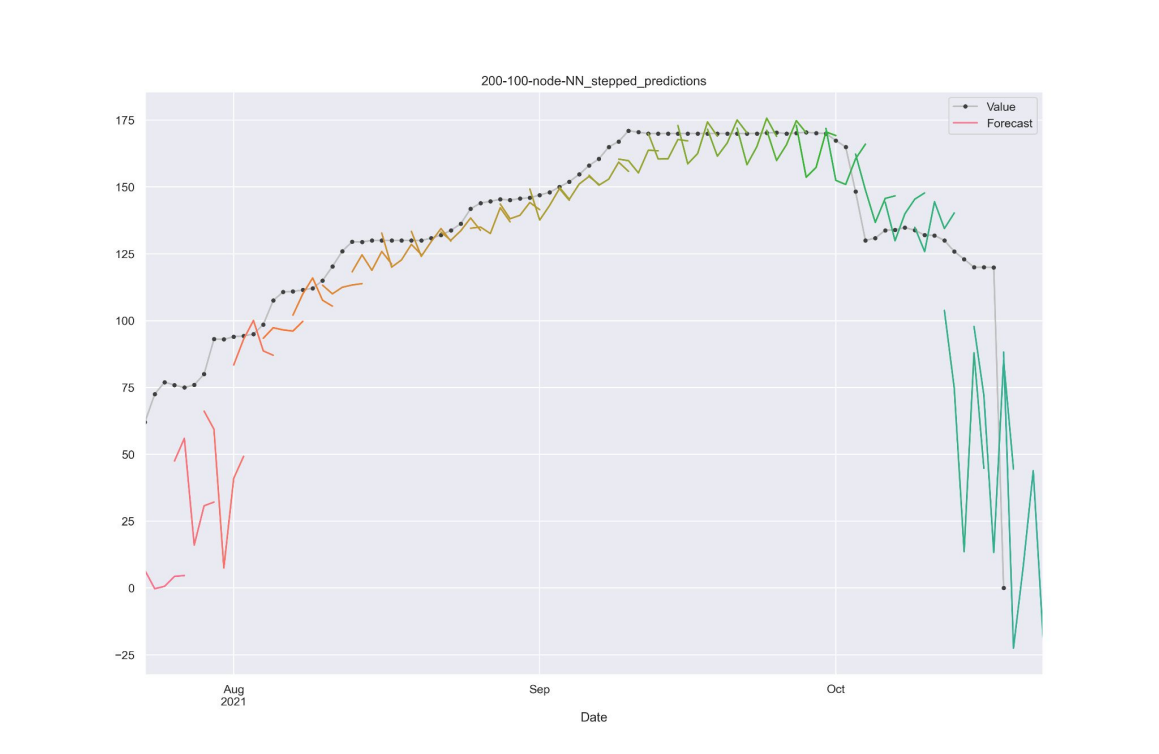


Training:
- MSE: 293.68
- MAPE: 0.13

Validation:
- MSE: 555.90
- MAPE: 0.46

COMPARISON

- **200-100-5 Neural Network** estimator



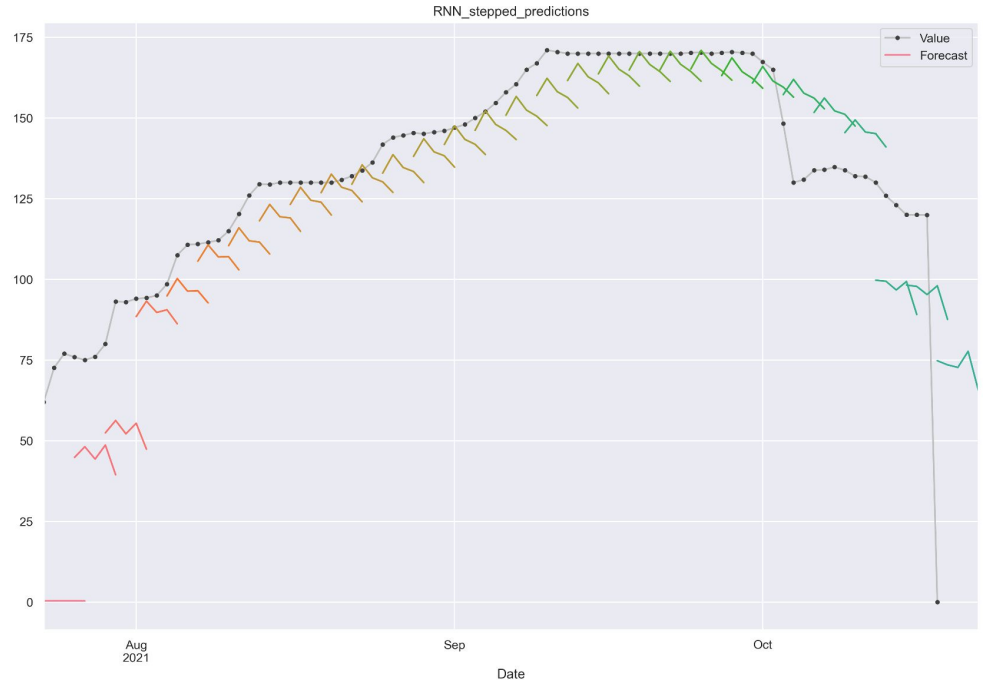
Training:
- MSE: 206.07
- MAPE: 0.12

Validation:
- MSE: 544.84
- MAPE: 1.48

RECURRENT NEURAL NETWORK

COMPARISON

- **RNN** estimator (200-100-5)



Training:
- MSE: 359.21
- MAPE: 0.216

Validation:
- MSE: 529.92
- MAPE: 2.42

COMPARISON

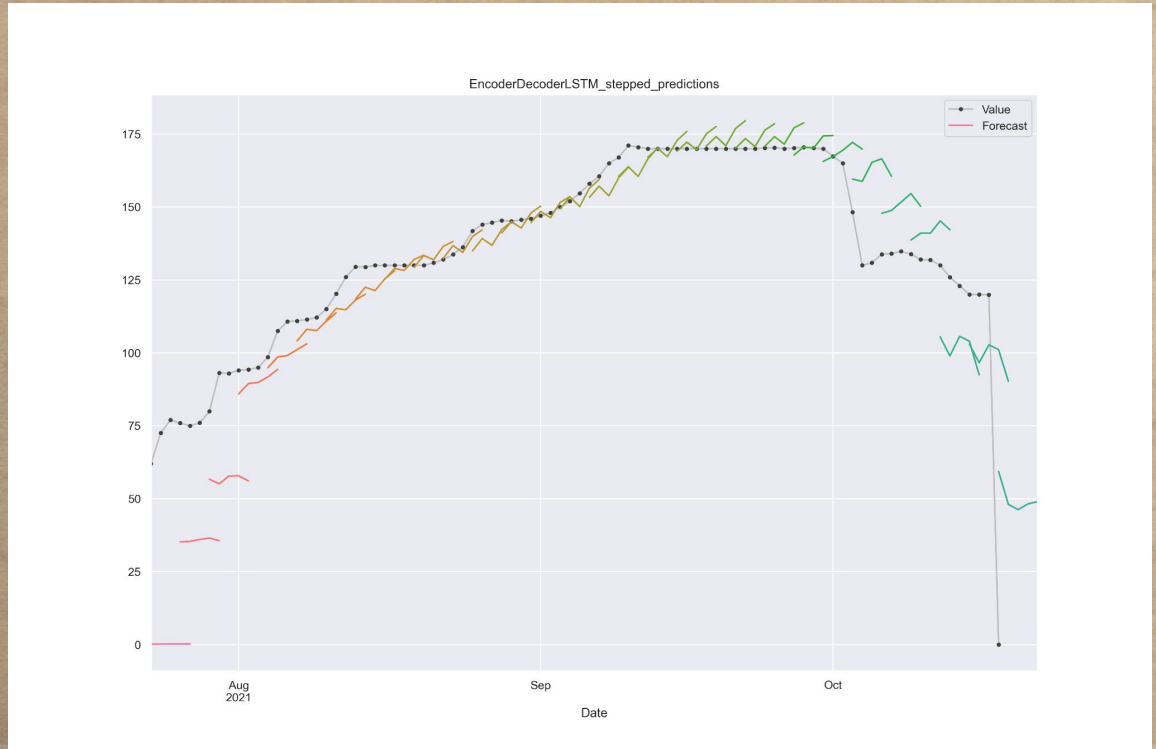
- **LSTM** estimator (200-100-5)

Training:
- MSE: 213.72
- MAPE: 0.56

Validation:
- MSE: 494.97
- MAPE: 10.60

COMPARISON

- **Enc-Dec LSTM** estimator (200-5-200-100-5)



Training:
- MSE: 228.11
- MAPE: 0.28

Validation:
- MSE: 482.68
- MAPE: 4.49

COMPARISON

- **Stacked LSTM** estimator (100-100-100-5)

Training:
- MSE: 12101.90
- MAPE: 10.72

Validation:
- MSE: 16513.87
- MAPE: 13.01

Comparison Summary

Model	TRAIN		VALIDATION		Note
	MSE	MAPE	MSE	MAPE	
CHAIN LINEAR	106.38	0.08	641.39	0.844	?
CHAIN XGB	**7.531**	**0.01**	**507.65**	**0.208**	**Overfit?**
CHAIN FOREST	**38.85**	**0.028**	**229.73**	**0.136**	**Best**
CHAIN LASSO	107.39	0.074	608.02	0.586	
NN 64	293.68	0.130	555.90	0.468	
NN 200	206.07	0.128	554.84	1.489	❌
RNN	359.21	0.216	529.92	2.427	❌
LSTM	213.72	0.560	494.97	10.608	❌
Enc-Dec LSTM	228.11	0.286	482.68	4.495	❌
Stack LSTM	***1211.9***	***10.72***	***16513.8***	***13.01***	***Worst***

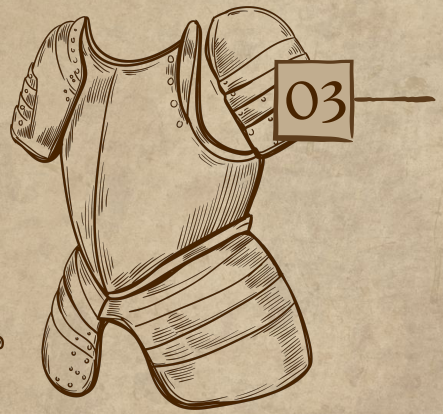
5. Expansion

https://github.com/produdez/poe-economy/blob/main/ExpandedModeling.ipynb

EXPANSION (on best model)

DIRT TIER

- Armourer's Scrap
- Orb of Alteration

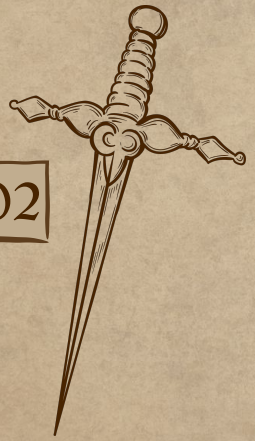


MEDIUM TIER

- Divine Orb
- Mortal Ignorance

LOW TIER

- Vaal Orb
- Prime Sextant

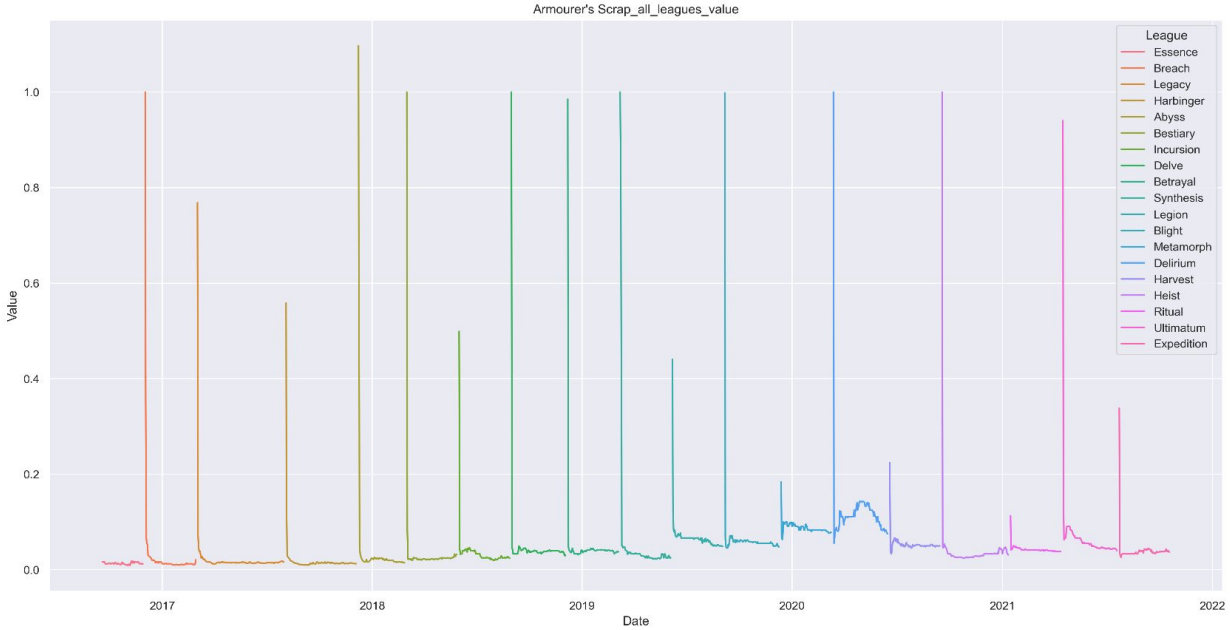


HIGH TIER

- Chayula's Breachstone
- Blessing of Chayula

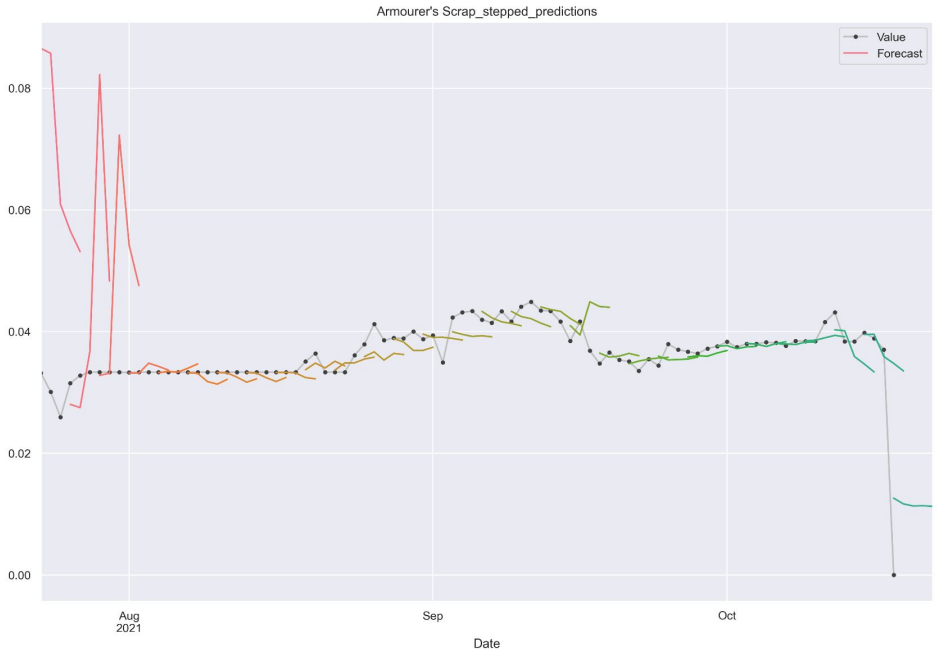
DIRT TIER

- **Armourer's Scrap**



DIRT TIER

- **Armourer's Scrap**

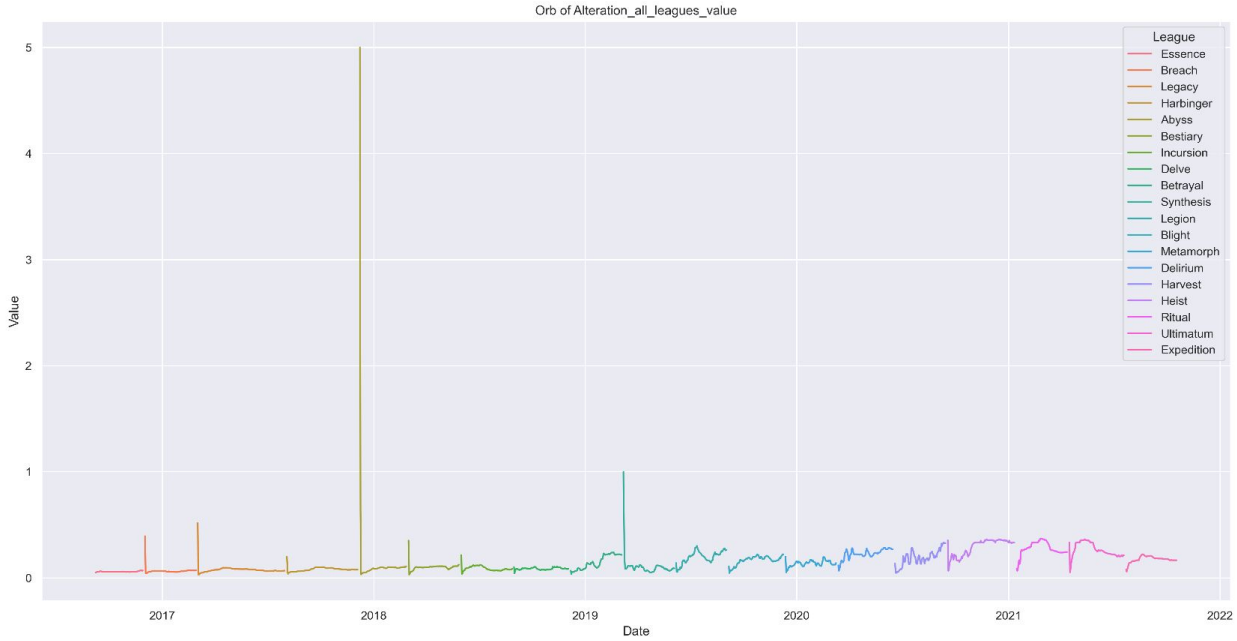


MAPE:

- Train: 0.052
- Validation: 0.105

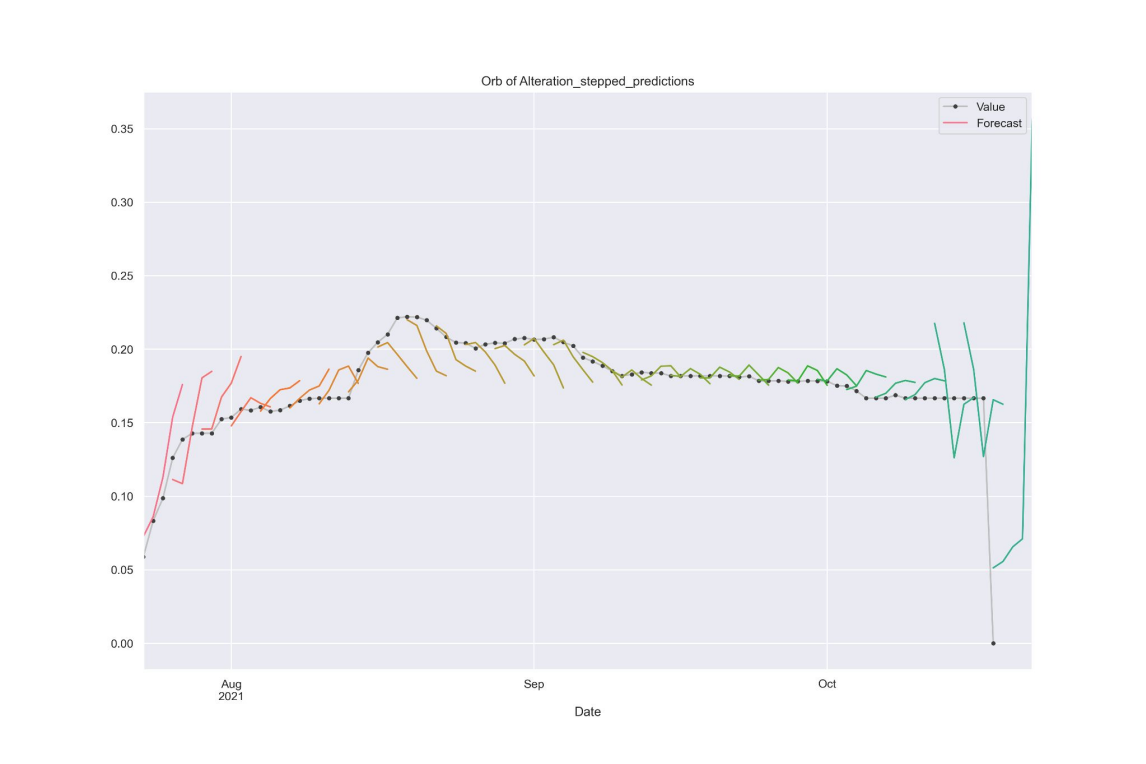
DIRT TIER

- **Orb of Alteration**



DIRT TIER

- **Orb of Alteration**

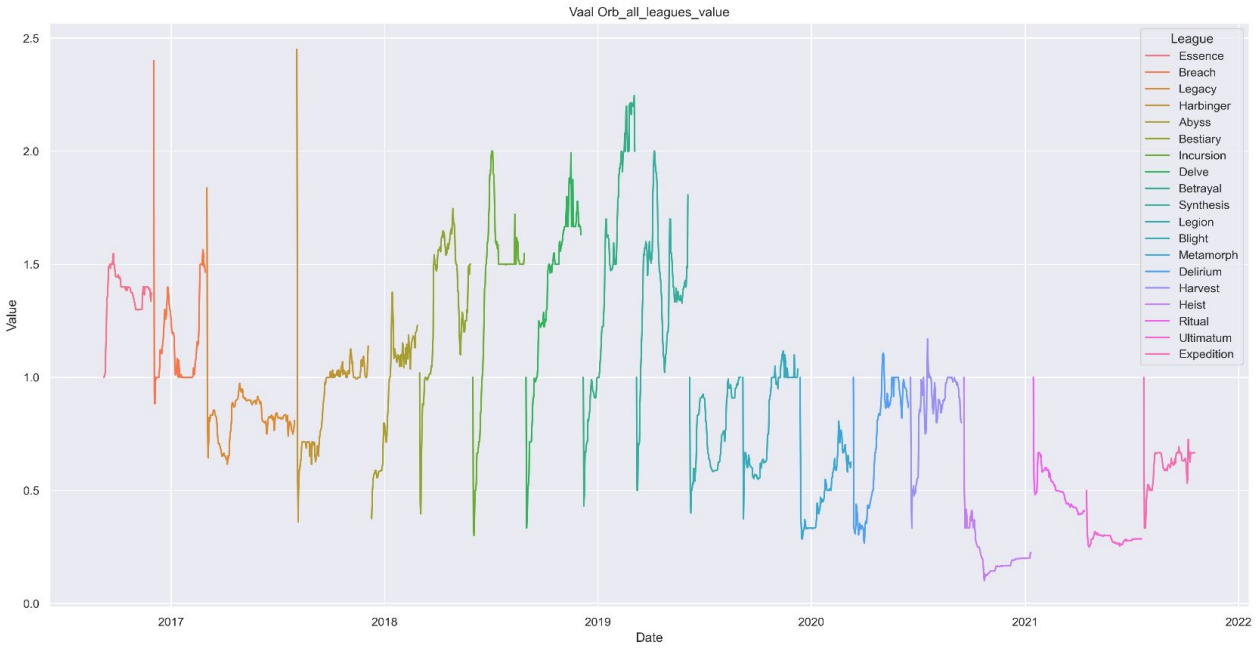


MAPE:

- Train: 0.047
- Validation: 0.093

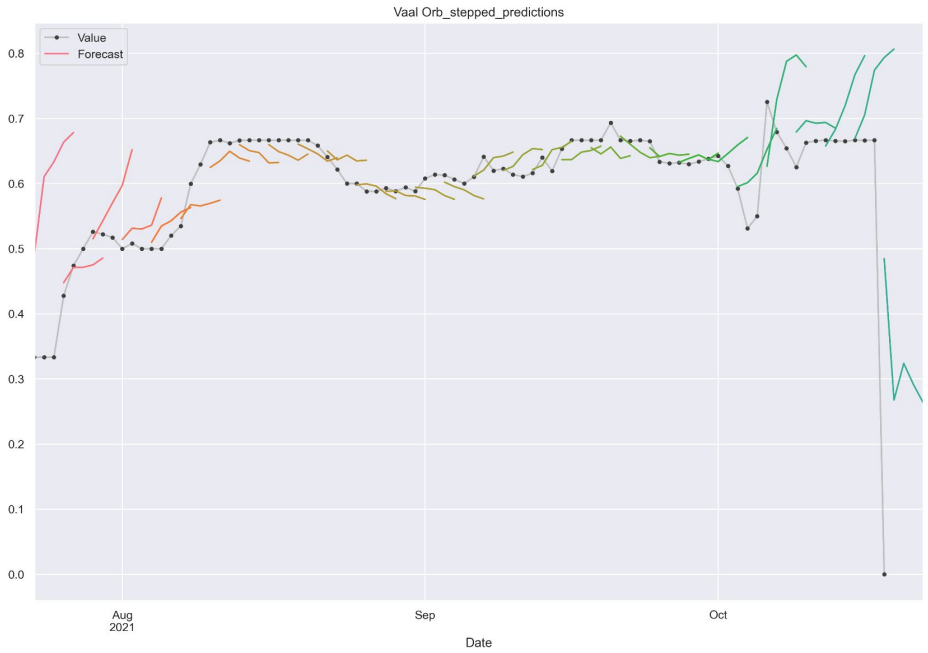
LOW TIER

- **Vaal Orb**



LOW TIER

- **Vaal Orb**

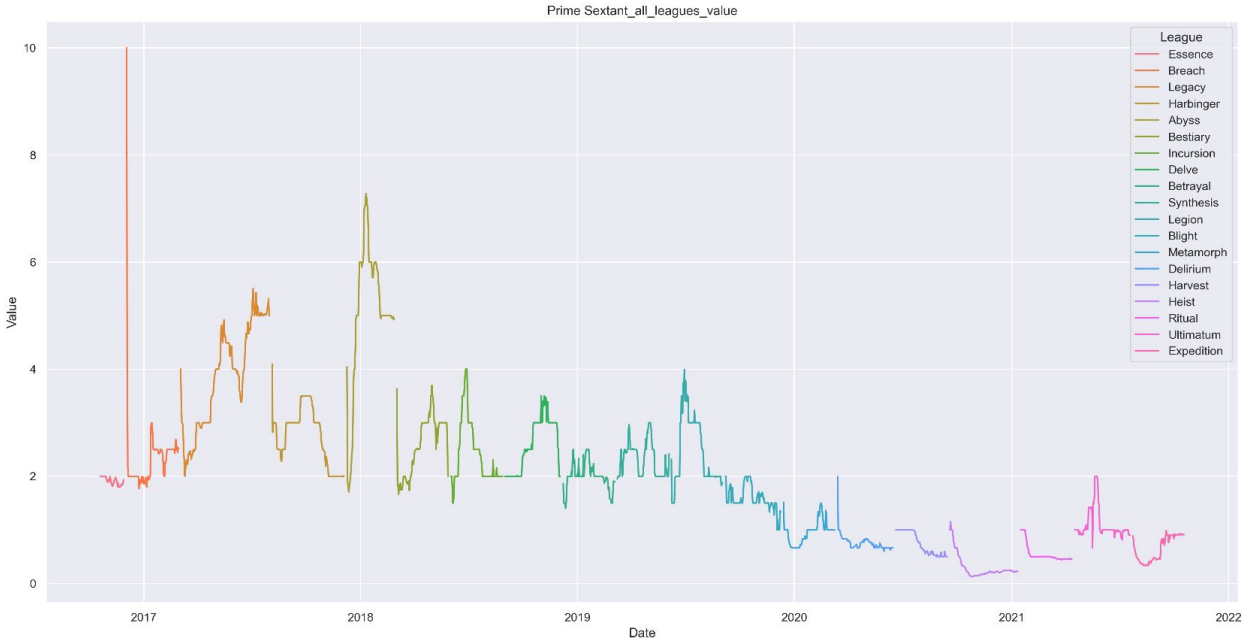


MAPE:

- Train: 0.030
- Validation: 0.086

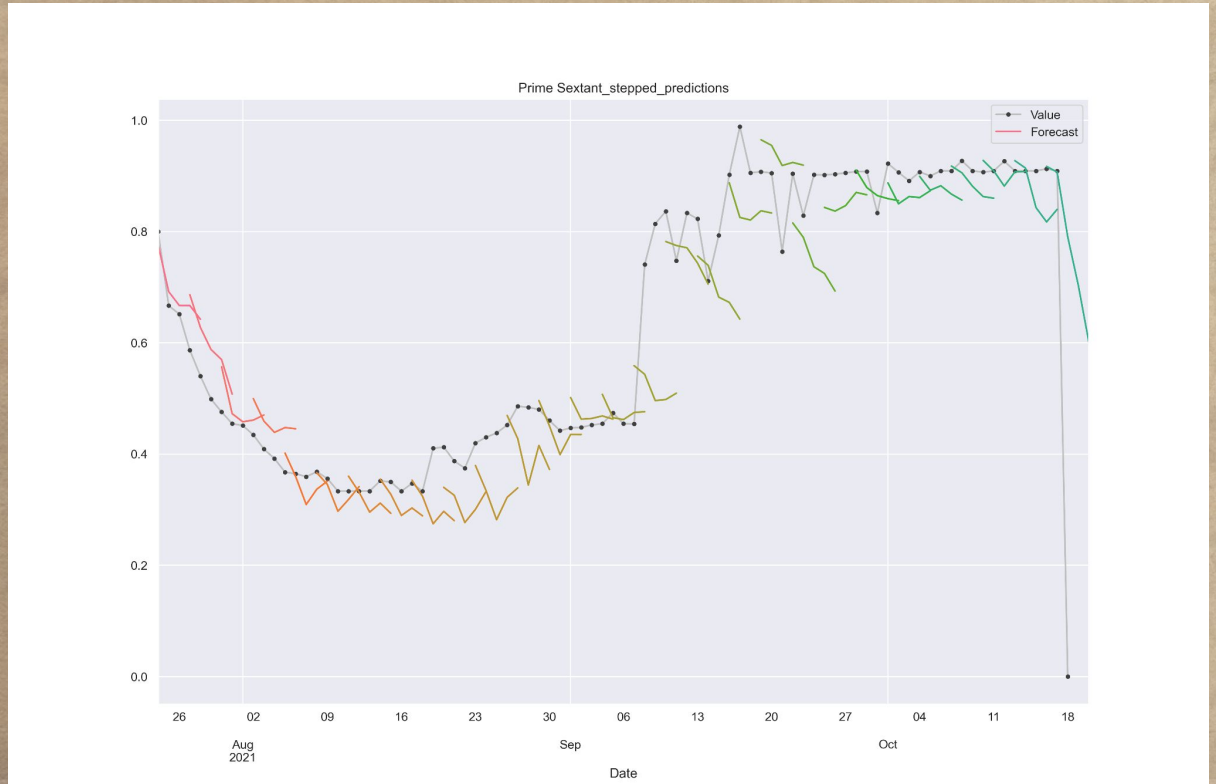
LOW TIER

- **Prime Sextant**



LOW TIER

- **Prime Sextant**

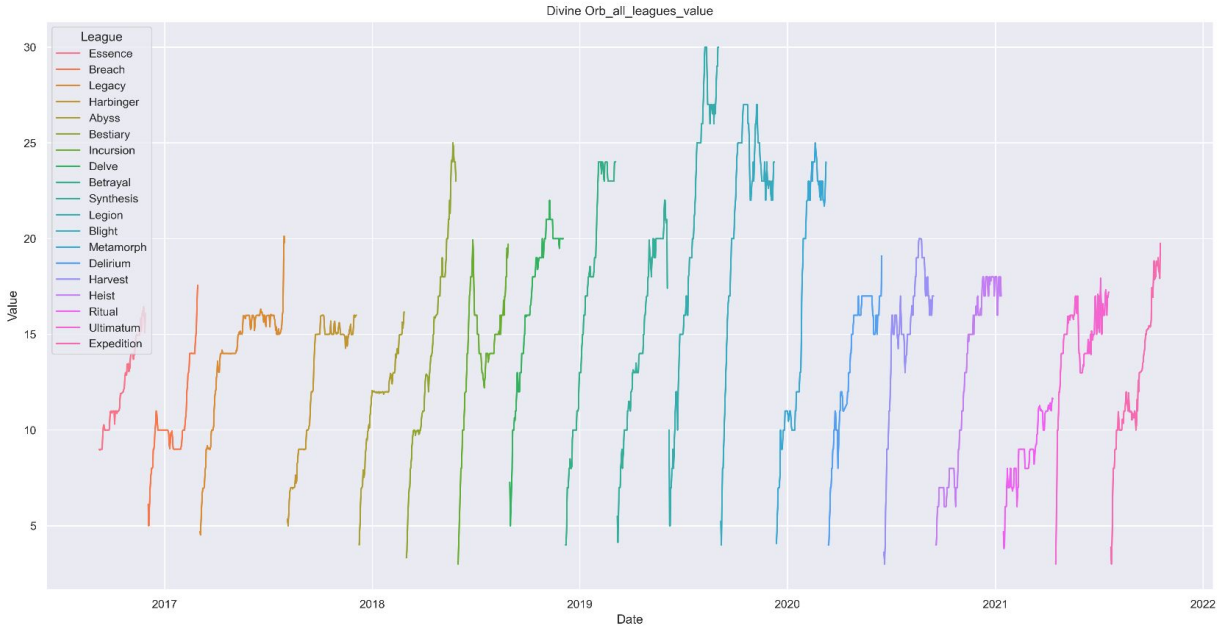


MAPE:

- Train: 0.0323
- Validation: 0.156

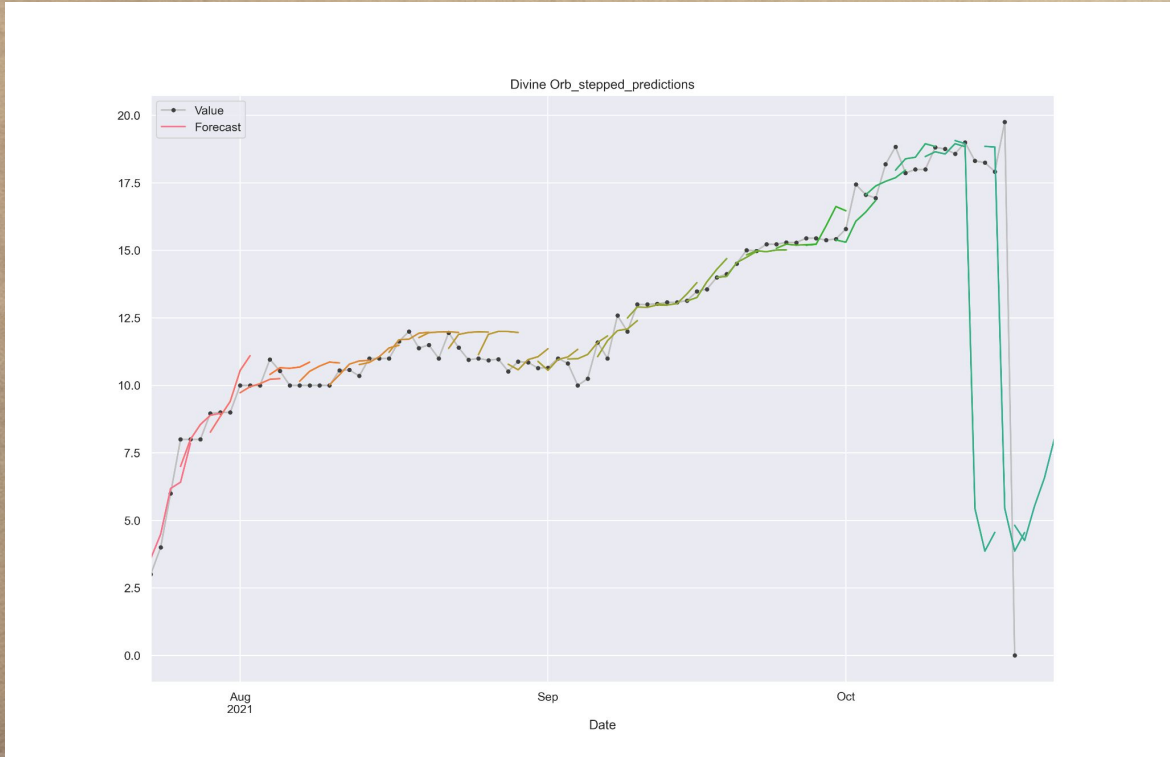
MEDIUM TIER

- **Divine Orb**



MEDIUM TIER

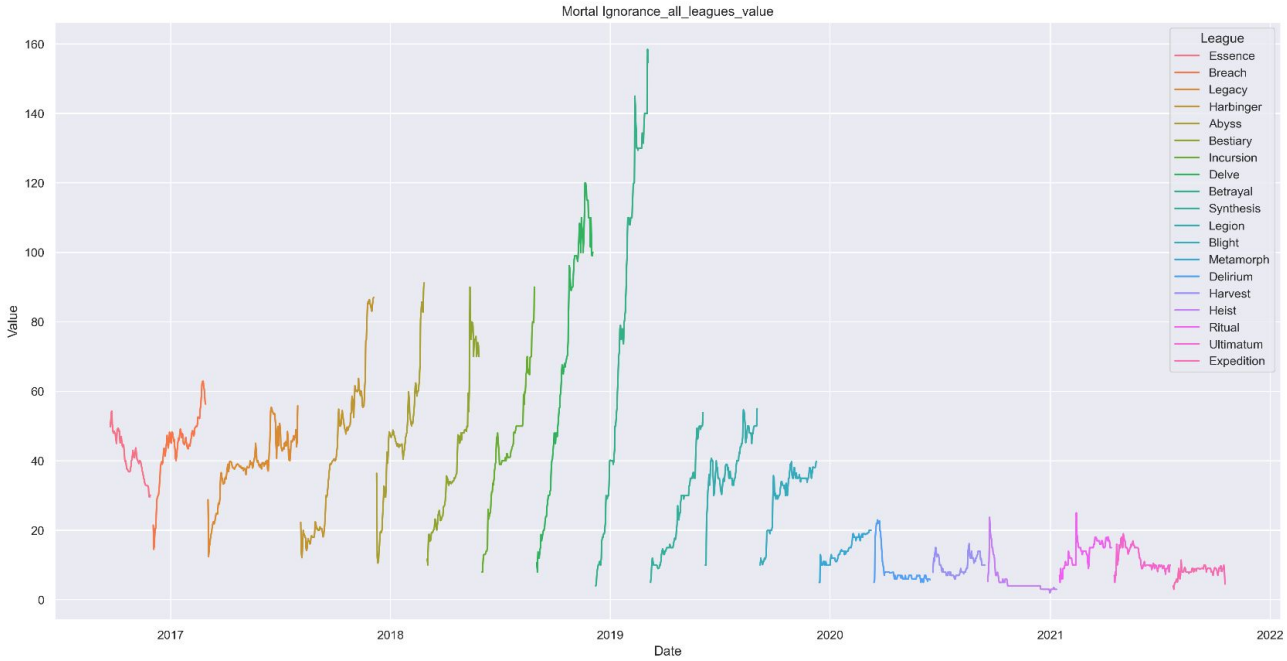
- **Divine Orb**



MAPE:
- Train: 0.021
- Validation: 0.132

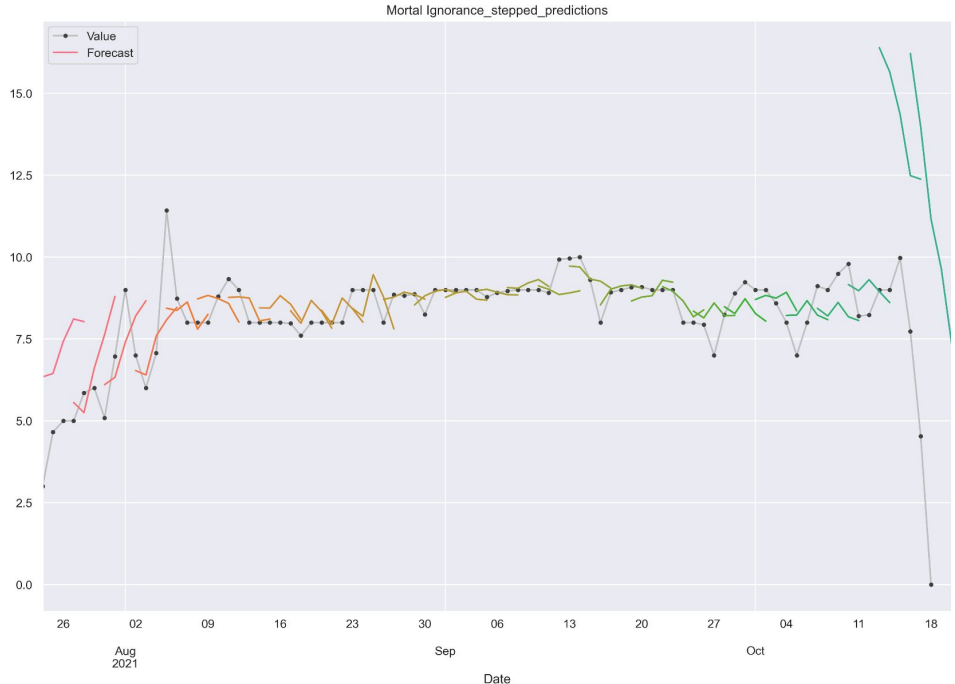
MEDIUM TIER

- **Mortal Ignorance**



MEDIUM TIER

- **Mortal Ignorance**

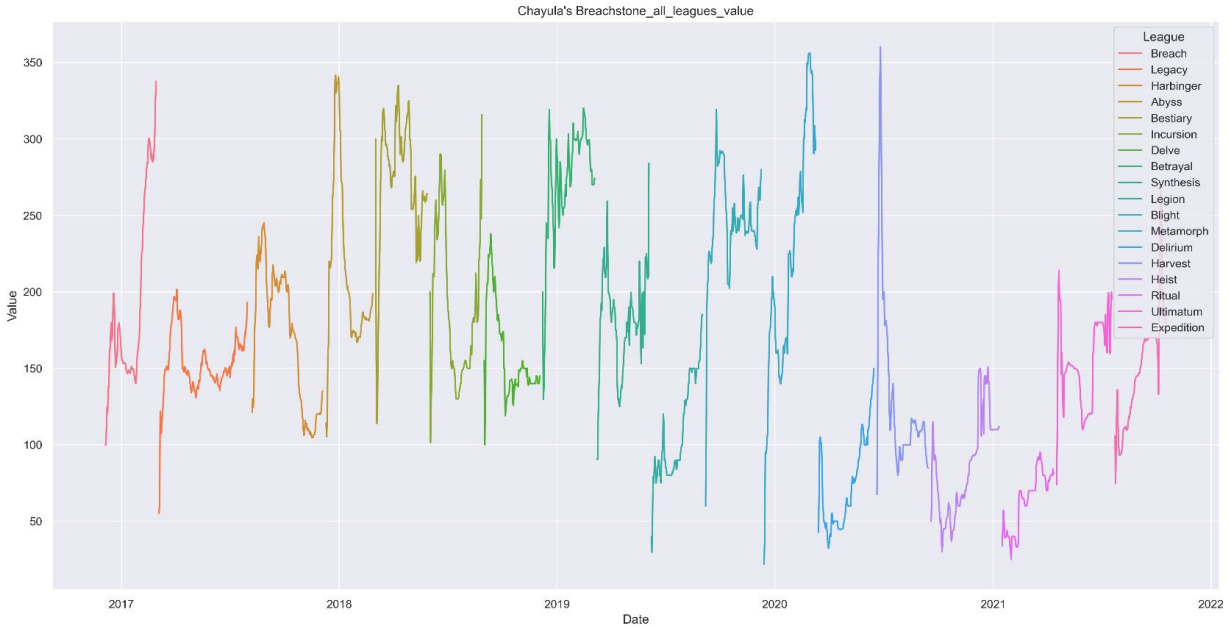


MAPE:

- Train: 0.040
- Validation: 0.123

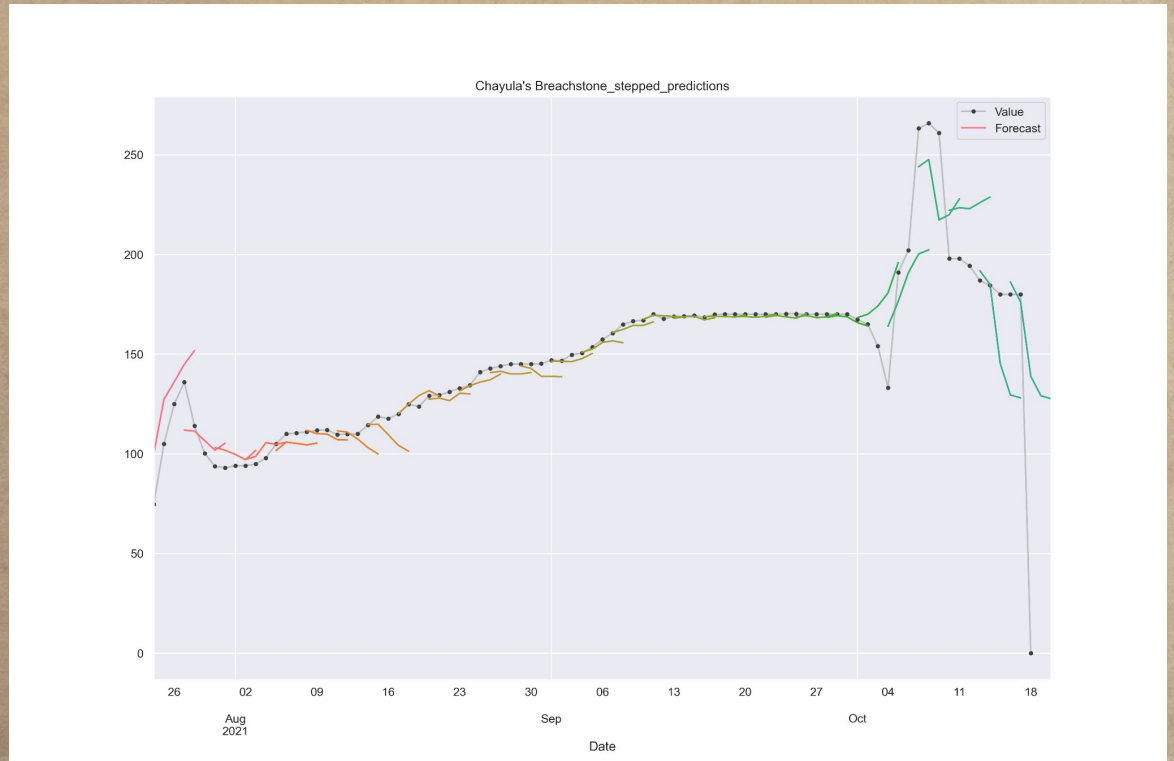
HIGH TIER

- **Chayula's Breachstone**



HIGH TIER

- **Chayula's Breachstone**

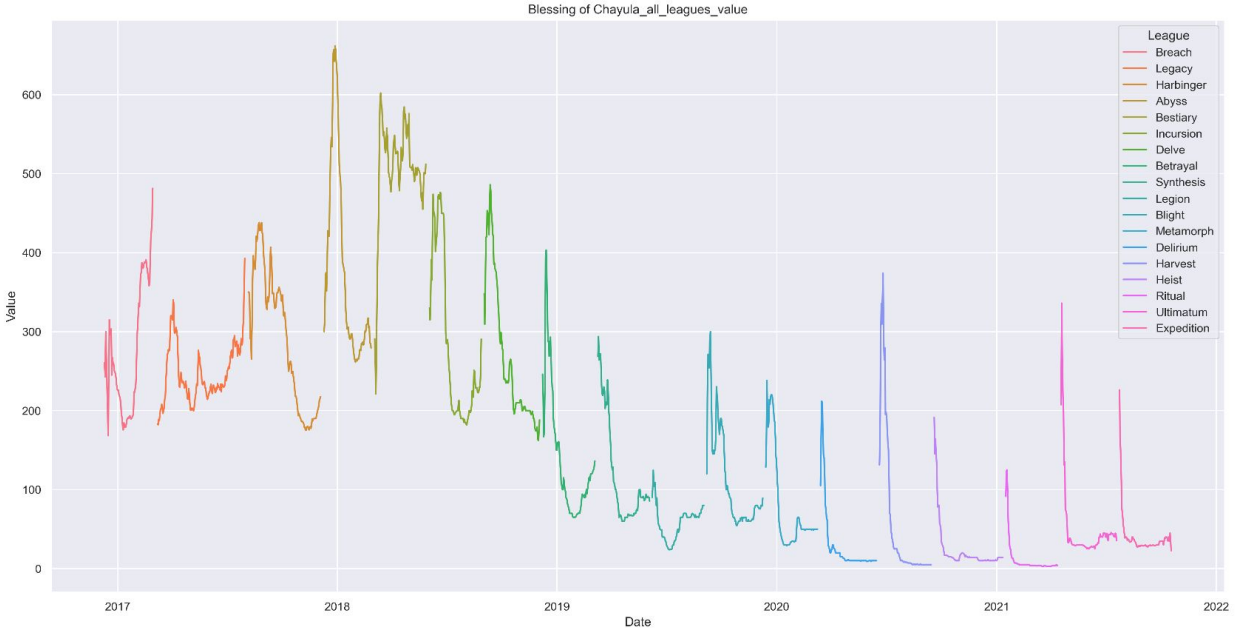


MAPE:

- Train: 0.037
- Validation: 0.090

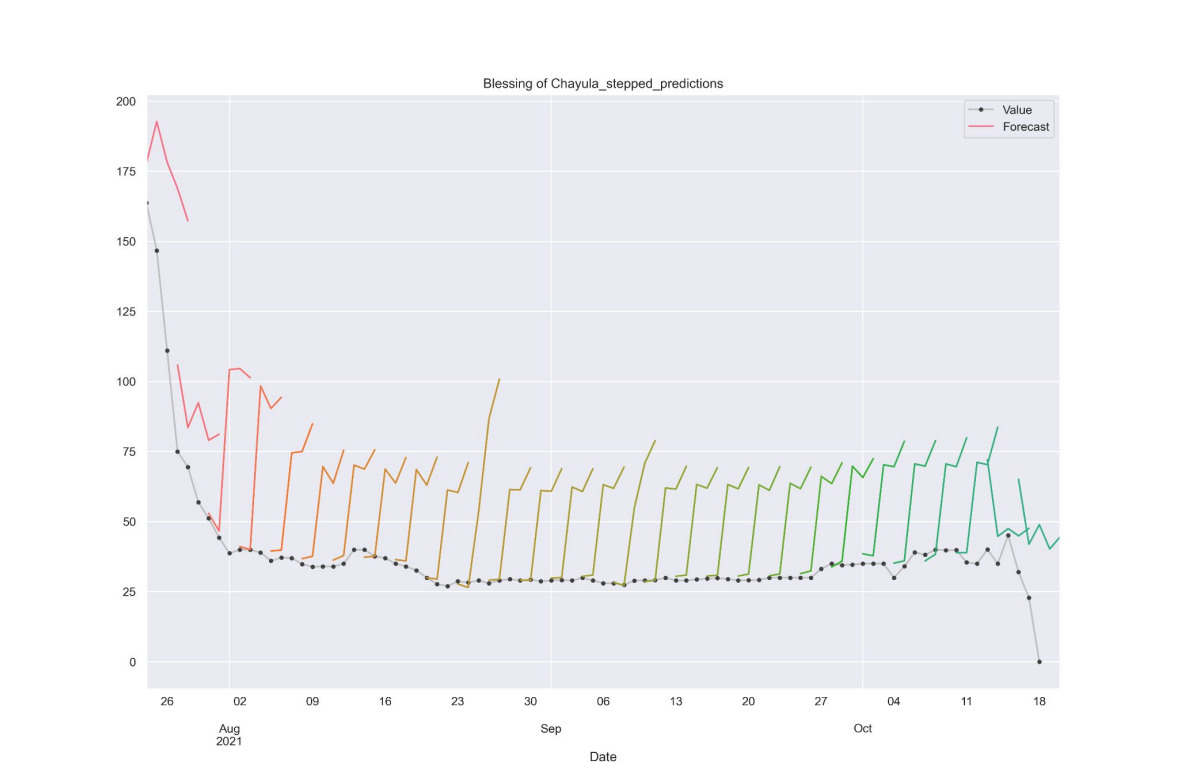
HIGH TIER

- **Blessing of Chayula**



HIGH TIER

- **Blessing of Chayula**



MAPE:

- Train: 0.039
- Validation: 0.363

Different Objects Summary

Model:
RegChain Forest

TIER	MAPE	TRAIN	VALIDATION	Note
DIRT	Armourer's Scrap	0.052	0.105	
	Orb of Alteration	0.047	0.093	Good
LOW	Vaal Orb	0.030	0.086	Good
	Prime Sextant	0.032	0.156	
MEDIUM	Divine Orb	0.021	0.132	
	Mortal Ignorance	0.040	0.123	
HIGH	Chayula's Breachstone	0.037	0.090	Good
	Blessing of Chayula	***0.039***	***0.363***	***WORST***
	Exalted Orb	**0.024**	**0.076**	**Best**

6. Conclusion

https://github.com/produdez/poe-economy/blob/main/Comparison-Conclusion.ipynb

ACHIEVEMENTS

- Experiment on various models
- Compare and choose best result
- Best model is moderate (avg ~0.1 MAPE)
- A learning experience

DOWNSIDES

- Best model result varies by object
- ~0.8 - 0.1 MAPE for most
- Worst is 0.36 MAPE
- Data is quite random (no trend, no season, no clear cycle)
- Overfit? Preprocess? Feature Engineer? More experience!

POSSIBLE IMPROVEMENTS

01

LIVE DATA

Test the model with live market data, using market APIs

02

TOOL DEV

Could develop into a usable tool

03

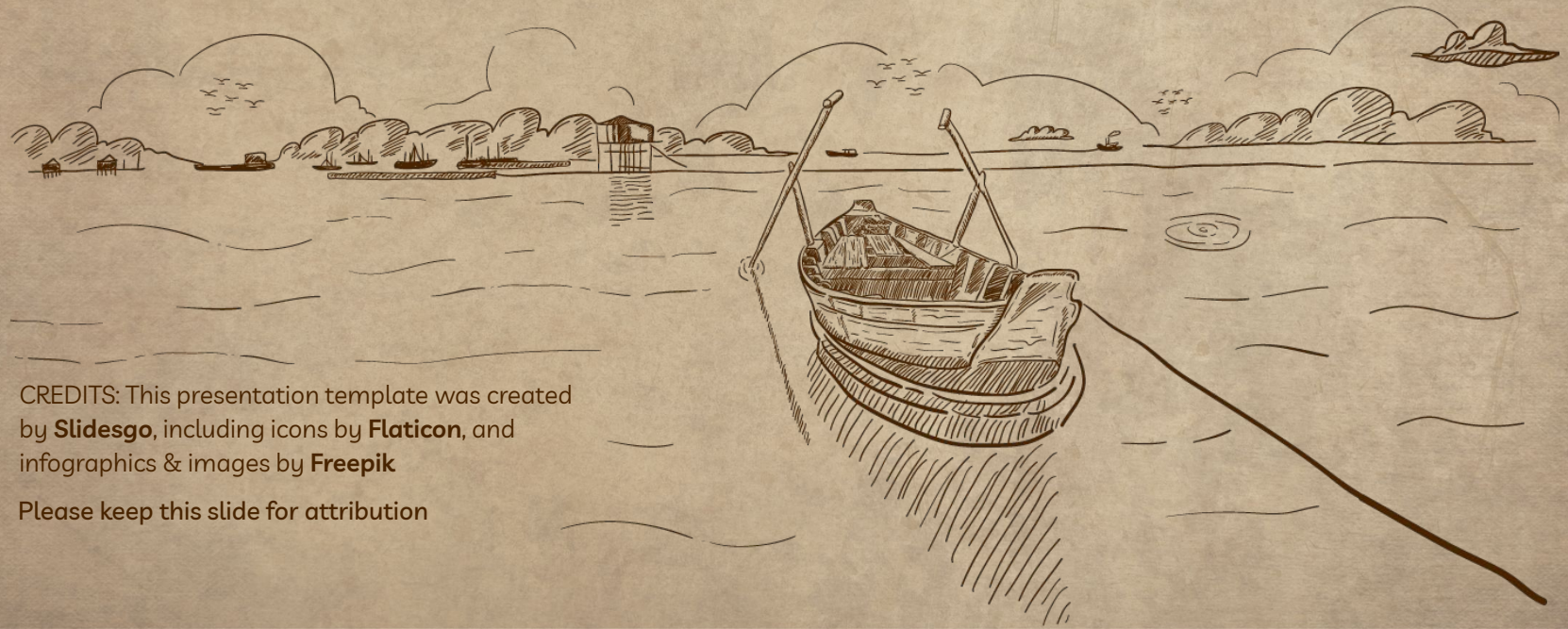
MORE RESEARCH

Of course, more research is needed overall for better result

THANKS Exile!

Do you have any questions?

long.tranhoang@hcmut.edu.vn



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—SOMEONE FAMOUS

INTRODUCTION

Venus has a beautiful name and is the second planet from the Sun. It's terribly hot—even hotter than Mercury—and its atmosphere is extremely poisonous

DEFINITION OF CONCEPTS

01

MERCURY

Mercury is the smallest planet in our Solar System

02

MARS

Despite being red, Mars is actually a cold place

03

NEPTUNE

Neptune is the fourth-largest planet in our Solar System

04

SATURN

Saturn is composed mostly of hydrogen and helium

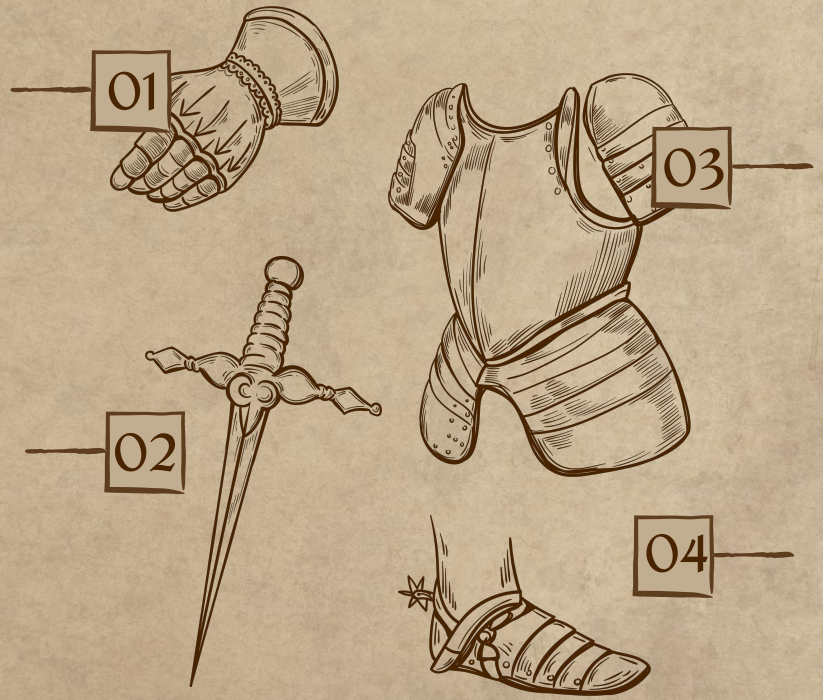
FEATURES OF THE TOPIC

MARS

Despite being red, Mars is a cold place

MERCURY

It's the closest planet to the Sun



JUPITER

It's the biggest planet in our Solar System

VENUS

Venus is the second planet from the Sun

1346

The plague arrives in England

1453

The fall of Constantinople to the Ottoman

1564

William Shakespeare is born

PRACTICAL USES OF THIS SUBJECT

MERCURY

Mercury is the closest planet to the Sun

MARS

Despite being red, Mars is a cold place

SATURN

Saturn is the ringed one and a gas giant

VENUS

Venus has a beautiful name, but it's quite hot

NEPTUNE

Neptune is the farthest planet from the Sun

JUPITER

It's the biggest planet in our Solar System

MULTIMEDIA

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A PICTURE IS WORTH A THOUSAND WORDS

DID YOU KNOW THIS?

01

SATURN

Yes, this is the ringed planet. It's a gas giant, composed of hydrogen and helium

02

NEPTUNE

Neptune is the farthest planet from the Sun and the fourth-largest by diameter in our Solar System

03

VENUS

It has a beautiful name and is the second planet from the Sun. It's quite hot, even hotter than Mercury

PROBLEM

Despite being red, Mars is actually a cold place. It's full of iron oxide dust, which gives the planet its reddish cast

SOLUTION

Venus has a beautiful name and is the second planet from the Sun. It's terribly hot, even hotter than Mercury

THIS IS A TABLE

	1350	1400	1450	1500	1550
VENUS	123	444	321	235	452
MARS	457	864	1000	567	678
JUPITER	34	76	125	97	76

AWESOME WORDS

HISTORICAL DATA

VENUS A

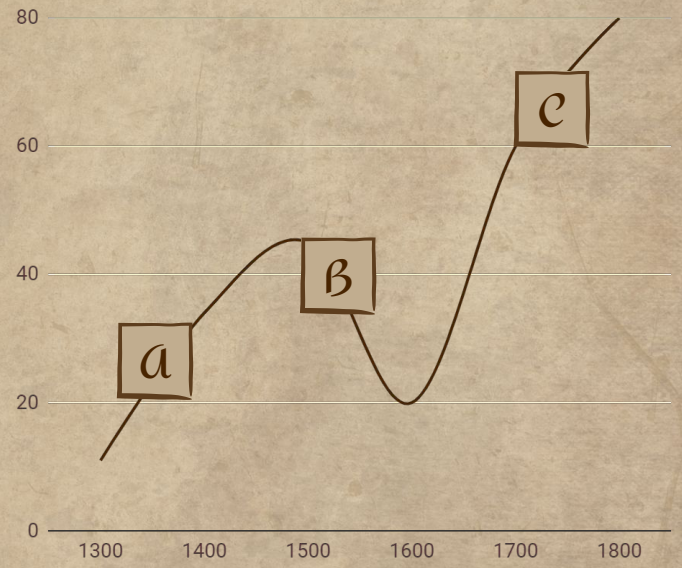
Venus has a beautiful name, but it's terribly hot

MARS B

Despite being red, Mars is actually a cold place

JUPITER C

It's the biggest planet in our Solar System



If you want to modify this graph, click on it, follow the link, change the data and replace it here

PROCESS

1390

VENUS

Venus is the second planet from the Sun

1450

MERCURY

Mercury is the closest planet to the Sun

1530

SATURN

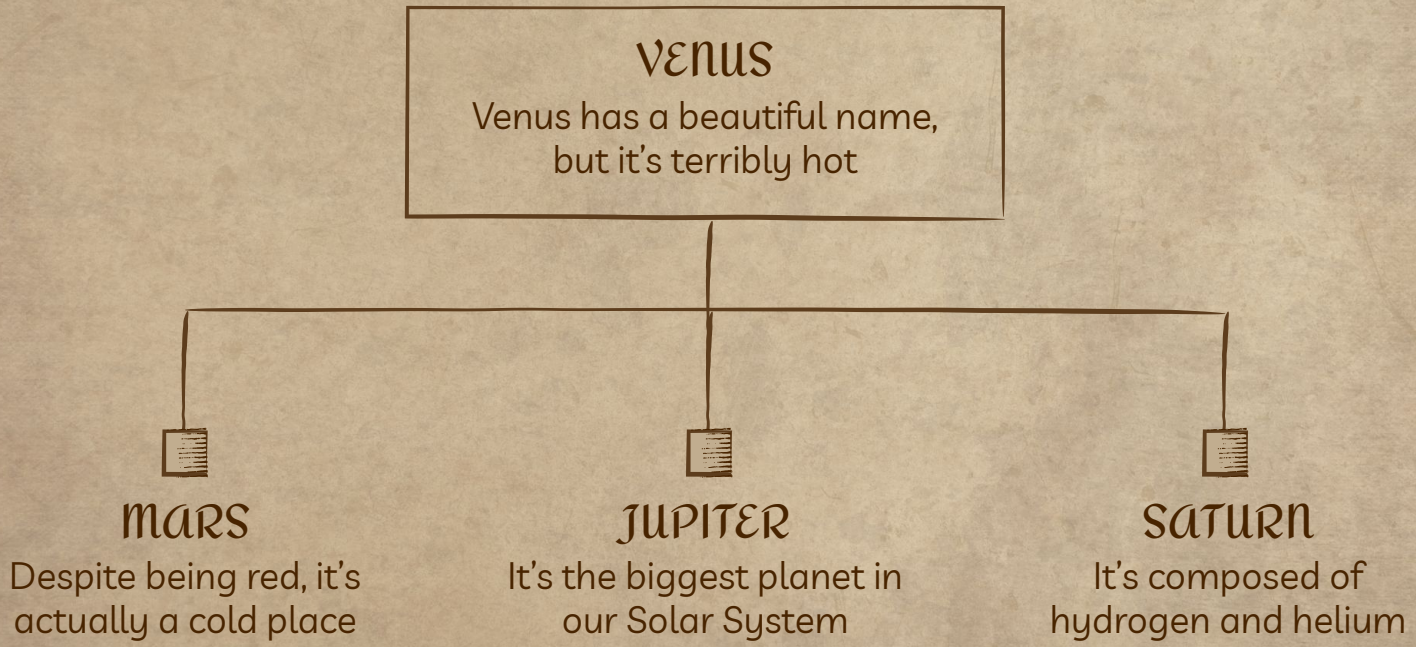
It's composed of hydrogen and helium

1610

MARS

Despite being red, it's actually a cold place

OVERVIEW DIAGRAM



EXERCISE

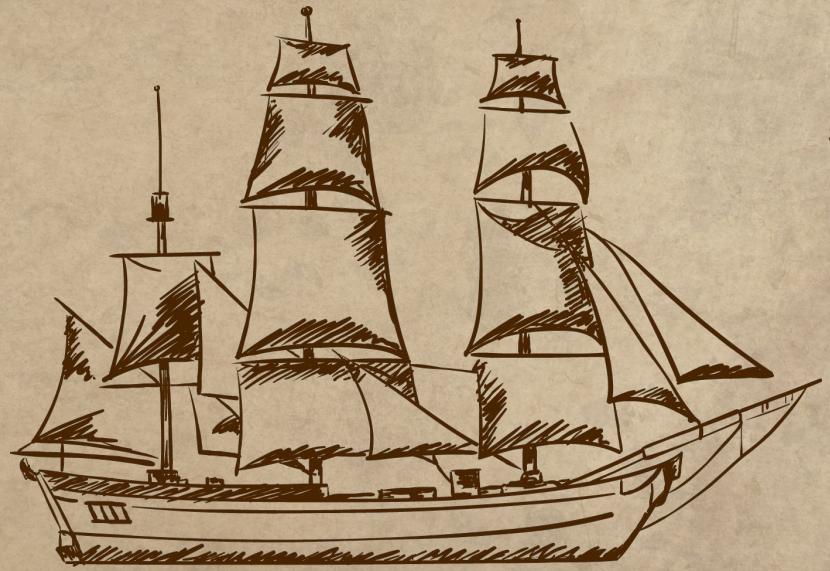
Fill in the blanks with the name of each part

_ _ _ _ _

Mercury is the smallest of them all

_ _ _ _ _

Despite being red, Mars is a cold place



_ _ _ _ _

Venus has a beautiful name, but it's too hot

assignment

1. Venus has a beautiful name, but it's terribly hot
2. Mercury is the closest planet to the Sun
3. Despite being red, Mars is actually a cold place

THANKS

Do you have any questions?

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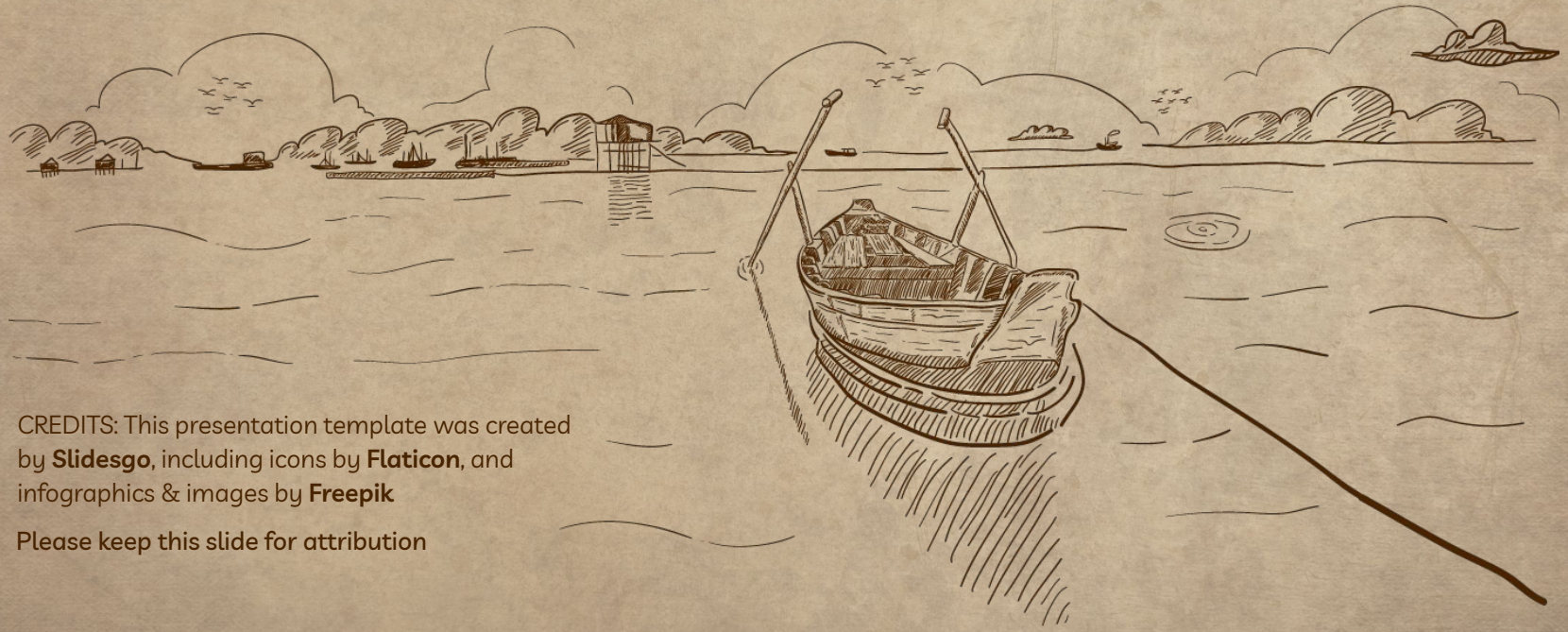

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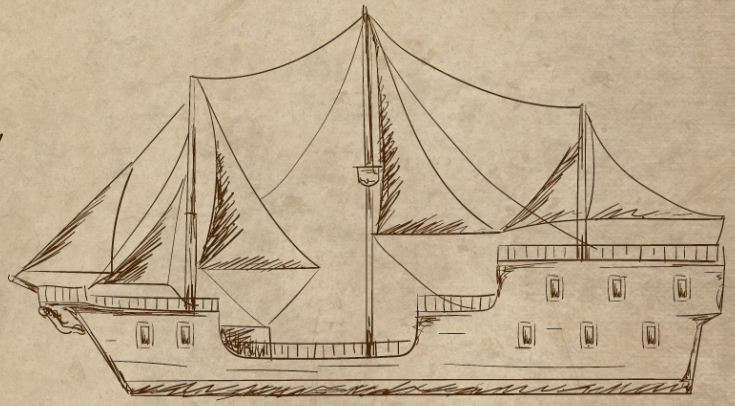

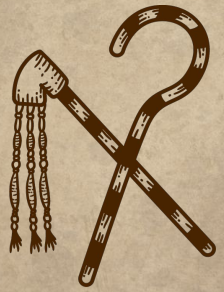
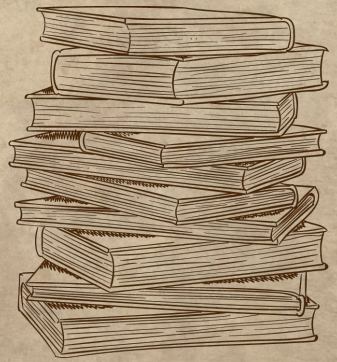

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- High angle view of old historic map

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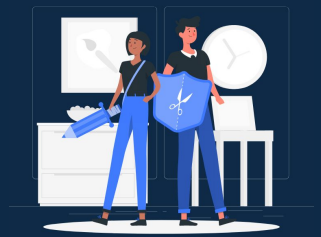

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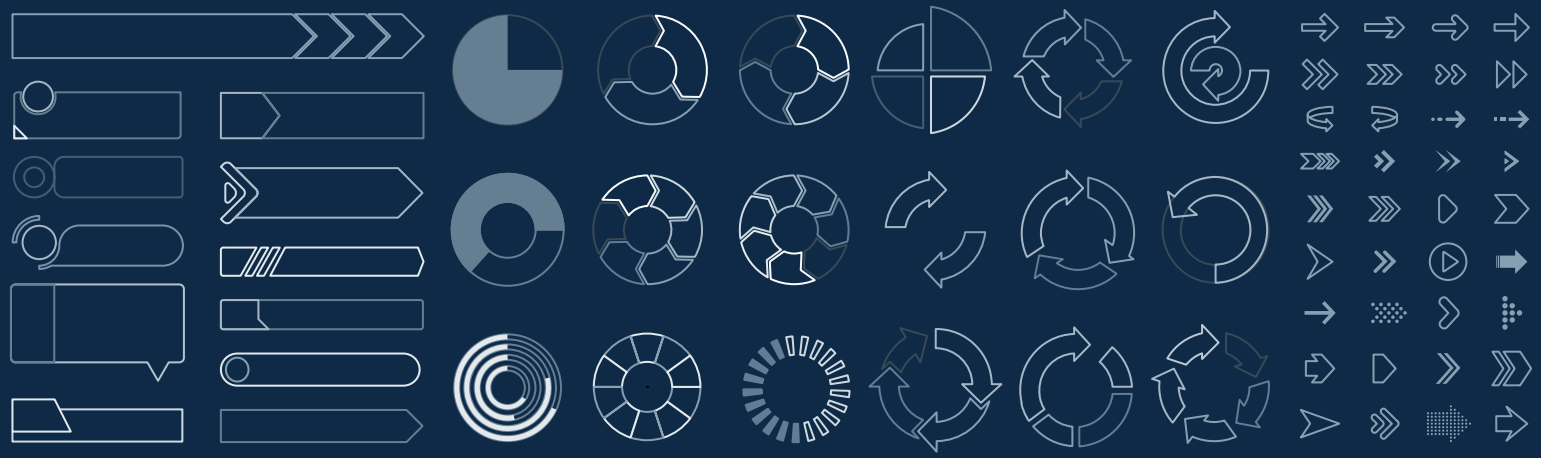

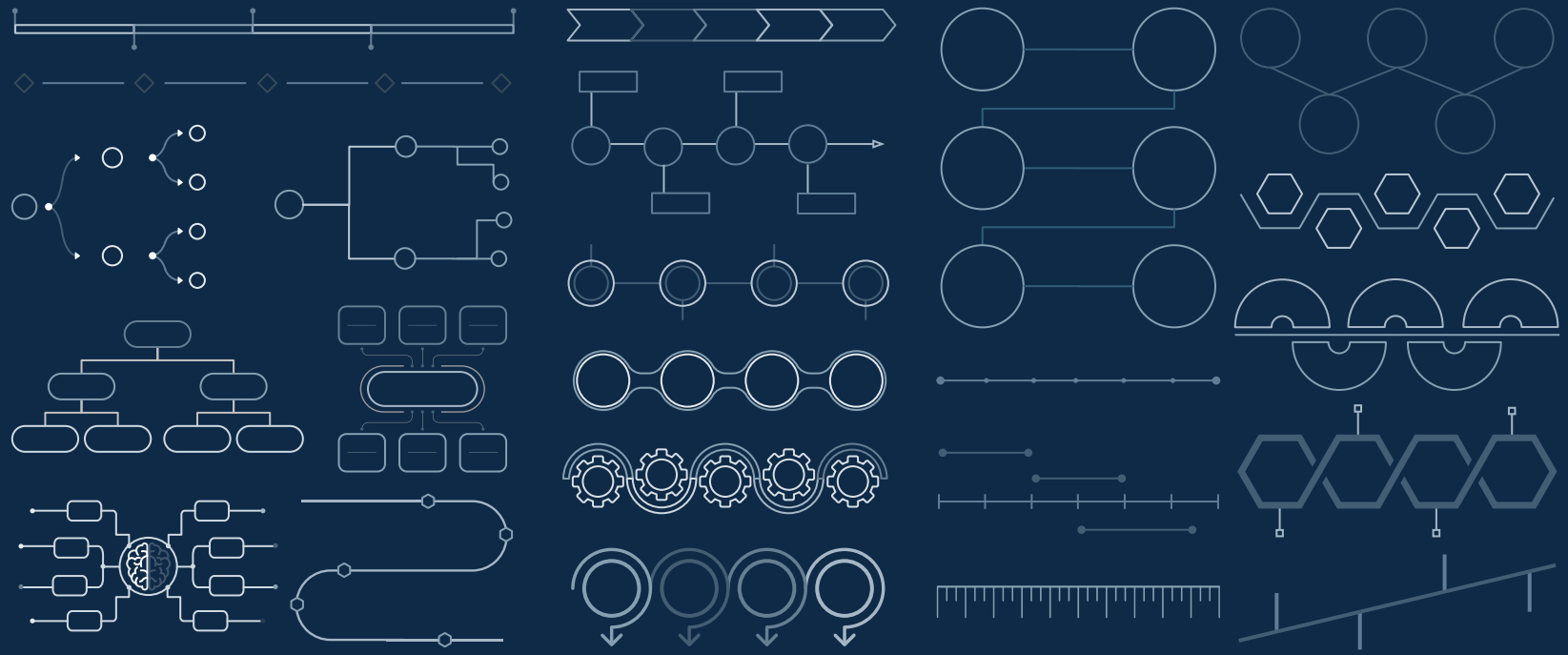

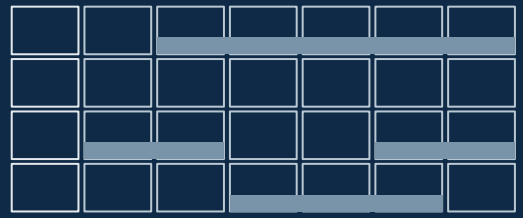

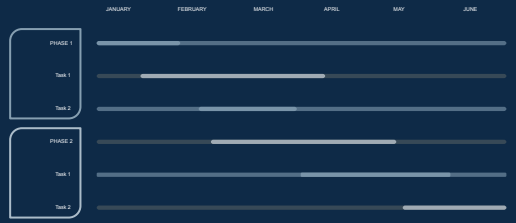
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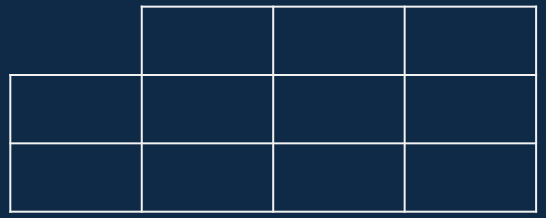

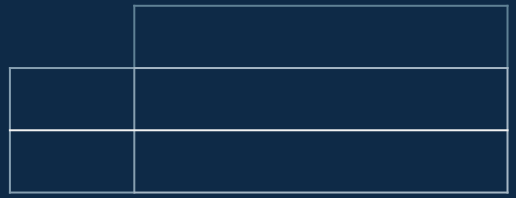

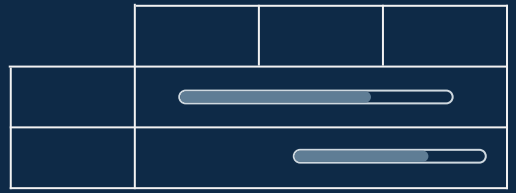

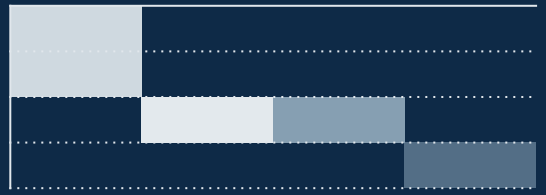

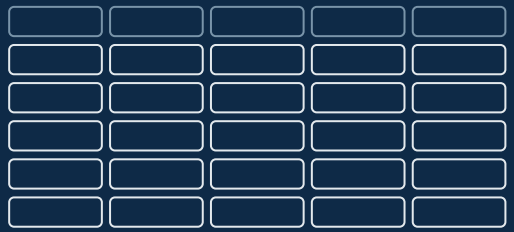

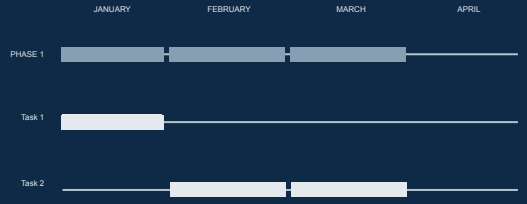
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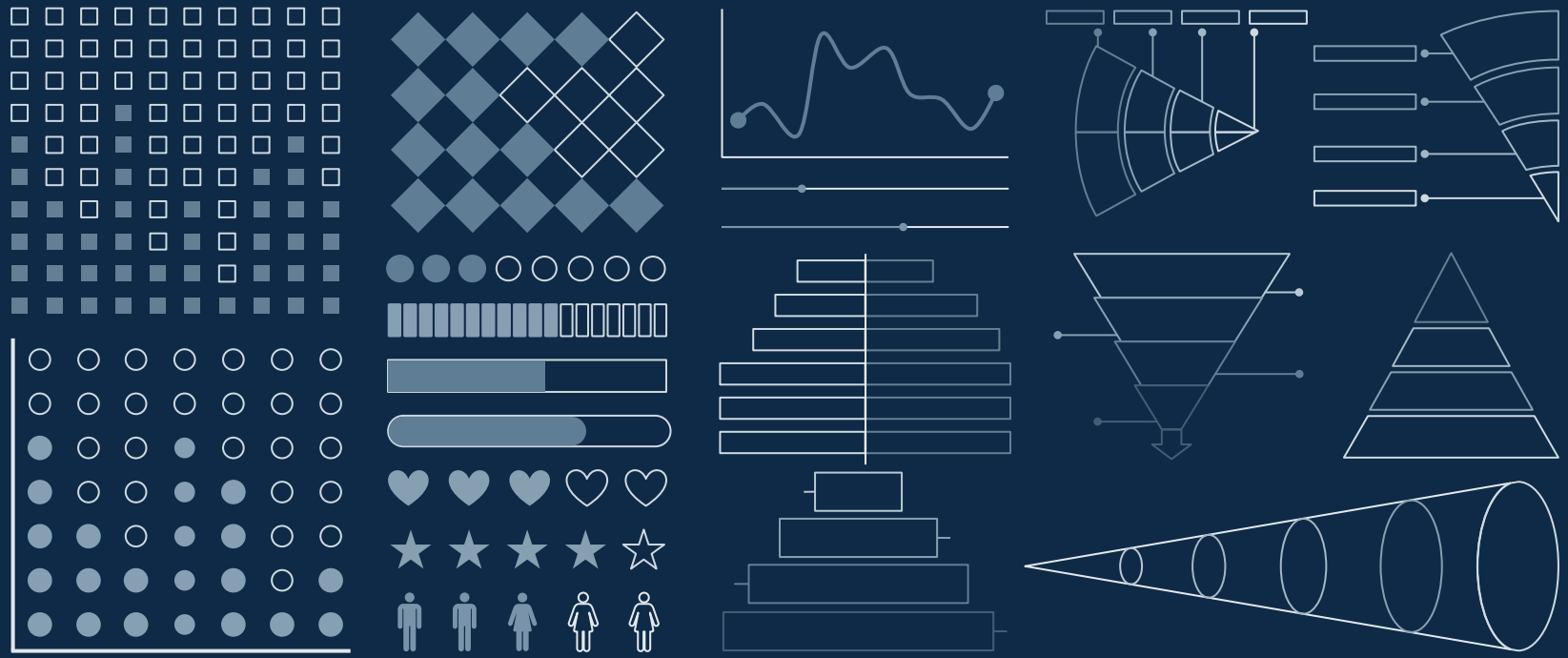

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