EMPIRE MACHINES AND BEYOND

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ABSTRACT

This paper addresses one key weakness in traditional State Machines: fixed behavior and number of states. We introduce Empire Machines, which solve that problems and pursue an equal and completely just world. They can also be used to model any Civilization game. Probably.

***K*eywords** Finite-State Machines · models of computation · Empire Machines · doing research like this is awesome · Civilization XXIV (when it comes out)

1 Introduction

State Machines have a long history: the first instance of them, Markov chains, was described and formalized in 1906 [1]. However, State Machines have one key limitation: the behavior of states, and the number of states, is fixed at compilation time [1]. This is obviously not realistic, as the conditions of the system being simulated may change. Moreover, states in real life do not behave like this: they conquer each other, have revolutions and occasionally self-destruct, which is kinda nice. The states of classical State Machines are too peaceful. The states with low probability are too conformist and cannot get out of their misery while the states with high probability will always hold the power and laugh at the weak. We feel in the moral obligation of ending this oppression that has been active for more than one hundred years. To achieve than, we feel proud to introduce the glorious concept of Empire Machines, a novel architecture that can end all of these problems and provide true justice.

2 Motivation

Look at the following map of the Roman Empire in 1356. Beautiful and chaotic, right?

[1]Note that interpreted programming languages are the work of the devil. We will ignore their existence in this paper.

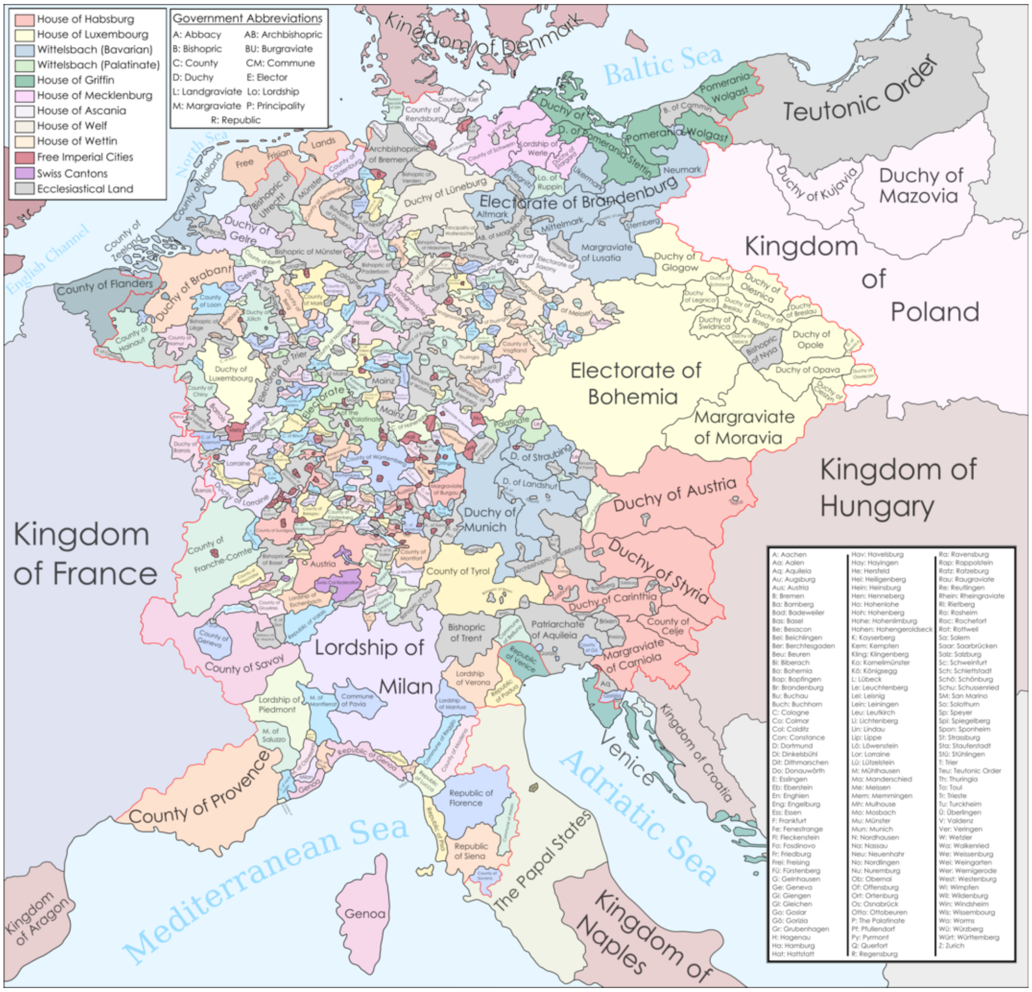
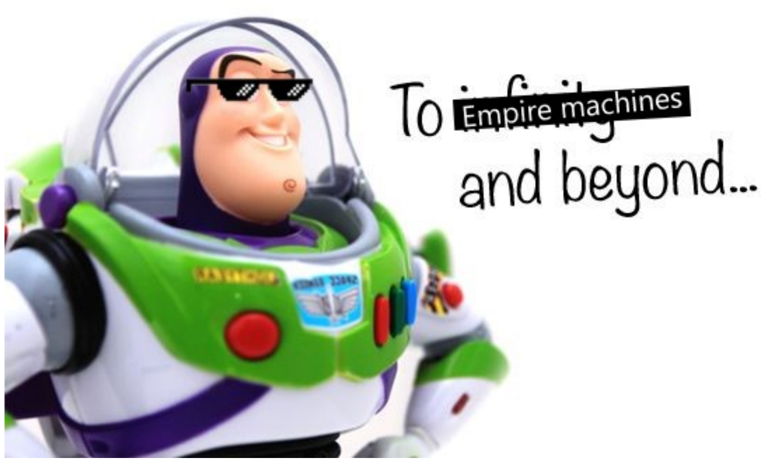


Figure 1: From `https://commons.wikimedia.org/wiki/File:Golden_Bull_of_1356.png`

Notice the perfection and marvelousness of this Empire Machine.

If one looks closely at the current map, one can notice that the distribution of countries is ""slightly"" different. Since each country is effectively a State Machine, that can only mean one thing. We. Are. Right. States machines are not an immutable entity, the can change form or size with time. Moreover, they are part of something bigger. In the particular case of our image, it is the Ancient European Empire Machine (official name from today on). But we can go further...



3 Related work

For more background on the useless Finite-State Machines please see [2].

See (partially unrelated) [3].

See the author's past work (obviously unrelated) [4].

Also important to understand motivation: `https://civilization.com/en-GB/`

4 Idea sketch

For inspiration (and also how to get the best intuition about Empire Machines) watch `https://www.filmaffinity.com/es/film485194.html` while drunk. The authors do not encourage nor discourage drunkenness.

Now that you are questioning why that film even exists, you can continue reading. Since your mind should be by now too occupied with that thought, you should not be able to question why our paper even exists. A clear win-win situation, right?

5 Definitions and formalism

If we want to model a Empire Machine, we first need to distinguish two different behaviors: the interactions that happen within a State Machine, and the interactions that happen between different State Machines within the bigger and more glorious Empire Machine.

5.1 Intra-State Machine interactions

Our novel State Machine model can still be modelled in the same way as a classical one. Each state has a certain power (AKA probability for noobs) and the sum of all of them needs to be equal to 1 (on further work we will expand the model to the case where the sum of probabilities equals π (or e (or 3, all of them are the same after all))). The power of the states evolves through time using the money transactions (AKA transition probabilities) between different states. The power after a time step can be computed in the same way as in a classical state machine, by multiplying the Money Transaction Matrix (or MTM, to make it shorter) times the current power.

So far so good. Now is where things start getting interesting.

5.1.1 Revolution

A revolution can happen if the following condition is fulfilled:

$$P_i^r < k \sum_{j \neq i}^{M} \frac{P_j^r}{M-1} \tag{1}$$

Where k is a State Machine-dependent non-negative, probably-positive, maybe-imaginary constant. For simplicity and since we are very lazy, we will only consider the case where P_i is positive.

When a revolt happens, a state is killed. Since states die when they are killed [5], it disappears without a trace and its power is distributed evenly between the rest of states. The MTM is recomputed by deleting the correspondent row and column and distributing the transaction routes evenly between the other states.

5.1.2 Division

A division can happen when there are too few commercial routes between any two subsets of states, S_1 and S_2, that cover the space of the State Machine and such that the number of states of the smallest of the two is at least one third the number of states of the biggest one. In this case the State Machine breaks apart into two different State Machines, which become part of the Empire Machine. The total power of each State Machine is normalized to add up to one again. The MTM breaks into two new MTMs and the money transactions are normalized within each column to maintain the correct behavior of the State Machines.

5.1.3 Birth

A state can appear out of nothing whenever it feels like it. Seriously. When this happens, the newborn state starts with 0 power. The MTM is modified by adding a row and a column. The column is initialized at random (with the condition that it adds up to 1) while the row is initialized by stealing some commercial routes from other states. The details of the second process are far too complex and are beyond the scope of this serious paper.

5.1.4 Pandemic

The State Machine enters a chaos era. Everything is randomized. The powers are distributed between the states and the MTM becomes a completely new matrix. Some states can also die, but the other states are usually too busy trying to survive to even notice that.

5.2 Inter-State Machine interactions

A Empire Machine can be modeled in the same way as a State Machine, with each State Machine possessing a certain power and some money transactions between State Machines. Hence, State Machines within a Empire Machine can interact between them using the same processes as the states within a State Machine. But they are more awesome. Additionally, there are a few operations that are specific to Empire Machines, as we describe below.

5.2.1 Fusion

If two State Machines have a strong commercial relation, they can fuse together with a certain probability that depends on the two States Machines. The condition for the fusion of the State Machines i, j reads:

$$\begin{cases} P_i^f P_j^f & \text{if} \quad \mathrm{MTM}_{ij}^1 \cdot \mathrm{MTM}_{ji}^2 \ \geq \ 0.5 \\ 0 & \text{if} \quad \mathrm{MTM}_{ij}^1 \cdot \mathrm{MTM}_{ji}^2 \ < \ 0.5 \end{cases} \tag{2}$$

The inner powers of the combined State Machine and the inner MTM are recomputed using the same principles as in the birth case but with more states.

5.2.2 Conquer

Conquer works in the same way as a Revolution, but the condition for it to happen is different. Each State Machine can randomly decide to conquer a different State Machine. The probability of the State Machine i to conquer the State Machine j at a certain time step is:

$$P = P_i^c \cdot (1 - \mathrm{MTM}_{ij}) \cdot (1 - \mathrm{MTM}_{ji}) \tag{3}$$

5.3 Other interactions

There are other interactions that are either spoilers or that we are investigating right now. We will publish the results in Nature or in Sigbovik 2021. Who knows.

6 Hierarchy

We now define common variations of the Empire Machine depending on the type of state considered.

Definition 6.1. A Planetary Empire Machine is an Empire Machine where the states are themselves Empire Machines.

Definition 6.2. A Galactic Empire Machine is an Empire Machine where the states are themselves Planetary Empire Machines.

Definition 6.3. A Multiversal Empire Machine is an Empire Machine where the states are themselves Galactic Empire Machines.

We now present a different formalization of the hierarchy of k-level State Machines using inductive definitions.

Definition 6.4. A 0-level State Machine is a single state Finite-State Machine with 0 probability (because we want to innovate).

Definition 6.5. A 1-level State Machine is a Finite-State Machine.

Definition 6.6. A 2-level State Machine is a Empire Machine.

Definition 6.7. A $(k+1)$-level (with $k \geq 2$) State Machine is a Empire Machine whose states are k-level State Machines.

7 Analyses

Through careful analysis we got to know of the awesomeness of this idea, see Section 8 for more details.

8 Theorems

Theorem 8.1. *Empire Machines can solve the Halting problem and therefore are models of hypercomputation.*

Proof. Proofs left as an exercise $\square$

Corollary 8.1.1. *Empire Machines are awesome.*

Corollary 8.1.2. *Galactic Empire Machines are even better.*

Corollary 8.1.3. *Multiverse machines require further research and more funding.*

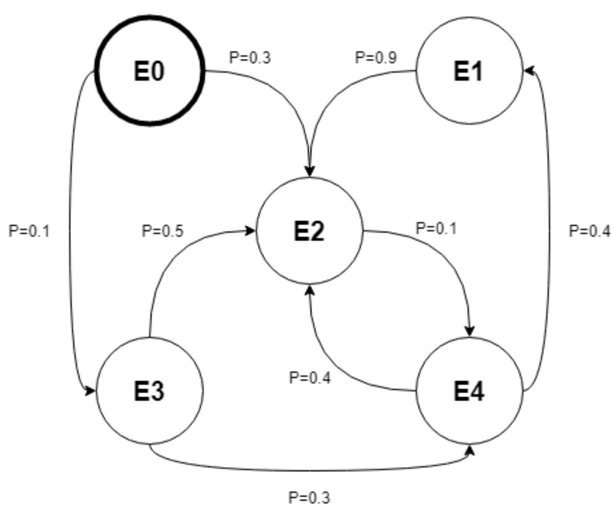
9 Relations to other complexity classes

Empire Machines win!

10 Relations to other decidability classes

Empire Machines win!

11 Pretty pictures

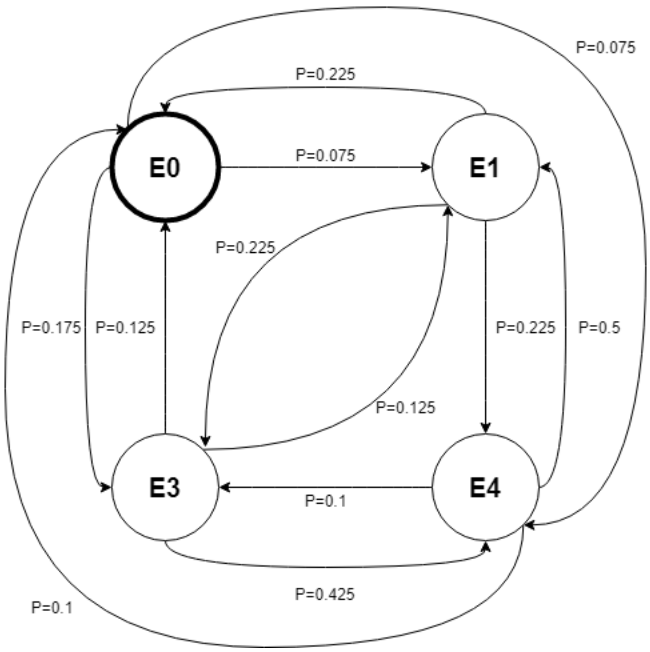


$$\begin{bmatrix} 0.6 & 0 & 0 & 0 & 0 \\ 0 & 0.1 & 0 & 0 & 0.4 \\ 0.3 & 0.9 & 0.9 & 0.5 & 0.4 \\ 0.1 & 0 & 0 & 0.2 & 0 \\ 0 & 0 & 0.1 & 0.3 & 0.2 \end{bmatrix}$$

Adjacency matrix

Figure 2: Unbalanced Planetary Empire Machine

Here we can see a normal Planetary Empire Machine. However, too many probabilities flow into Empire 2, whereas very few flow out of it. This will cause the remaining empires to wage war against Empire 2, and destroy it. Here is the end result:



$$\begin{bmatrix} 0.675 & 0.225 & 0.125 & 0.1 \\ 0.075 & 0.325 & 0.125 & 0.5 \\ 0.175 & 0.225 & 0.325 & 0.1 \\ 0.075 & 0.225 & 0.425 & 0.3 \end{bmatrix}$$

Adjacency matrix

Figure 3: Balanced Planetary Empire Machine
(after violence)

The probabilities that used to go into E2 are now divided between all the remaining empires. This will ensure the Planetary Empire Machine is peaceful again. Of course, until new empires appear or old empires gain too much power, in which we are back to the beginning, but oh well.

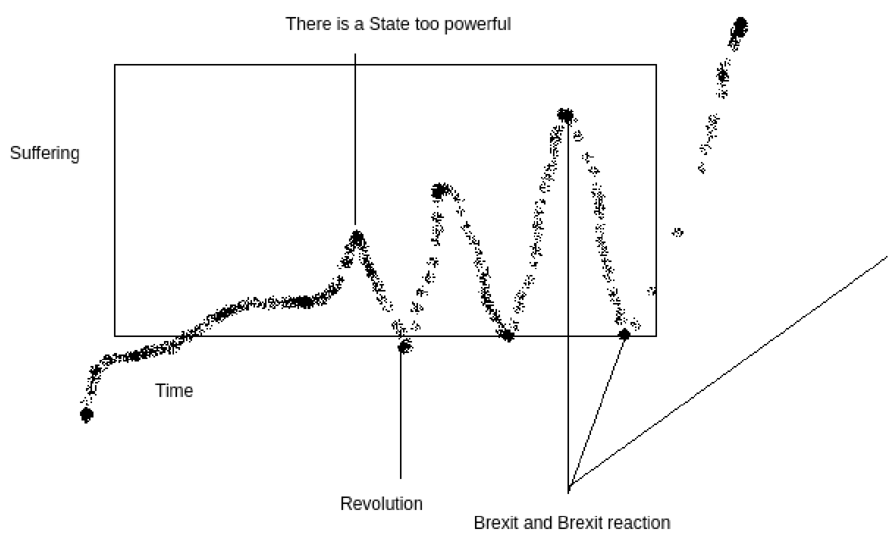


Figure 4: Plot showing evolution with respect to time of a complexity measure (specifically suffering which is also called productivity by economists), we have manually annotated relevant events to help explain the inflexion points, the interested reader may notice the non-monotonicity with respect to time.

12 Empirical evidence for the superiority of Empire Machines

Nobody cares

13 Potential moral implications

Nobody cares (again)

14 Benchmarking

Nobody cares

15 Reproducibility

The authors make no guarantee that this is reproducible or worth anyone's time. Someone tried to make code [6] but we do not know if it matches the content here.

16 Future work

Magic

17 Conclusion

Happiness

18 Are there page numbers?

No!

References

[1] A.A. Márkov. "Rasprostranenie zakona bol'shih chisel na velichiny, zavisyaschie drug ot druga". Izvestiya Fiziko-matematicheskogo obschestva pri Kazanskom universitete, 2-ya seriya, tom 15, pp. 135–156, 1906

[2] `https://en.wikipedia.org/wiki/Finite-state_machine`

[3] SIGBOVIK 2019 `http://sigbovik.org/2019/proceedings.pdf`

[4] RLIRFO `https://github.com/juancarlosmv/RLIRFO`

[5] A place where we learnt that people die when they are killed `https://typemoon.fandom.com/wiki/Fate_series`

[6] `https://github.com/juancarlosmv/MachineEmpires`