Magic the Gathering and its potential to be a Universal Turing Machine and by extension (in theory) run modern computing software (namely Windows 10)

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Preamble

Thanks to some research that went into proving that Magic the Gathering was in fact complicated enough to become a Universal Turing Machine (UTM)[1] by Alex Churchill[2] and by the sole fact that any true Universal Turing Machine can theoretically recreate any other Turing Complete Machine[3]. And based on this sole principle, I'm setting off to calculate how many cards would be needed to run modern software in a modern operating system being that as Magic the Gathering has been proved to be theoretically Turing Complete, it is on Turing Equivalence (having the ability to simulate) to other modern more practical computational methods (e.g. Windows 10 or rather an actual computer rather than small sheets with preset rules set on top of them)

Major Set Backs

A defining property of a UTM is that they are unable to simulate non-computational aspects of programs, that is to say you are unable to connect a mouse to a deck of cards, and in the same manner you can't hook up a monitor to your Magic the Gathering game either (Though in theory, since the data *is* there you can manually input the actually data from the buffer (which you can read freely given that it's a pile of cards in front of you) and put that into an image and "paint" the display output for yourself).

Another property of UTMs is that it assumes infinite resources, wether it be processing power (Moving your cards beyond humanly possible), or actually having enough of the cards to represent every last bit of information (yes that's a pun, thank you).

What is required

As per Churchill's design[4] the following cards:

The cards on the battlefield are as follows:

Kazuul Warlord*, controlled by Alex, hacked to read "Whenever ~this~ or another Yeti enters the battlefield under your control, you may put a +1/+1 counter on each Yeti creature you control."

Kazuul Warlord*, controlled by Alex, hacked to read "Whenever ~this~ or another Zombie enters the battlefield under your control, you may put a +1/+1 counter on each Zombie creature you control."

Noxious Ghoul*, controlled by Bob, reading its original text, "Whenever ~this~ or another Zombie enters the battlefield, all non-Zombie creatures get -1/-1 until end of turn."

Noxious Ghoul*, controlled by Bob, hacked to read "Whenever ~this~ or another Yeti enters the battlefield, all non-Yeti creatures get -1/-1 until end of turn."

Aether Flash, controlled by Cathy

Thirty-six copies of Rotlung Reanimator*, all controlled by Alex, all doubly hacked with Artificial Evolution, all granted phasing with Teferi's Curse or Cloak of Invisibility, and eighteen of them phased out by Reality Ripple. The eighteen initially phased-in encode the q1 program of Yurii Rogozhin's (2, 18) universal Turing machine: between them they say

Whenever an Ape (A0) dies, make a Siren (S1).

Whenever a Bat (B0) dies, make an Elf (E2).

... details omitted (show)...

Whenever a Pegasus (P0) dies, make a Rhino (R2M).

Whenever a Rat (R0) dies, make an Assassin (HALT).

Whenever a Shade (S0) dies, make a Camel (C2).

The eighteen that are phased out similarly encode the q2 program:

Whenever an Ape (A0) dies, make a Camel (C2).

Whenever a Bat (B0) dies, make a Camel (C2).

... details omitted (show)...

Whenever a Shade (S0) dies, make a Myr (M1).

The first sixteen Reanimators were cast in the normal fashion, four by each of the players, and donated by a Bazaar Trader. The other twenty are Clones and Vesuvan Shapeshifters copying a Rotlung Reanimator. The phasing enchantments

can include Teferi's Curse, Cloak of Invisibility, and Copy Enchantment, cast by any player and donated by a Bazaar Trader. These creatures and Auras must not be tokens, because tokens disappear when phased out.

All the creature types above are on the official list of Magic creature types: see How It Works for why these choices.

A rather large number of Dralnu's Crusade, all hacked. These can be token copies: we can animate one Crusade with e.g. Argent Mutation and Karn's Touch, then create many more with Rite of Replication or Spitting Image. The Crusades between them say the following:

All Assembly-Workers are also Yetis and Zombies

All A1s are also Yetis and A0s

All A2s are also Zombies and A0s

All B1s are also Yetis and B0s

All B2s are also Zombies and B0s

All C1s are also Yetis and C0s

All C2s are also Zombies and C0s

...

All S1s are also Yetis and S0s

All S2s are also Zombies and S0s

All B1Ms are also Reflections

All F2Ms are also Reflections

All I1Ms are also Reflections

All K2Ms are also Reflections

All L1Ms are also Reflections

All R2Ms are also Reflections

All S1Ms are also Reflections

All Constructs are also A0s

A Curse of Death's Hold enchanting Alex and two Engineered Plagues, one set to Yetis and one set to Zombies, to undo the P/T pumps of the Dralnu's Crusades

Eight Rotlung Reanimators*, controlled by Bob. These can be token copies, as they never phase out. These are hacked to say between them:

When a Basilisk (B1M) dies, make a Blinkmoth (B1).

When an F2M dies, make an F2.

When an I1M dies, make an I1.

When a K2M dies, make a K2.

When an L1M dies, make an L1.

When an R2M dies, make an R2.

When an S1M dies, make an S1.

When a Construct dies, make a Construct.

Chancellor of the Spires, controlled and owned by Alex

Tajuru Archer*, controlled by Alex, hacked to read "Whenever ~ or another Reflection enters the battlefield under your control, you may have ~ deal damage to target creature with flying equal to the number of Reflections you control", and equipped with Blight Sickle

At least six Reflection tokens*, controlled by Alex

Necroskitter, controlled by Cathy

Vengeful Dead, controlled by Alex, hacked to read "Whenever ~ or another Assassin dies, each opponent loses 1 life."

There can be any number of lands controlled by any of the players, which helps when setting this up. There can be other enchantments and artifacts too if desired, and other creatures as long as they're turned into Assembly-Workers.

The takeaway here is the Dralnu’s Crusade which are used to serve as the main processing information in the design

Monetary cost of simulating Windows 10

This is all assuming infinite resources, regarding amount of cards printed and their individual resale price as of April 6th 2019 not including shipping or taxes.

Card	Price	Amount	**Total**
Zazuul Warlord	0.99	2	1.98
Noxious Ghoul	2.49	2	4.98
Aether Flash	1.98	1	1.98
Rotlung Reanimator	2.00	54	108.00
Artificial Evolution	1.99	1	1.99
Teferi’s Curse	1.00	1	1.00
Reality Ripple	3.15	1	3.15

Curse of Death's Hold	1.25	1	1.25
Engineered Plagues	6.99	2	13.98
Chancellor of the Spries	1.25	1	1.25
Tajuru Archer	0.99	1	0.99
Blight Sickle	1.89	1	1.89
Necrosktiter	4.00	1	4.00
Vengeful Dead	1.89	1	1.89
Dralnu's Crusade	1.99	A lot*	1.99
Argent Mutation	2.49	1	2.49
Karn's Touch	1.50	1	1.50
Total (Not Accounting for Dralnu's Crusade)			140.23

So we are going to need A LOT of Dralnu's Crusade (Or we could just replicate it with a couple cards, but that's no fun, and makes everything hard)

The sheer amount of Dralnu's Crusade

As per the official Windows 10 system requirements[5] we are going to need a 1 gigahertz processor (Restriction lifted thanks to the nature of UTM's), 1 gigabyte of random access memory (minimally), as well as a minimum of 16 gigabytes of storage to store the operating system itself, and a Direct X 9 Graphics card and a Display with a resolution of 800x600 (Both of which lifted again due to the nature of UTM's).

So assuming Dralnu's crusade is our bit, we can then go ahead and solve for how many sheer individual bits this huge number is:

We know a byte is 8 individual bits of data (What a Dralnu's Crusade represents, or in other words a 1 or 0, on or off state) and that a kilobyte is 1024 bytes, a megabyte is 1024*1 kilobyte, and a gigabyte is 1024*1 megabyte, so there fore to simplify, a gigabyte can be seen as 1 bit*(1024^3*8) or again simplified 1 bit*8589934592. And put into this function table, results in outputs as follows for function:

$$f(x) = x \times 8589934592$$

Where X is gigabytes and f(x) is the result in bits):

X	f(X)
1	8589934592
2	17179869184
3	25769803776
4	34359738368
…	…
16	137438953472

Therefore given these values, all we need to do is compute for 17 gigabytes of data needed to store all of the necessary data for the given information (16+1 accounting for Random Access Memory and General Purpose Storage combined),

which results in 146,028,888,064 or in English, One Hundred Forty-Six Billion Dralnu's Crusade cards, assuming that amount even exists

$$146028888064 \times 1.99 = 290597487247.36$$

Or a total of **290,597,487,247.36**, and then adding the 140.23 initial cost of the rest of the Magic the Gathering cards results in:

$$290{,}597{,}487{,}247.36 + 140.23 = \mathbf{290597487387.59}$$

Which Is just a big number, so let me write it out in plain easy to understand English for those who want to get a picture of what this means:

> **Two Hundred Ninety Billion, Five Hundred Ninety-Seven Million, Four Hundred Eighty-Seven Thousand, Three Hundred Eighty-Seven Dollars and Fifty-Nine Cents.**

This insanely huge number is big enough for approximately **1,827,687,153 brand new Air Pods**, or taking the lowest specifications available new on the retail market (2 gigabytes of random access memory, and 32 gigabytes of storage, *twice* the computed specifications of our "computer") the monetary cost of **actual computers you could buy and use would be 3,632,468,591**, or a luxurious amount of food according to the USDA cost of food in 2014[6] for the average adult, **food for 79,843 years**, 1,124 times the human lifespan!

Sources

1 - https://www.toothycat.net/~hologram/Turing/HowItWorks.html

2 - https://www.toothycat.net/~hologram/Turing/About.html

3 - Arora, Sanjeev; Barak, Boaz (2009). "Complexity Theory: A Modern Approach". Cambridge University Press. ISBN 978-0-521-42426-4. section 1.4, "Machines as strings and the universal Turing machine" and 1.7, "Proof of theorem 1.9"

4 - https://www.toothycat.net/~hologram/Turing/Cards.html

5 - https://www.microsoft.com/en-us/windows/windows-10-specifications

6 -https://www.cnpp.usda.gov/sites/default/files/-usda_food_plans_cost_of_food/CostofFoodJul2014.pdf