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- Jack James (ninjafoodstuff)

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Star Realms Simulator!!(↗ /thread/1462398/star-realms-simulator)

Star Realms – Amazon.com \$13.97 ✓prime

John🔧 @icesphere Oct 28, 2015 (edited)

I have created a Star Realms Simulator!!

Why is a simulator awesome?? Because I can simulate 10,000 games in under 10 seconds. There is a lot of interesting data you can get from 10,000 games!!

Now before you get too excited, currently it is only running on my computer. However if there is enough interest I plan on making a website where anyone can try different strategies and run them against the simulator.

Also currently the simulator only handles the Base Set, although I plan on eventually adding in all of the cards.

I have created several "bots" to test different strategies. Here are the current set of bots:

ExpensiveBot - Always buys the most expensive card

VelocityBot - Favors scrap

AttackBot - Favors attack

DefenseBot - Favors lifegain/defense

HareBot - Combination of attack and scrap

TortoiseBot - Combination of defense and scrap

VelocityBot/AttackBot/DefenseBot were inspired by Benjotron's post: [Wheel of Strategic Dominance](#)

HareBot/TortoiseBot were inspired by HomerJr's post: [The Tortoise, the Hare, and the Missile Bot](#)

Now for some results!!

Each bot played each other bot 10,000 games each. Each bot also played itself to see what the 1st player advantage is when using the same strategy.

--ExpensiveBot--

ExpensiveBot v HareBot - 27.93% - 72.07% (Avg # turns: 27.88)

ExpensiveBot v AttackBot - 40.39% - 59.61% (Avg # turns: 27.77)

ExpensiveBot v DefenseBot - 42.48% - 57.52% (Avg # turns: 30.23)

ExpensiveBot v VelocityBot - 23.84% - 76.16% (Avg # turns: 27.67)

ExpensiveBot v TortoiseBot - 29.96% - 70.04% (Avg # turns: 28.45)

ExpensiveBot v ExpensiveBot - 1st player wins: 55.20% (Avg # turns: 29.57)

--VelocityBot--

VelocityBot v HareBot - 53.97% - 46.03% (Avg # turns: 27.26)
VelocityBot v AttackBot - 59.85% - 40.15% (Avg # turns: 26.45)
VelocityBot v DefenseBot - 70.78% - 29.22% (Avg # turns: 28.91)
VelocityBot v TortoiseBot - 57.67% - 42.33% (Avg # turns: 28.14)
VelocityBot v ExpensiveBot - 76.36% - 23.64% (Avg # turns: 27.60)
VelocityBot v VelocityBot - 1st player wins: 57.92% (Avg # turns: 27.70)

--AttackBot--

AttackBot v HareBot - 39.37% - 60.63% (Avg # turns: 27.95)
AttackBot v DefenseBot - 52.04% - 47.96% (Avg # turns: 29.68)
AttackBot v VelocityBot - 39.05% - 60.95% (Avg # turns: 26.52)
AttackBot v TortoiseBot - 44.50% - 55.50% (Avg # turns: 27.23)
AttackBot v ExpensiveBot - 60.03% - 39.97% (Avg # turns: 27.88)
AttackBot v AttackBot - 1st player wins: 54.66% (Avg # turns: 29.48)

--DefenseBot--

DefenseBot v HareBot - 36.77% - 63.23% (Avg # turns: 29.16)
DefenseBot v AttackBot - 47.76% - 52.24% (Avg # turns: 29.72)
DefenseBot v VelocityBot - 29.82% - 70.18% (Avg # turns: 28.93)
DefenseBot v TortoiseBot - 36.19% - 63.81% (Avg # turns: 31.15)
DefenseBot v ExpensiveBot - 57.83% - 42.17% (Avg # turns: 30.24)
DefenseBot v DefenseBot - 1st player wins: 57.45% (Avg # turns: 36.45)

--TortoiseBot--

TortoiseBot v HareBot - 48.46% - 51.54% (Avg # turns: 27.77)
TortoiseBot v AttackBot - 56.20% - 43.80% (Avg # turns: 27.28)
TortoiseBot v DefenseBot - 63.97% - 36.03% (Avg # turns: 31.25)
TortoiseBot v VelocityBot - 41.54% - 58.46% (Avg # turns: 28.14)
TortoiseBot v ExpensiveBot - 69.29% - 30.71% (Avg # turns: 28.47)
TortoiseBot v TortoiseBot - 1st player wins: 58.46% (Avg # turns: 30.37)

--HareBot--

HareBot v AttackBot - 60.91% - 39.09% (Avg # turns: 27.91)
HareBot v DefenseBot - 62.83% - 37.17% (Avg # turns: 29.11)
HareBot v VelocityBot - 46.15% - 53.85% (Avg # turns: 27.07)
HareBot v TortoiseBot - 52.69% - 47.31% (Avg # turns: 28.06)
HareBot v ExpensiveBot - 71.70% - 28.30% (Avg # turns: 27.86)
HareBot v HareBot - 1st player wins: 56.81% (Avg # turns: 27.84)

Some interesting results:

- I wasn't expecting ExpensiveBot to do so well.
- According to the "Wheel of Dominance" Lifegain will beat Damage, Damage will beat Scrap, Scrap will beat Lifegain. Scrap definitely beat Lifegain, however these results show that Damage has a small advantage against Lifegain, and Scrap beats Damage.
- 1st player has a significant advantage.

Should 1st player only start with 2 cards??

HareBot (always 1st) v HareBot (always 2nd)
1st player starts with 3 cards: 56.81% - 43.19%
1st player starts with 2 cards: 48.3% - 51.7%

1st player wins across all different strategies: (60,000 games):
1st player starts with 3 cards: 1st player wins 55.89%
1st player starts with 2 cards: 1st player wins 49.24%

When 1st player starts with only 2 cards the win rate for 1st player is a lot closer to 50%.

I feel like I've just scratched the surface of what I can do with this simulator, so if you have ideas of other things to try, let me know!!

Joe Kundlak Designer @Joeyeti Oct 28, 2015

While a nice scientific exercise, these simulations do not interest me at all when looking at a game. Luckily.

G Mc @gmc14 [Oct 28, 2015](#)

I would love to see this in action.
Are your bots written in such a way that others could easily contribute new ones? Do you have a GitHub/Bitbucket link for us?

Simon Taylor ⚡ @simondtaylor [Oct 28, 2015](#)

INteresting, but I think your AI has too simple rules to balances the plays out.

What about a bot that plays for gold, until the first few turns are up, then switches to attack (like most people do).

What about a bot that does the above, but goes for faction synergy when they have it.

Granted, that takes a more complicated ruleset, but I think, while your analysis is impressive, the constant win percentage of 59%, driving your conclusion for a 2 card 1st draw, is a little too hasty.

Sebastian Zarzycki ⚡ @rattkin [Oct 28, 2015](#)

Amazing stuff! Confirms my findings, but it's nice to see it backed by some numbers.

John 🕒 @icesphere [Oct 28, 2015](#)

The bots do actually give higher value to trade cards in the first couple of decks.

Mark Stang @stangm [Oct 28, 2015](#)

Simon Taylor @simondtaylor wrote:

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I think this is an awesome first step as well. But, as you imply, one of the interesting things about Star Realms is that you have to adjust your strategy to A) the trade row, and B) what your opponent is doing. If you have a scrap first strategy, at some point you probably need to stop buying red, and there are certain cards are pretty much insta buy regardless of strategy.

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The bots are written in JSON, I plan on doing a post showing how to create a bot. I haven't made the code available yet, but I'll probably add it to GitHub.

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Actually the bots are able to adjust, it's just a matter of programming the rules in. Each bot has a set of buy rules that can look at several data points to determine the value of a card.

Jeremy Hager @PraetorianXVIII Oct 28, 2015

This is cool! Thank you for this, and it's very interesting!

G Mc @gmc14 Oct 28, 2015

John @icesphere wrote:

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The bots are written in JSON, I plan on doing a post showing how to create a bot. I haven't made the code available yet, but I'll probably add it to GitHub.

Sounds great. I'd love to be able to have a bot battle. I look forward to creating my own JSON bots; very cool.

Matt Schoonmaker-Ga... @railbaron Oct 28, 2015

Wow, thanks for sharing this!

I'm sure it took a lot of work to build the simulator, but now that it's built you're just scratching the surface for what it can do.

I think you have a great start of things you're looking at, but I'm curious about the 'rule set' you used for each bot. Obviously that makes a huge difference in the results you get. Without knowing more, I'm a bit skeptical of the conclusions you've drawn regarding which strategy beats which strategy, and also that the first player should only have 2 cards. That is a pretty big advantage, and makes me question your simulator rule-set more than it makes me question the rules of the game :-).

So how easy is it to share your rule-set for a bot?

Also if you were looking for opinions about 'what to do next', I would say to keep honing the rule-set for the bots. Oh, another thing I wish I had is the ability to input the current situation of a game (authority, cards in deck, cards in hand, cards in discard), and then simulate the game out to see how often each player wins. This could even just ignore purchases, since sometimes near the end neither player is purchasing anything. Maybe you can already do this with your simulator, since it should be easier than what you've already done!

Thanks again!

Scott Heise Designer @HomerJr Oct 28, 2015

Ok wow, this sounds awesome. I've always wanted something like this. I'm so excited and have so many questions, I just can't even... 🤔

I am very curious to know how it all works. Is the simulator abstracted, or does it actually simulate real card draws and hands? Can you go into more detail about the logic behind the bots decisions; for example, what data points about the cards available to buy does it consider? Can you adjust the value of each card individually to test fringe scenarios like "always buy a Blob Fighter if able" or "never buy a Cutter"?

So I guess my big questions are...
- How can I get my hands on this?
- How can I help?!



John 🗨️ @icesphere Oct 28, 2015

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Thanks again!

I plan on posting the bots when I do the post about how to create a bot.

I really like the idea of putting in current game state and then simulating from there. Obviously the better the AI, the better the results you would get from that. I was planning on working on a "smart" bot that doesn't always follow a specific strategy, but instead bases strategy on trade row, current cards in deck, hand, and discard, and cards purchased by opponents, bases in play, etc.

I'm hoping that once I post how to create a bot then other people can work on creating really good bots, and then I can focus more of my time on other features.

@greylag [Oct 28, 2015](#)

If you have the ability to do quick rollouts (simulate thousands of games in a split second) then you might be better off using monte carlo to weight buys than using a rules-based system. But that's a whole 'nothing category of bot!

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- So I guess my big questions are...
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It simulates real card draws and hands.

I'll go into more detail when I post on how to create a bot, but basically each card can have a set of rules that determines the value of the card. So when the bot goes to buy a card it applies the rules for each card available to buy to determine the score for that card and then sorts by score and buys the card with the highest score, if a card returns a score of 0 that means the bot won't buy the card. Currently most of my bots use rules that base the score on which deck cycle you are in, so trade cards will have a higher score in your first deck cycle, and then can return 0 once you don't want anymore trade. There are lots of other things you can base the score on like current turn, authority, trade, combat, number of bases, etc. There are also rules to help decide which card to discard, which card to scrap, which base to use first, etc.

I haven't spent very much time yet creating really smart bots, so probably the biggest help would be to create some better bots so that we can get better data from the simulations.

Mark Stang [@stangm](#) [Oct 28, 2015](#)

John @icesphere wrote:

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Simon Taylor @simondtaylor wrote:

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wow very cool.
this is impressive stuff

Ben Gartner @benjotron [Oct 28, 2015](#)

Very interesting for what it is. The fact that the first player's winrate is pretty consistent across bots does prompt me to reconsider my previous stance that I'd prefer to go second, slightly.

I'm a bit confused as to why you don't show these stats for interbot play. The "mirror match" seems like a random struggle for the same cards. The second player has the advantage of reacting to the first players strategy by picking a dominating strategy OR fight them using an identical strategy.

However, I don't think it's fair to draw any broad conclusions based on a simulation that I haven't seen the source for, or bots that can't react to their opponents strategies - IE one that selects its strategy before looking at the trade row. That's the entire strategic basis of the game in my opinion - looking at the trade row, figuring out the best strategy, and executing it while adjusting for your opponent actions.

Why shouldn't the second bot get to select their strategy after the first bot has committed to its purchase? If the second player always picks a strategy that matches up well, based on the stats below, that would outstrip the typical 59% to 41% differential, right?

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Those are all really good points.

I did track 1st player wins for interbot play:
1st player wins across all different strategies: (60,000 games):
1st player starts with 3 cards: 1st player wins 56.97%
1st player starts with 2 cards: 1st player wins 51.32%

I started off by trying to compare different strategies since that was easier. Obviously a bot that can react to the trade row and the other player to decide strategy would be better, so hopefully we will be able to come up with some better bots. It will be interesting to see if the 1st player advantage holds up when we have better bots to simulate with.

Erwin Bonsma [@eriban](#) [Oct 28, 2015](#)

Interesting results, thanks for sharing!

I am curious, other than the buy decisions how did you handle the other choices?

For example:

- What option to use for cards with a choice?
- What order to play cards in? This is relevant for example when you can draw and put a card on top of your deck.
- When to use a card's scrap ability?
- Which card to scrap in case of a choice?
- Which outpost to destroy in case of a choice?
- Destroy a non-outpost base, or target the player?
- Which card to let Needle copy?

etc

Is it possible for the bots to decide on what to do, or did you hard-code logic in the simulator?

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- Destroy a non-outpost base, or target the player?
- Which card to let Needle copy?

etc

Is it possible for the bots to decide on what to do, or did you hard-code logic in the simulator?

A lot of those are still hard-coded, but I plan on moving those decisions to the bots.

John  [@icesphere](#) [Oct 28, 2015](#)

@greylag wrote:

If you have the ability to do quick rollouts (simulate thousands of games in a split second) then you might be better off using monte carlo to weight buys than using a rules-based system. But that's a whole 'nothing category of bot!

Sounds interesting, I'll have to look into that.

Nick Burger [@Ardemus](#) [Oct 28, 2015](#)

I've been interested in a statistics calculator for star realms decks. The initial statistics are easy, average damage per card, average authority gain, etc. With average draw/card it's not too hard to add in statistics based on the value of the additional cards. However, factoring in deck size advantages (like turning a deck during a draw), and ally abilities, starts to make my head hurt. Anyway, it's a big project, but even a partial implementation would add some very useful data points to your simulation.

Do I buy an explorer? It's turn 3, there are no expensive cards in the trade row, 3 of these 6 cards have already been purchased, my average trade per turn (5+(average cards drawn * 5 recursive) cards) is 6, I'm dealing 3 average damage per turn, my opponent is dealing 7 average damage per turn, my defense + healing is 6 authority per turn...

Then again, people are smart and AI programming is hard. Maybe I'll just go watch youtube or something.

John  [@icesphere](#) [Oct 29, 2015](#)

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Then again, people are smart and AI programming is hard. Maybe I'll just go watch youtube or something.

I like that idea. Like you said things like ally abilities and drawing cards would make it trickier, but it's probably possible to factor all of that in somehow.

John  [@icesphere](#) [Oct 29, 2015](#)

MoppyD wrote:

This is the ideal situation to use a GA (genetic algorithm).

Have "genes" that define factors such as "Percent chance to buy most expensive card" and "Desired ratio of scrap cards to regular".

Let them fight, clone and mutate the winners, run it again.

There's a lot of writing on GAs if you need to research further. In essence though, it's not that hard. Just add or subtract a few percent from each of the percent chances for the new generation.

Sounds interesting, not sure how much work that would be, but it probably wouldn't be super hard.