Modelling Magic with Python: Ertai

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Abstract

This paper introduces Ertai: a python library that allows for the mathematical modelling of a popular Collectible Card Game (CCG): Magic the Gathering (MtG).

As well as describing the high level functionality of this library, a specific use case will be given that allows for the calculation of a 'Mana Curve' which is of strategic interest to players of MtG.

1   Introduction

Magic the Gathering (MtG) is a Collectible Card Game (CCG) first released in 1993 [3] and is arguably the first and most popular CCG.

The game has a number of strategic elements of gameplay:

1. Card selection: from ones collection deciding which cards to use to form a *deck*.

2. In play strategy: during the play against an opponent, the large number of card combinations allow for many strategic possibilities.

3. Card trading: by design cards have varying value and are often the subject of trades.

The `ertai` library aims to allow for the simulation of certain aspects of game play as applied to the first of these: how to select cards in a specific way.

At its core MtG has a dynamic of casting spells (playing cards) which requires a player to spend "Mana". This resource can be of various types, that correspond to the colours of Magic in MtG: black, white, blue, red or green.

One of the things that can be done with `ertai` is an arithmetic of Mana. For example, we can take a specific combination of Mana (1 Blue, 2 Red) away from a collection of 3 Blue, 2 Red and 1 Black Mana.

```
>>> import ertai
>>> mana_cost = ertai.Mana("Blue", "Red", "Red")
>>> mana_pool = ertai.Mana("Blue", "Blue", "Blue", "Red", "Red", "Black")
>>> mana_cost <= mana_pool
True
>>> mana_pool - mana_cost
2 Blue Mana, 1 Black Mana
```

As well as this, card objects can be created which allows for the modelling of the card selection. For example, in Figure 1 the proportion of the available resources used at each turn for 3 different card selections is obtained through Monte Carlo simulation.

2   Statement of need

This type of analysis is not novel, for example [1] describes some academic work that aimed to optimise deck building (which is the term used to describe card selection). This highlights that mathematical modelling of MtG is of interest. Interestingly it is also studied in a social science setting [2].

In [1] a number of other libraries that can be used to simulate plays of the game are described, for example: Magarena `https://magarena.github.io` which is an open source library built in Java.

The `ertai` library is the first Python library (to the authors knowledge) which allows it to be readily used in conjunction with other scientific tools. Furthermore one particular goal of `ertai` is to be specifically translatable to mathematical models of MtG.
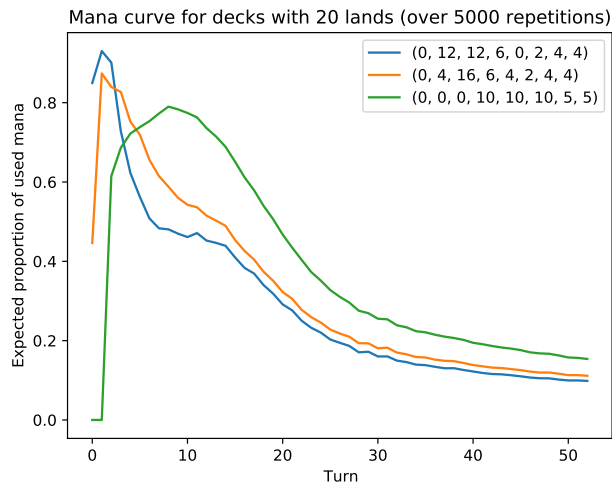
Figure 1: A mana curve: the proportion of available resources used at each turn for a given deck selection. The three selections represent number of cards of a given cost.

3   Conclusion

This paper has given a description of `ertai`: a library with a goal of allowing for the mathematical modelling of MtG.

The current capabilities of the library are limited but as it is written in Python, the object oriented nature of the library can be used to make the library extendable to other aspects of MtG. Every ability of a Magic card can be added as a method on the `ertai.Card` class.

The library is written in a fully modular way, is well documented and is automatically tested.

Furthermore, the library is already installable using standard python workflow:

```
$ python -m pip install ertai
```

The source code is available at `https://github.com/drvinceknight/ertai`.

References

[1] Sverre Johann Bjørke and Knut Aron Fludal. Deckbuilding in magic: The gathering using a genetic algorithm. Master's thesis, NTNU, 2017.

[2] Jan Švelch. Mediatization of a card game: Magic: The gathering, esports, and streaming. *Media, Culture & Society*, 42(6):838–856, 2020.

[3] Wikipedia. Magic: The Gathering. `https://en.wikipedia.org/wiki/Magic:_The_Gathering`. Accessed: 2021-04-16.