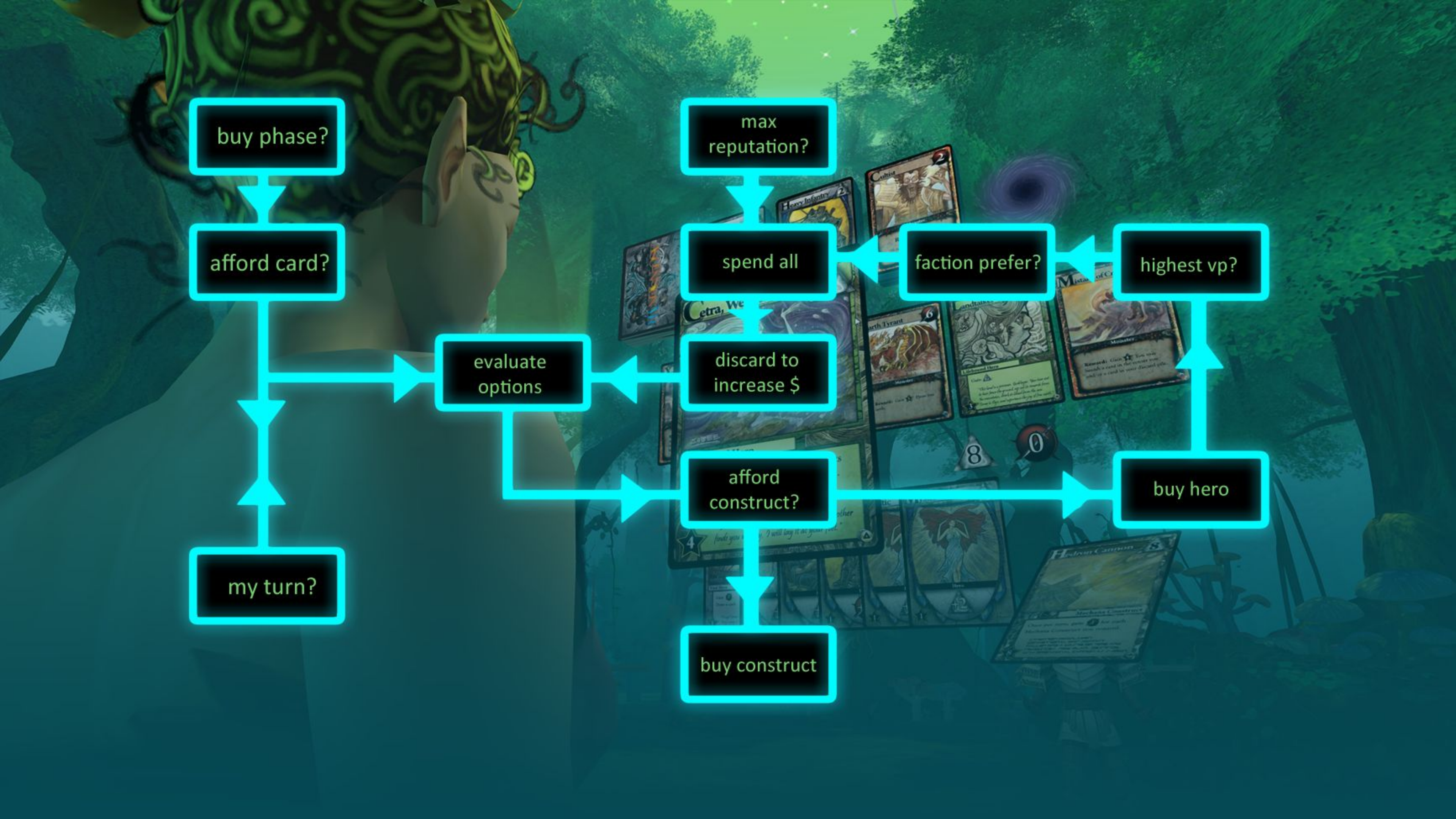
Race for the Galaxy: A Neural Network in Production

Race for the
Galaxy

TOM LEHMANN
RACE FOR THE galaxy
RACE FOR THE galaxy

Cetra, Weaver of Stars
7
Lifebound Hero
Acquire a Hero without paying its cost. Place it on top of your deck.
"Your destiny is in the stars, and if the Mother finds you worthy, I will lay it at your feet."
4
Mystic 3
Heavy Infantry 2
Cultist 2
Monster
Reward: 1
Earth Tyrant 6
Monster
Landtalker 6
Lifebound Hero
Mistake of Creation 4
Monster
8
0
Mystic 3
Hero
+2
Hedron Cannon 8
Mechana Construct
Once per turn, gain for each Mechana Construct you control.



buy phase?

afford card?

my turn?

evaluate options

max reputation?

spend all

faction prefer?

highest vp?

discard to increase $

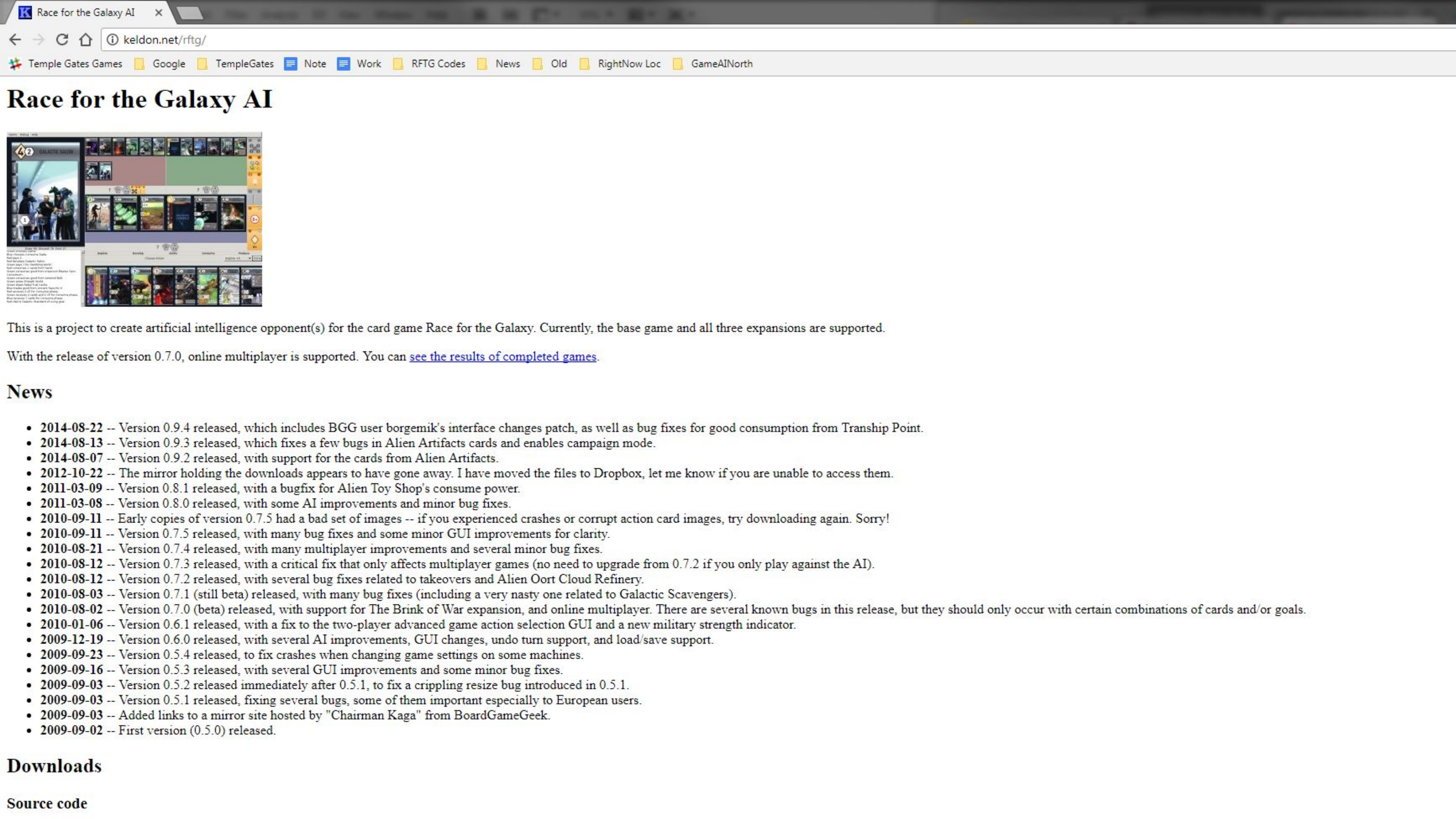
afford construct?

buy hero

buy construct

RACE FOR THE
galaxy
RACE FOR THE
galaxy

MINING CONGLOMERATE
MERCHANT WORLD
TERRAFORMING ROBOTS
RACE FOR THE
galaxy



Race for the Galaxy AI

This is a project to create artificial intelligence opponent(s) for the card game Race for the Galaxy. Currently, the base game and all three expansions are supported.

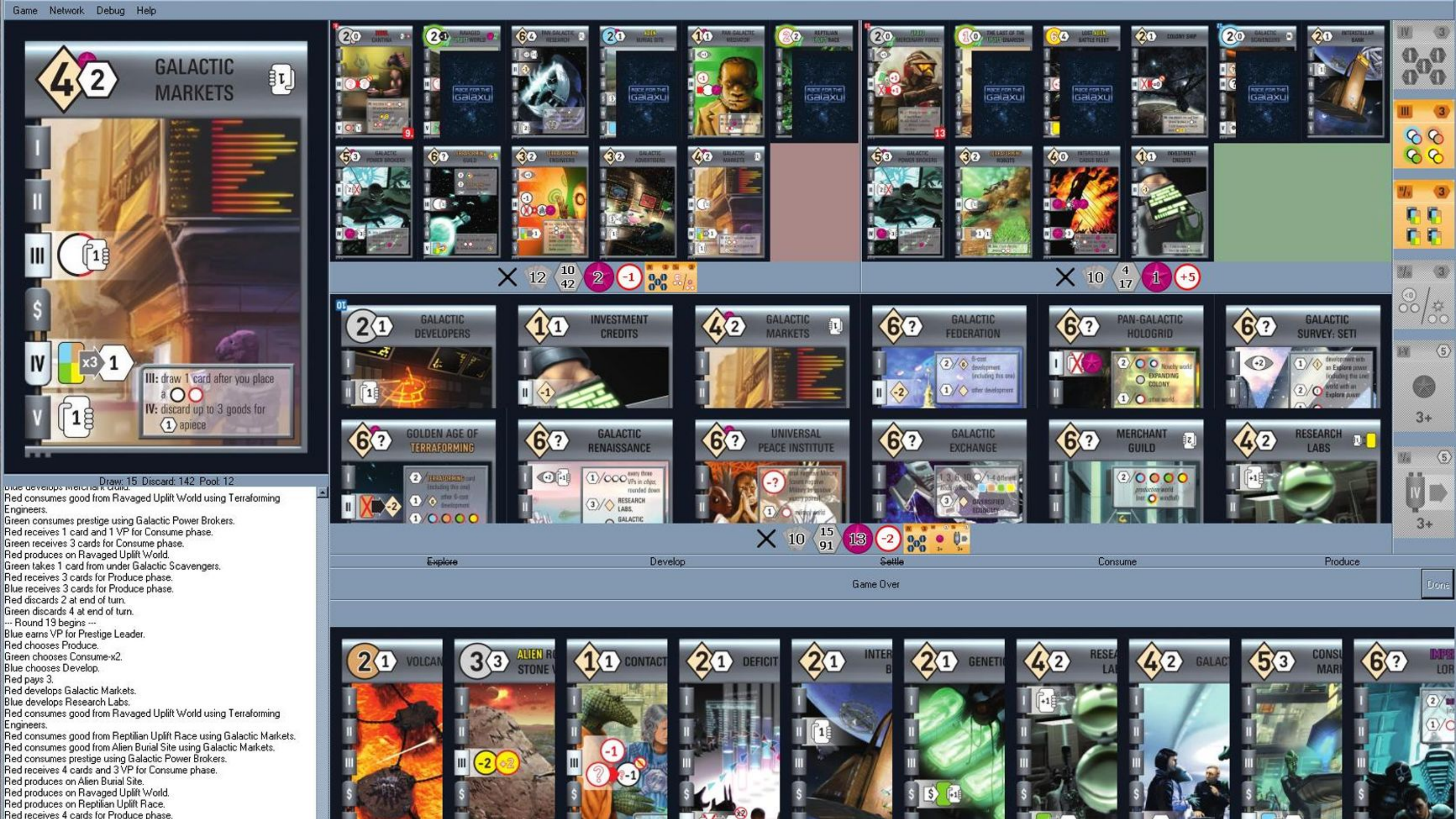
With the release of version 0.7.0, online multiplayer is supported. You can see the results of completed games.

News

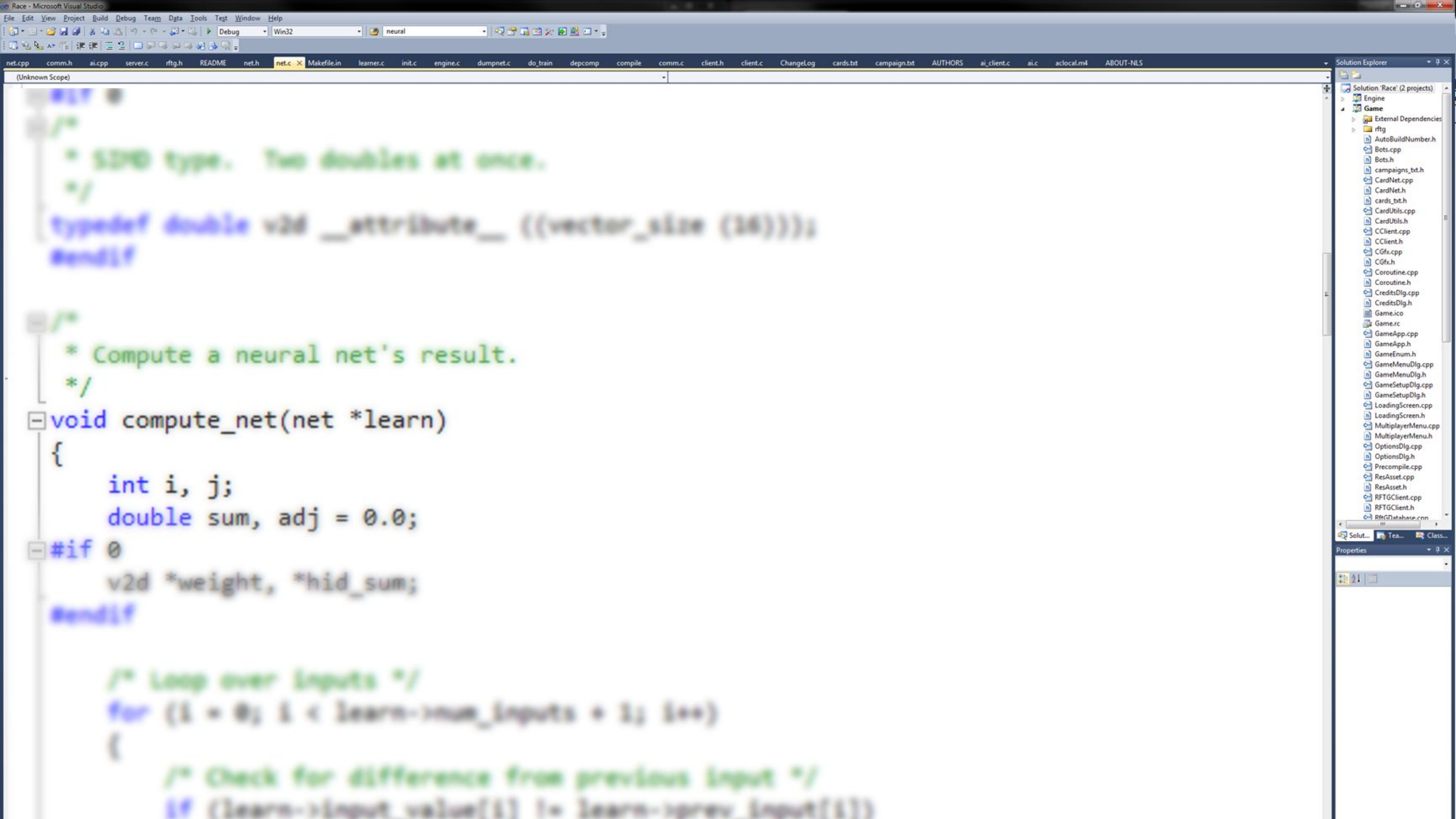
- **2014-08-22** -- Version 0.9.4 released, which includes BGG user borgemik's interface changes patch, as well as bug fixes for good consumption from Tranship Point.
- **2014-08-13** -- Version 0.9.3 released, which fixes a few bugs in Alien Artifacts cards and enables campaign mode.
- **2014-08-07** -- Version 0.9.2 released, with support for the cards from Alien Artifacts.
- **2012-10-22** -- The mirror holding the downloads appears to have gone away. I have moved the files to Dropbox, let me know if you are unable to access them.
- **2011-03-09** -- Version 0.8.1 released, with a bugfix for Alien Toy Shop's consume power.
- **2011-03-08** -- Version 0.8.0 released, with some AI improvements and minor bug fixes.
- **2010-09-11** -- Early copies of version 0.7.5 had a bad set of images -- if you experienced crashes or corrupt action card images, try downloading again. Sorry!
- **2010-09-11** -- Version 0.7.5 released, with many bug fixes and some minor GUI improvements for clarity.
- **2010-08-21** -- Version 0.7.4 released, with many multiplayer improvements and several minor bug fixes.
- **2010-08-12** -- Version 0.7.3 released, with a critical fix that only affects multiplayer games (no need to upgrade from 0.7.2 if you only play against the AI).
- **2010-08-12** -- Version 0.7.2 released, with several bug fixes related to takeovers and Alien Oort Cloud Refinery.
- **2010-08-03** -- Version 0.7.1 (still beta) released, with many bug fixes (including a very nasty one related to Galactic Scavengers).
- **2010-08-02** -- Version 0.7.0 (beta) released, with support for The Brink of War expansion, and online multiplayer. There are several known bugs in this release, but they should only occur with certain combinations of cards and/or goals.
- **2010-01-06** -- Version 0.6.1 released, with a fix to the two-player advanced game action selection GUI and a new military strength indicator.
- **2009-12-19** -- Version 0.6.0 released, with several AI improvements, GUI changes, undo turn support, and load/save support.
- **2009-09-23** -- Version 0.5.4 released, to fix crashes when changing game settings on some machines.
- **2009-09-16** -- Version 0.5.3 released, with several GUI improvements and some minor bug fixes.
- **2009-09-03** -- Version 0.5.2 released immediately after 0.5.1, to fix a crippling resize bug introduced in 0.5.1.
- **2009-09-03** -- Version 0.5.1 released, fixing several bugs, some of them important especially to European users.
- **2009-09-03** -- Added links to a mirror site hosted by "Chairman Kaga" from BoardGameGeek.
- **2009-09-02** -- First version (0.5.0) released.

Downloads

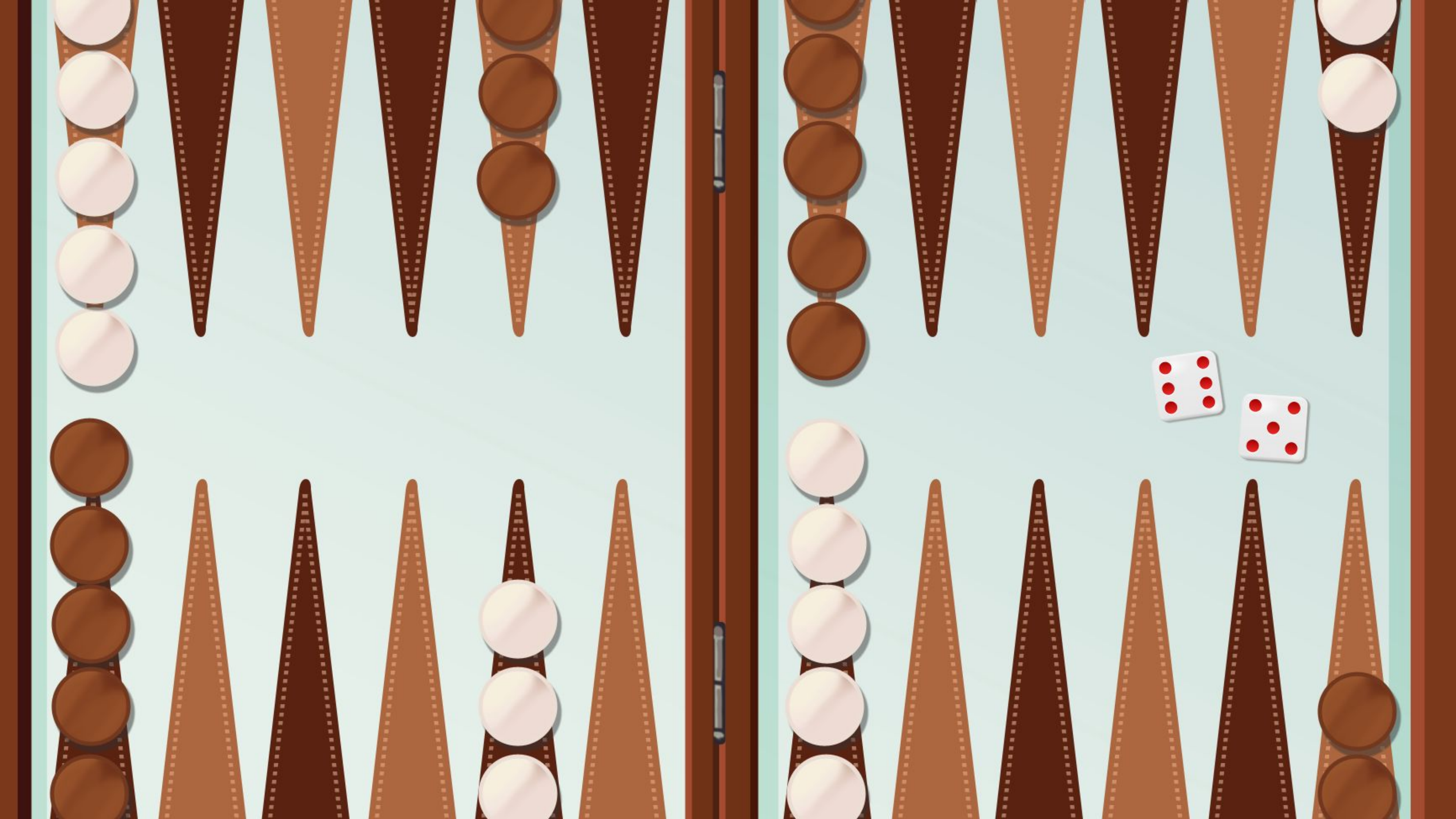
Source code

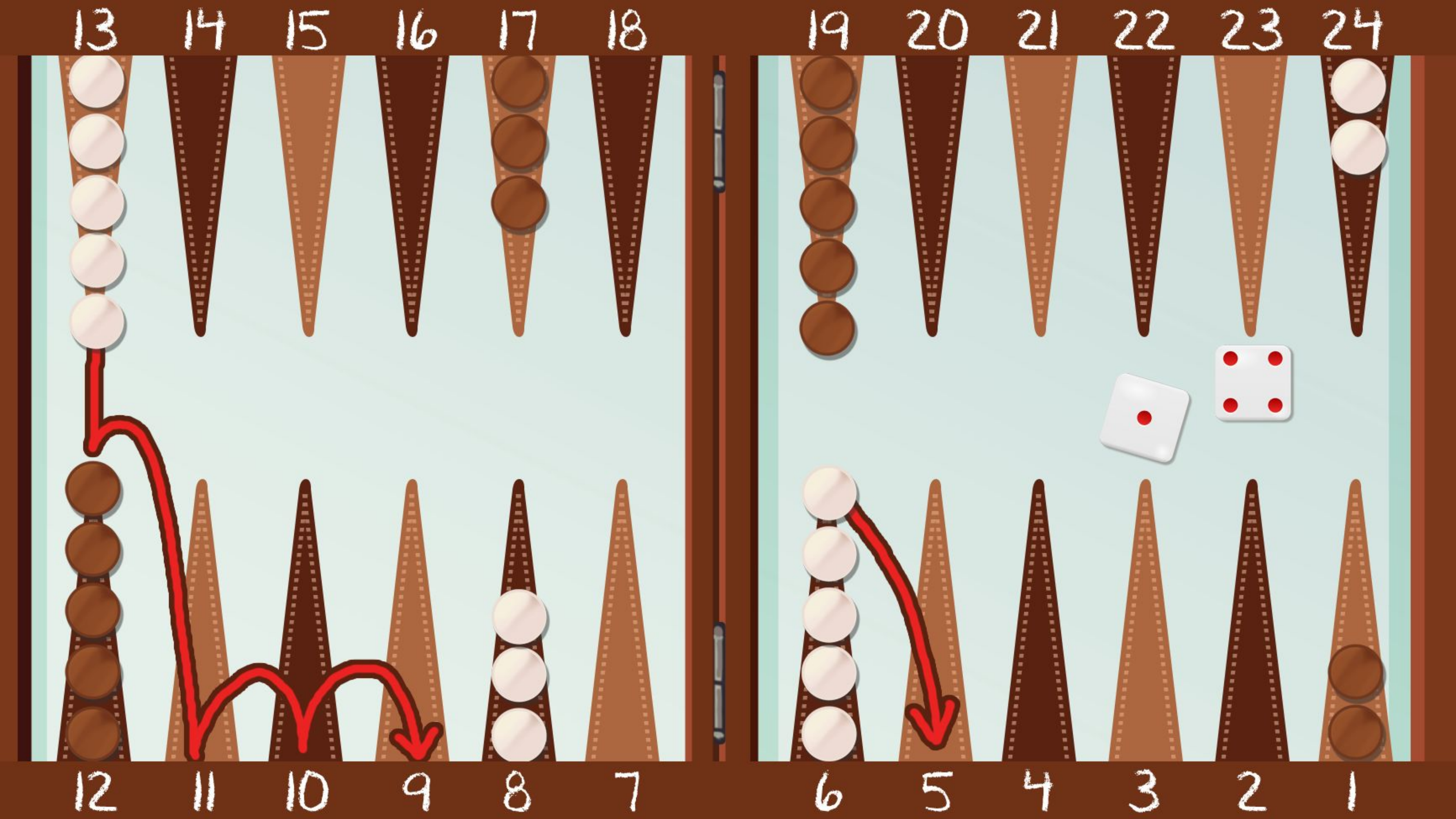

Game
Network
Debug
Help
GALACTIC MARKETS
III: draw 1 card after you place a ○ ●
IV: discard up to 3 goods for 1 apiece
GALACTIC DEVELOPERS
INVESTMENT CREDITS
GALACTIC MARKETS
GALACTIC FEDERATION
PAN-GALACTIC HOLOGRID
GALACTIC SURVEY: SETI
GOLDEN AGE OF TERRAFORMING
GALACTIC RENAISSANCE
UNIVERSAL PEACE INSTITUTE
GALACTIC EXCHANGE
MERCHANT GUILD
RESEARCH LABS
Draw: 15 Discard: 142 Pool: 12
~~Explore~~
Develop
~~Settle~~
Consume
Produce
Game Over
Done

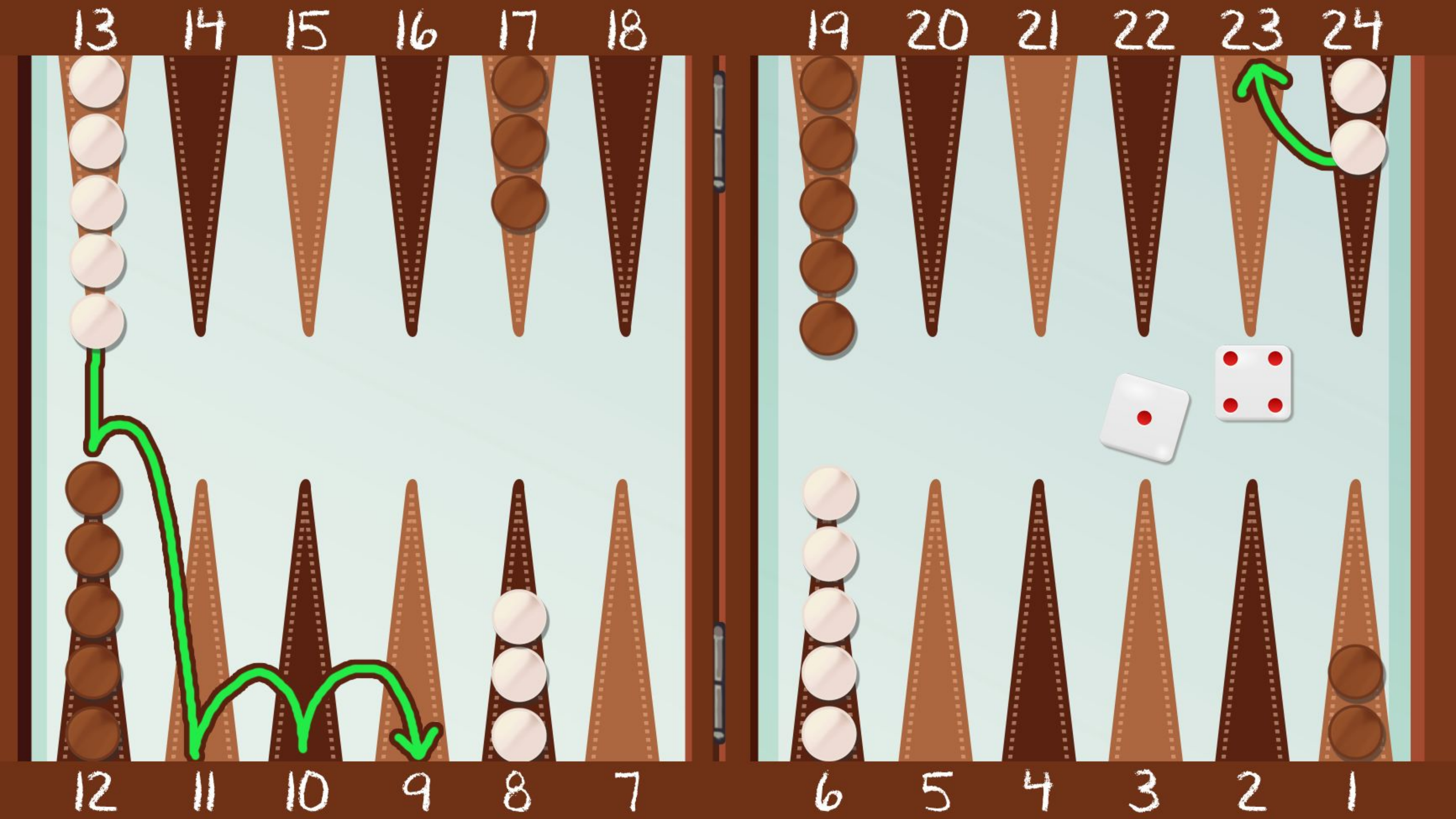
```
Blue develops Merchant Guild.
Red consumes good from Ravaged Uplift World using Terraforming
Engineers.
Green consumes prestige using Galactic Power Brokers.
Red receives 1 card and 1 VP for Consume phase.
Green receives 3 cards for Consume phase.
Red produces on Ravaged Uplift World.
Green takes 1 card from under Galactic Scavengers.
Red receives 3 cards for Produce phase.
Blue receives 3 cards for Produce phase.
Red discards 2 at end of turn.
Green discards 4 at end of turn.
--- Round 19 begins ---
Blue earns VP for Prestige Leader.
Red chooses Produce.
Green chooses Consume-x2.
Blue chooses Develop.
Red pays 3.
Red develops Galactic Markets.
Blue develops Research Labs.
Red consumes good from Ravaged Uplift World using Terraforming
Engineers.
Red consumes good from Reptilian Uplift Race using Galactic Markets.
Red consumes good from Alien Burial Site using Galactic Markets.
Red consumes prestige using Galactic Power Brokers.
Red receives 4 cards and 3 VP for Consume phase.
Red produces on Alien Burial Site.
Red produces on Ravaged Uplift World.
Red produces on Reptilian Uplift Race.
Red receives 4 cards for Produce phase.
```

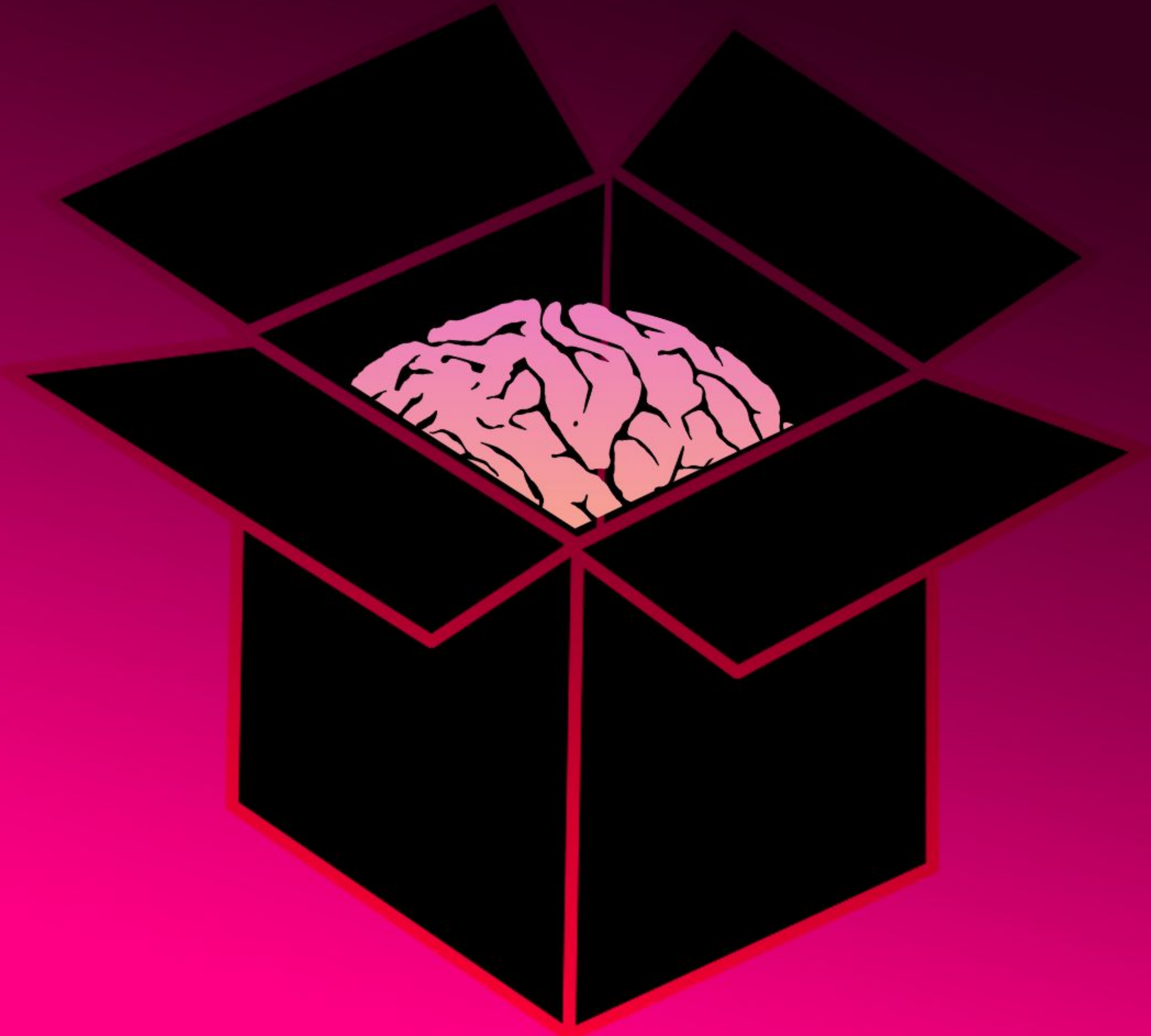

Race - Microsoft Visual Studio
File Edit View Project Build Debug Team Data Tools Test Window Help
Debug
Win32
neural
net.cpp comm.h ai.cpp server.c rftg.h README net.h net.c Makefile.in learner.c init.c engine.c dumpnet.c do_train depcomp compile comm.c client.h client.c ChangeLog cards.txt campaign.txt AUTHORS ai_client.c ai.c aclocal.m4 ABOUT-NLS
(Unknown Scope)
Solution Explorer
Solution 'Race' (2 projects)
Engine
Game
External Dependencies
rftg
AutoBuildNumber.h
Bots.cpp
Bots.h
campaigns_txt.h
CardNet.cpp
CardNet.h
cards_txt.h
CardUtils.cpp
CardUtils.h
CClient.cpp
CClient.h
CGfx.cpp
CGfx.h
Coroutine.cpp
Coroutine.h
CreditsDlg.cpp
CreditsDlg.h
Game.ico
Game.rc
GameApp.cpp
GameApp.h
GameEnum.h
GameMenuDlg.cpp
GameMenuDlg.h
GameSetupDlg.cpp
GameSetupDlg.h
LoadingScreen.cpp
LoadingScreen.h
MultiplayerMenu.cpp
MultiplayerMenu.h
OptionsDlg.cpp
OptionsDlg.h
Precompile.cpp
ResAsset.cpp
ResAsset.h
RFTGClient.cpp
RFTGClient.h
Solut... Tea... Class...
Properties

```
#if 0
/*
 * SIMD type.  Two doubles at once.
 */
typedef double v2d __attribute__ ((vector_size (16)));
#endif


/*
 * Compute a neural net's result.
 */
void compute_net(net *learn)
{
	int i, j;
	double sum, adj = 0.0;
#if 0
	v2d *weight, *hid_sum;
#endif

	/* Loop over inputs */
	for (i = 0; i < learn->num_inputs + 1; i++)
	{
		/* Check for difference from previous input */
		if (learn->input_value[i] != learn->prev_input[i])
```









	Move	Estimate	Rollout
Convention	13-9, 6-5	-0.014	-0.040
AI	13-9, 24-23	+0.005	+0.005

CAT?

Input

800x @2p
+200 pp

=

Cards in deck / discard

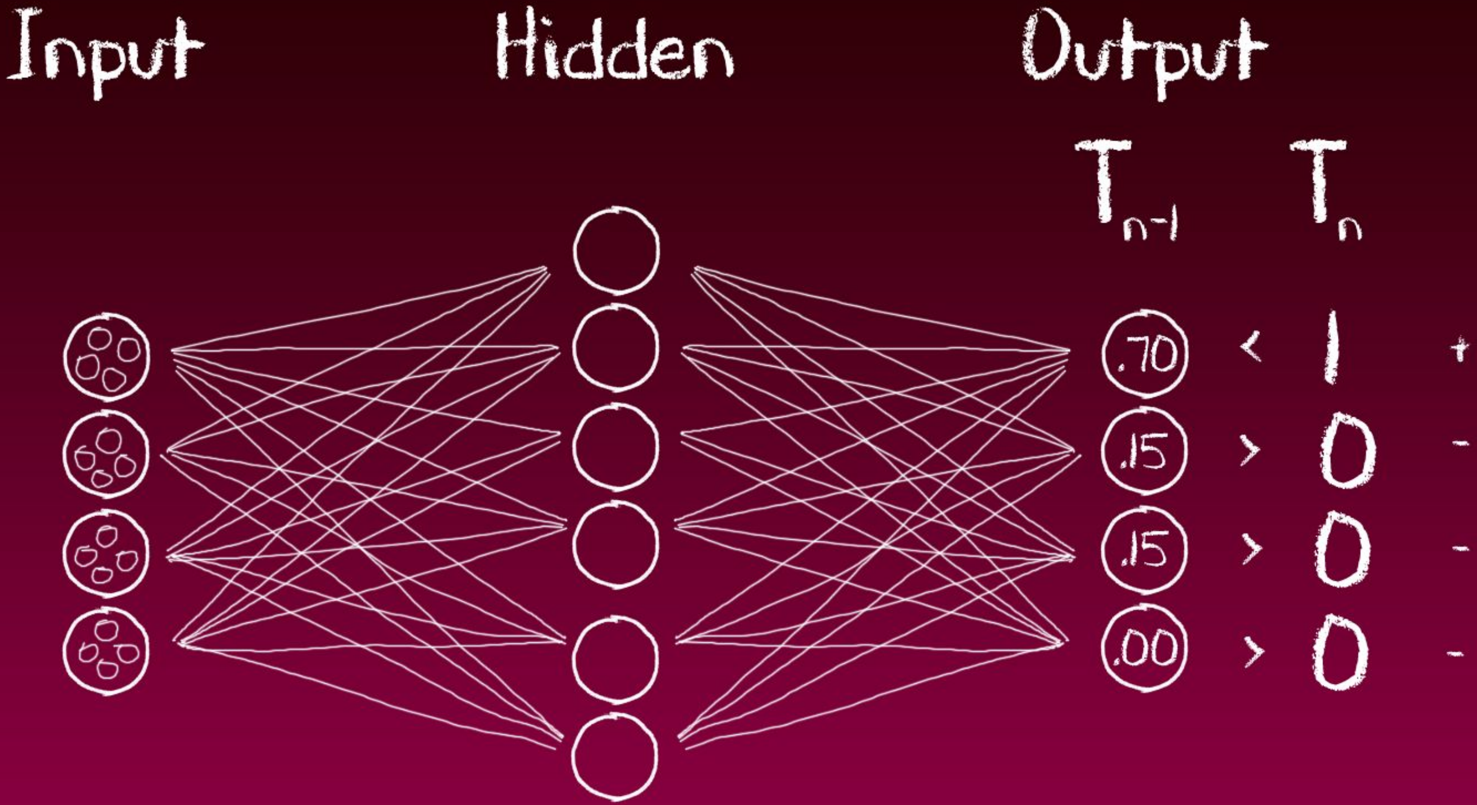
Is player x winning

How many goods on cards

Is x card in player y hand

Etc.

	T_1	T_2	T_{etc}	T_{n-1}	T_n
Player 1	.25			.70	1
Player 2	.25			.15	0
Player 3	.25			.15	0
Player 4	.25			.00	0


Input
Hidden
Output
T_{n-1}
T_n
.70 < 1 +
.15 > 0 -
.15 > 0 -
.00 > 0 -

$$w_{t+1} - w_t = \alpha(Y_{t+1} - Y_t) \sum_{k=1}^{t} \lambda^{t-k} \nabla_w Y_k$$

$$\boxed{w_{t+1} - w_t =} \alpha (Y_{t+1} - Y_t) \sum_{k=1}^{t} \lambda^{t-k} \nabla_w Y_k$$

$$w_{t+1} - w_t = \alpha \left(Y_{t+1} - Y_t \right) \sum_{k=1}^{t} \lambda^{t-k} \nabla_w Y_k$$

$$w_{t+1} - w_t = \alpha\left(Y_{t+1} - Y_t\right) \sum_{k=1}^{t} \boxed{\lambda^{t-k} \nabla_w Y_k}$$

$$w_{t+1} - w_t = \alpha\left(Y_{t+1} - Y_t\right) \sum_{k=1}^{t} \lambda^{t-k} \nabla_w Y_k$$

$$\lambda = .7$$

$$w_{t+1} - w_t = \alpha(Y_{t+1} - Y_t)\sum_{k=1}^{t} \lambda^{t-k} \nabla_w Y_k$$

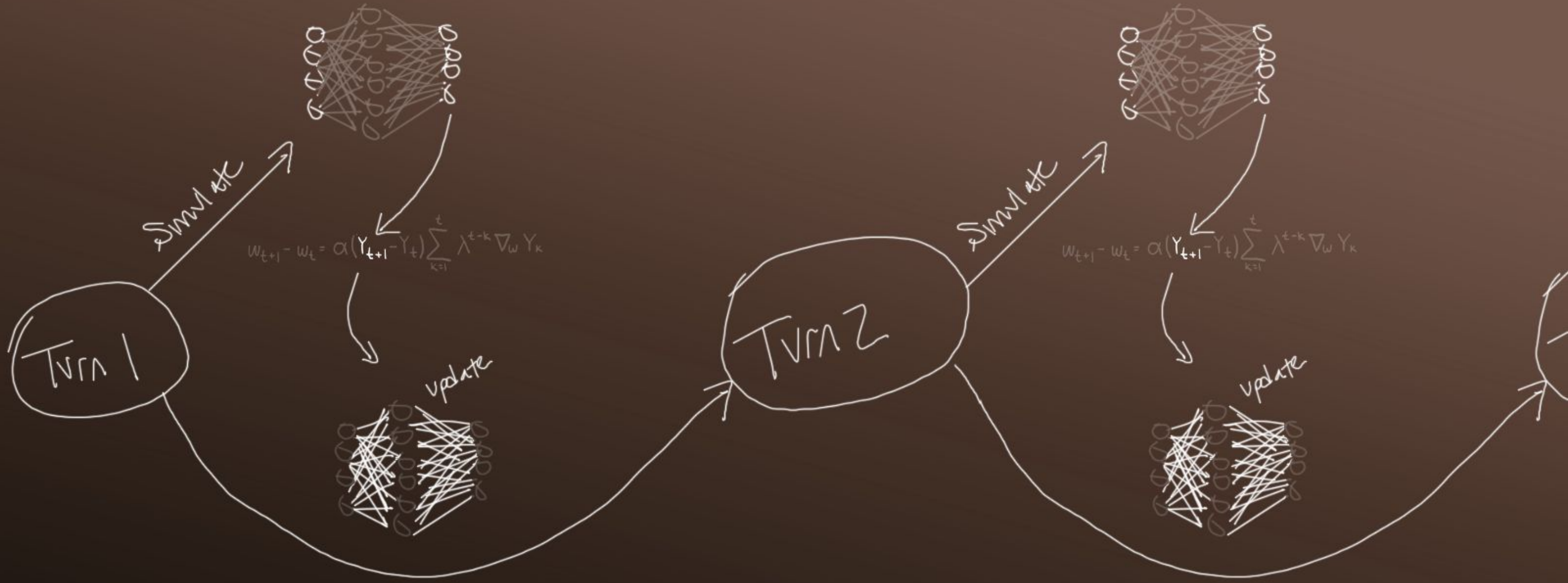
$\lambda^{t-k} =$

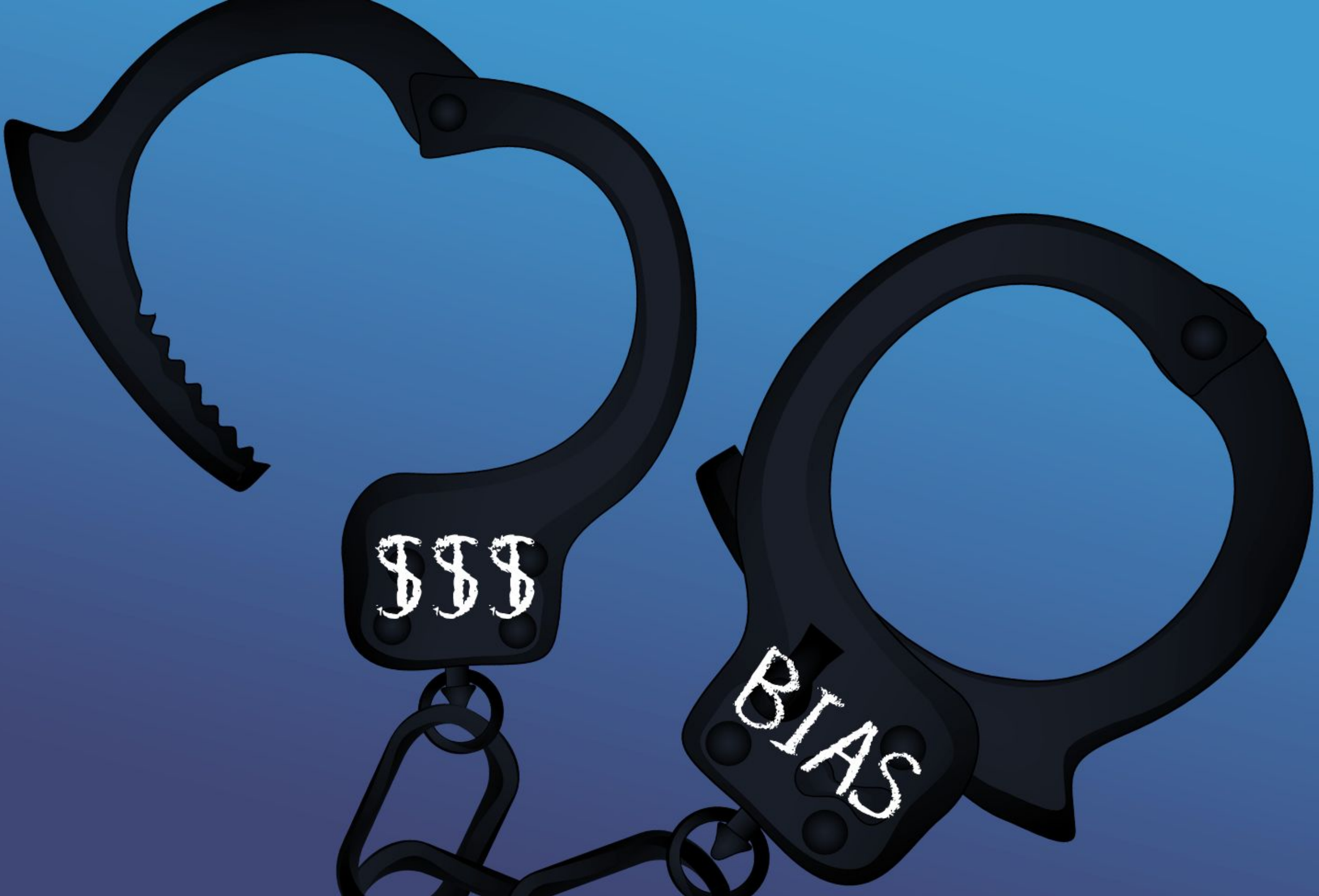
1 for k = t

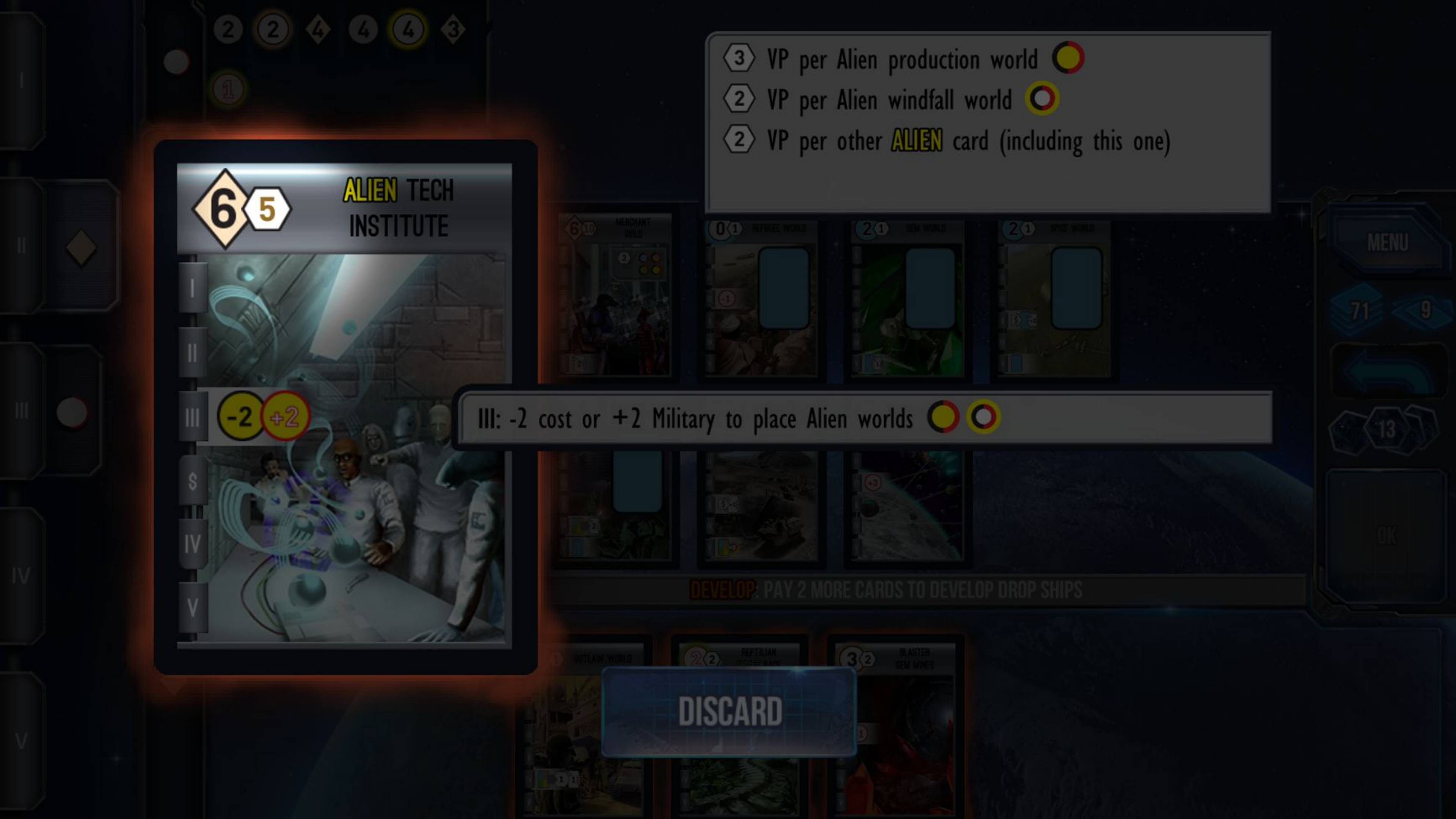
.7 for k = t - 1 (one turn ago)

$.7^2 = .49$ for k = t-2 (two turns ago)

$.7^3 = .34$ for k = t-3 (three turns ago)


Turn 1
Simulate
$w_{t+1} - w_t = \alpha(Y_{t+1} - Y_t)\sum_{k=1}^{t} \lambda^{t-k} \nabla_w Y_k$
update
Turn 2
Simulate
$w_{t+1} - w_t = \alpha(Y_{t+1} - Y_t)\sum_{k=1}^{t} \lambda^{t-k} \nabla_w Y_k$
update


$$$
BIAS



ALIEN TECH INSTITUTE

6 5

3 VP per Alien production world

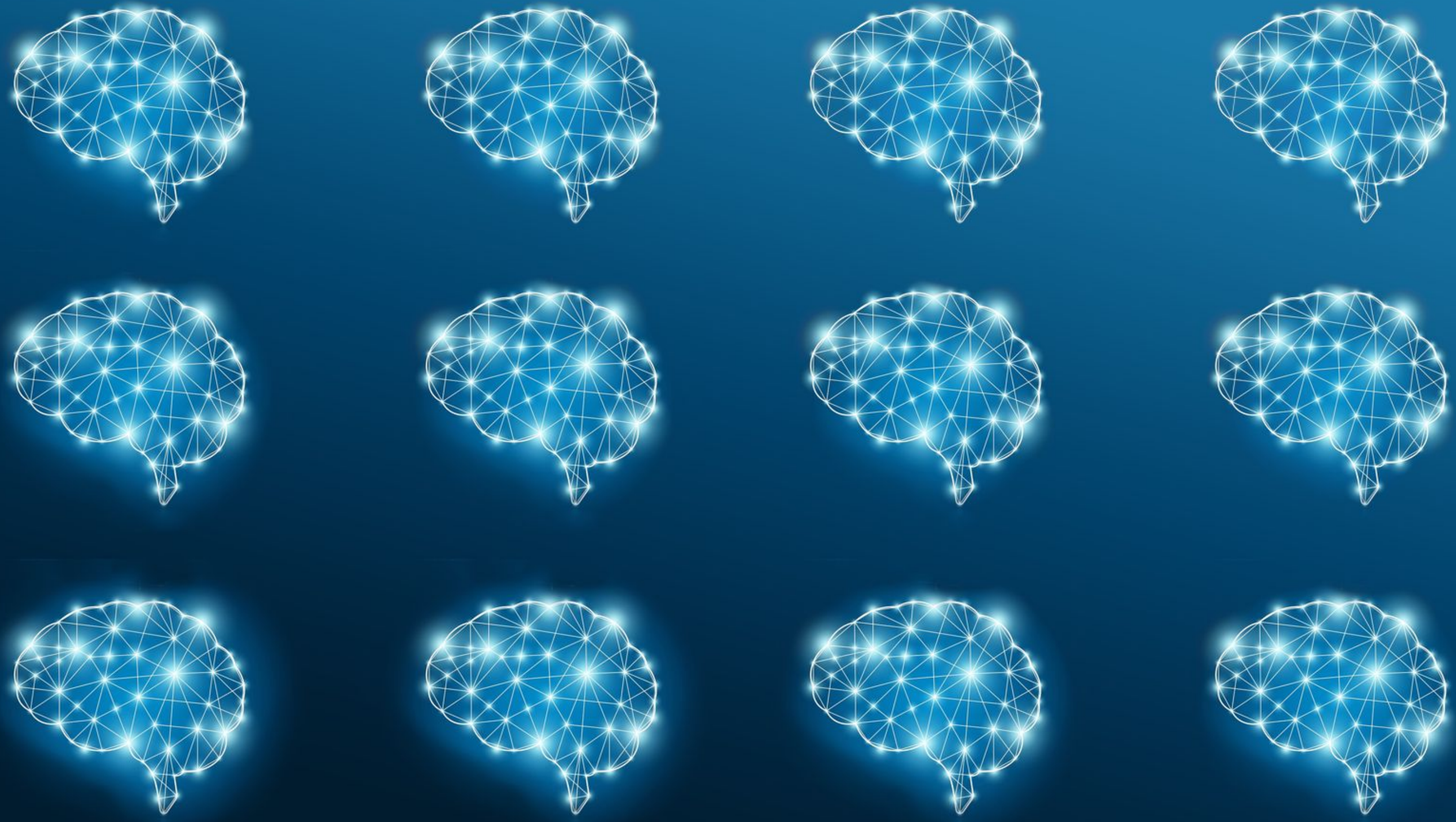
2 VP per Alien windfall world

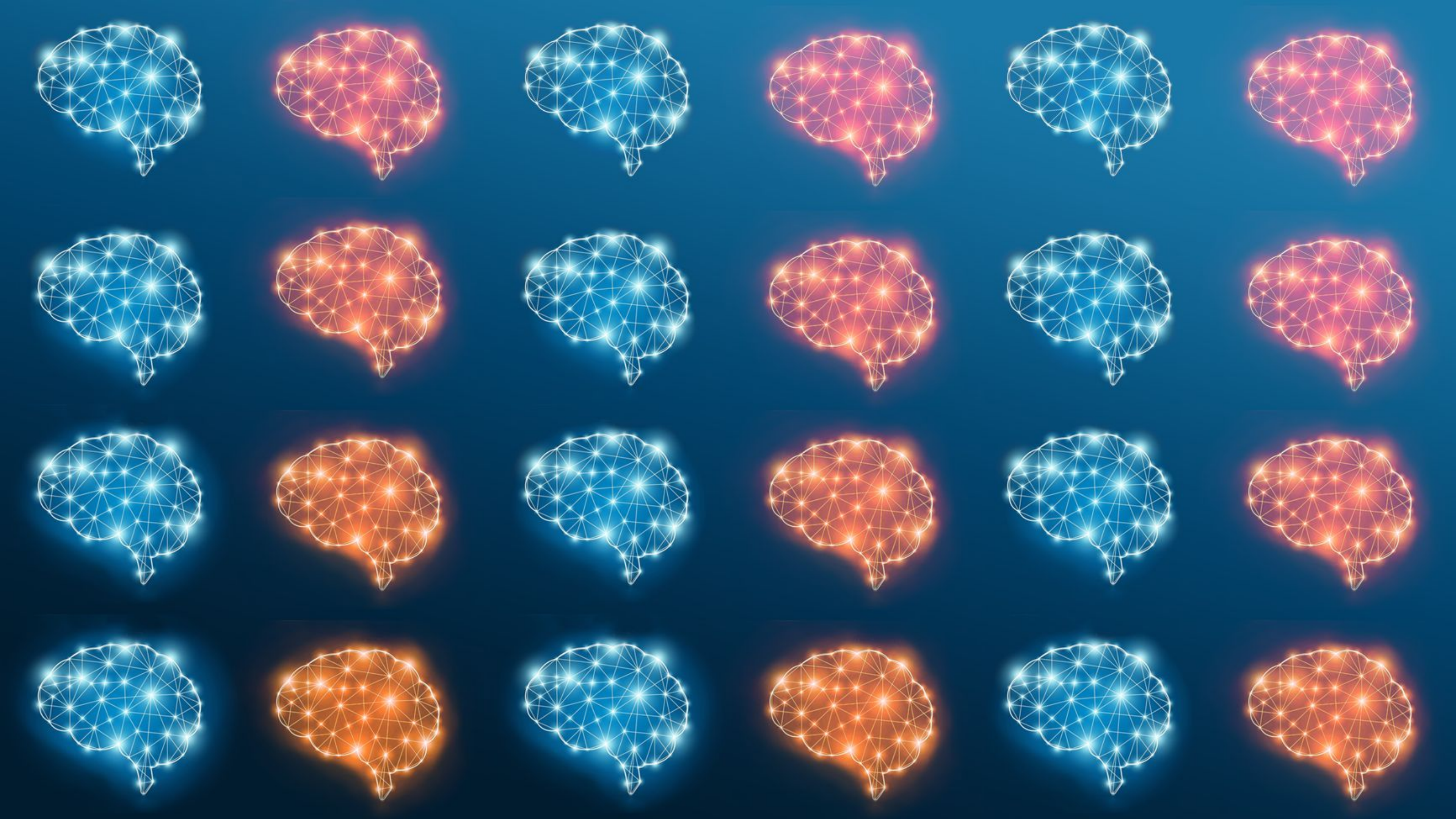
2 VP per other ALIEN card (including this one)

III: -2 cost or +2 Military to place Alien worlds

DEVELOP: PAY 2 MORE CARDS TO DEVELOP DROP SHIPS

2
2
4
4
4
3
1
I
II
III
-2
+2
$
IV
V
MERCHANT GUILD
REFUGEE WORLD
GEM WORLD
SPICE WORLD
OUTLAW WORLD
BLASTER GEM MINES
DISCARD
MENU
71
9
13
OK





Output

eval_board -> float

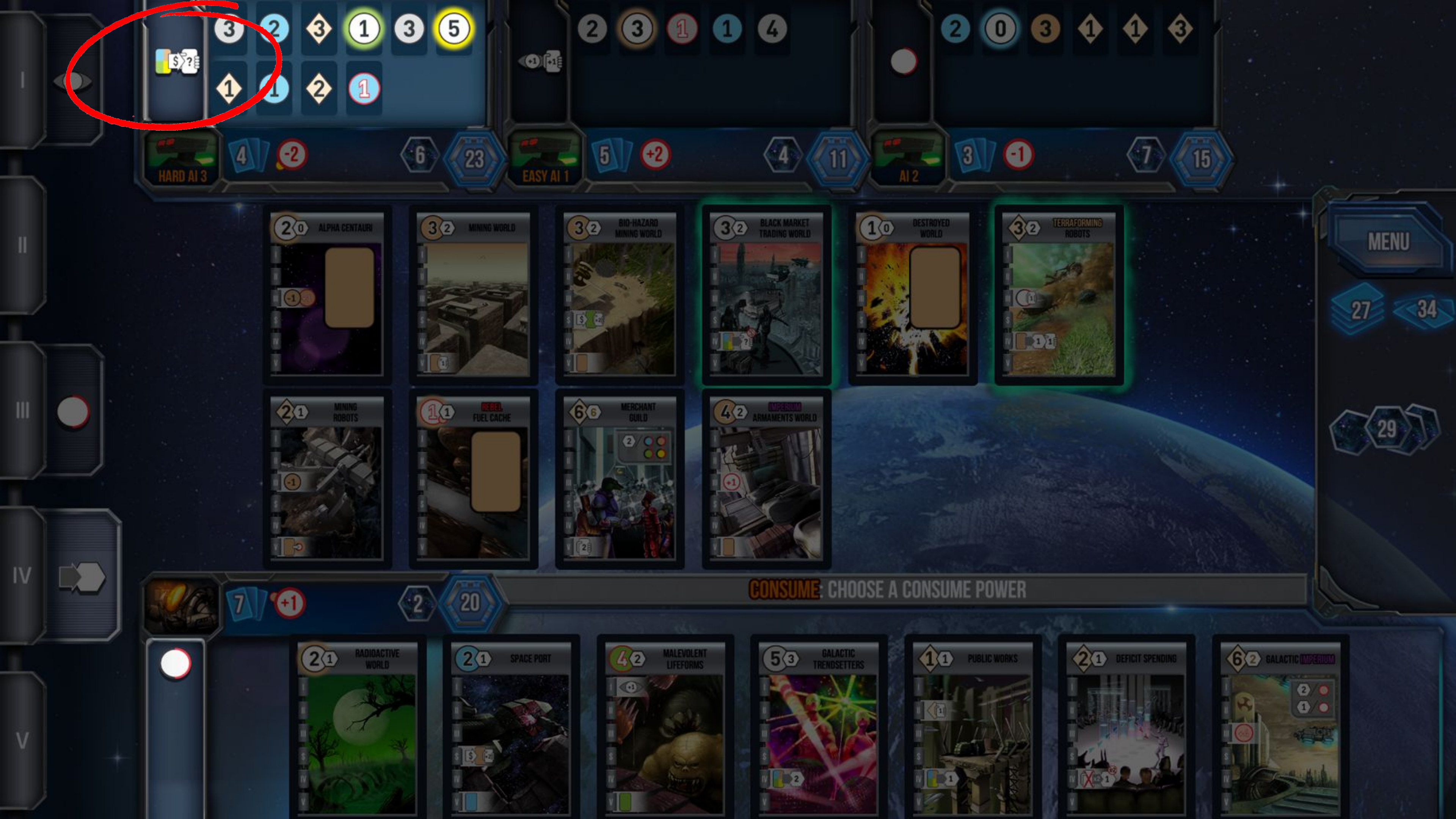
(score)

or

eval_role -> [float]

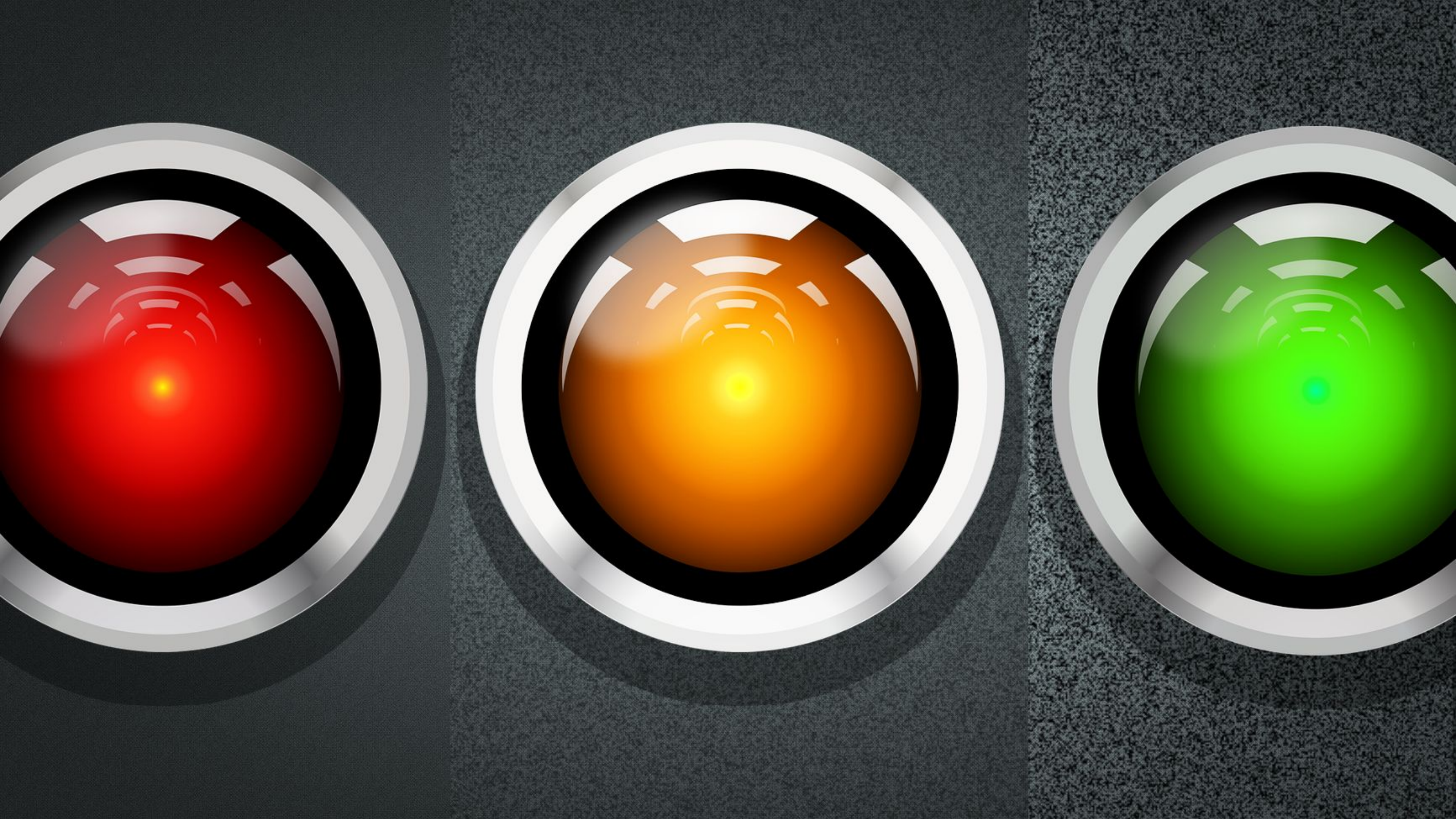
(1x / role)

= ○



CONSUME: CHOOSE A CONSUME POWER

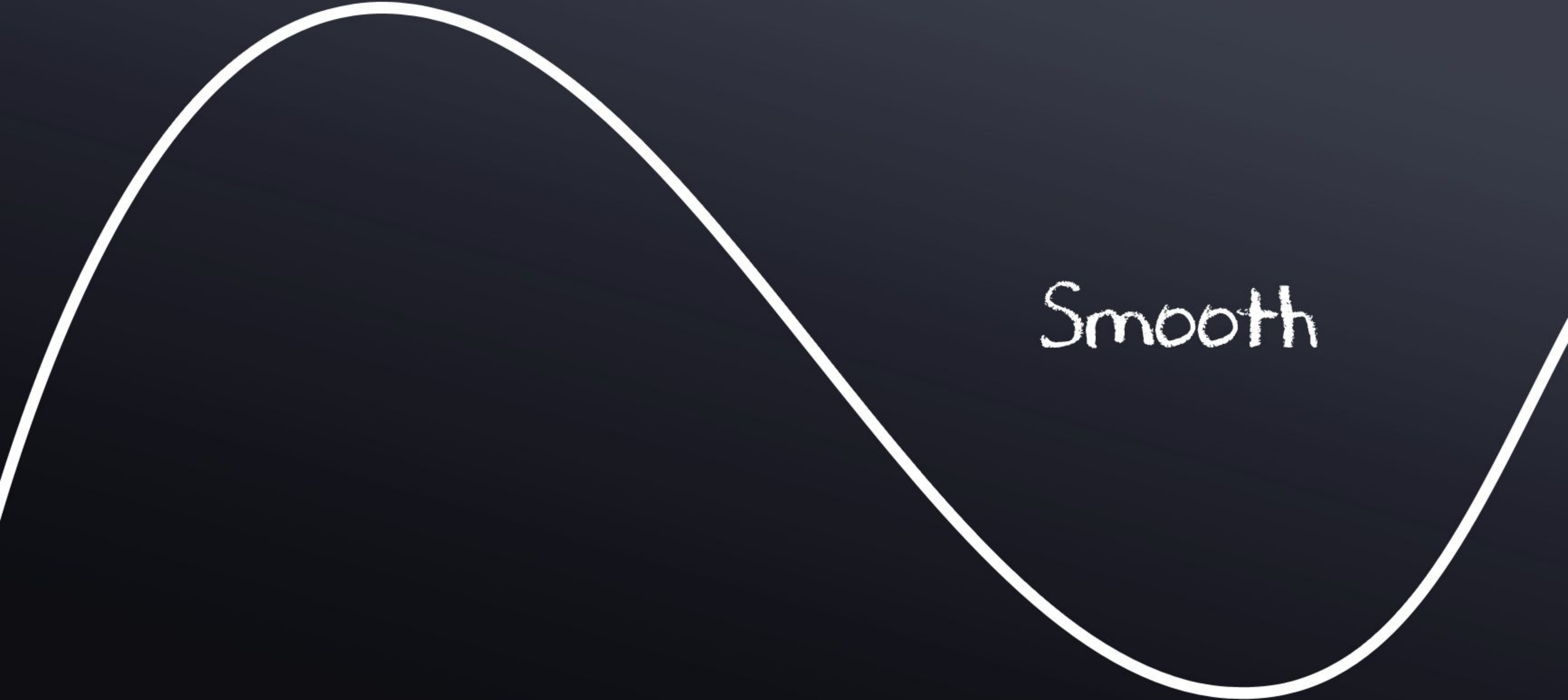
HARD AI 3
EASY AI 1
AI 2
MENU
ALPHA CENTAURI
MINING WORLD
BIO-HAZARD MINING WORLD
BLACK MARKET TRADING WORLD
DESTROYED WORLD
TERRAFORMING ROBOTS
MINING ROBOTS
REBEL FUEL CACHE
MERCHANT GUILD
IMPERIUM ARMAMENTS WORLD
RADIOACTIVE WORLD
SPACE PORT
MALEVOLENT LIFEFORMS
GALACTIC TRENDSETTERS
PUBLIC WORKS
DEFICIT SPENDING
GALACTIC IMPERIUM
I
II
III
IV
V
27
34
29



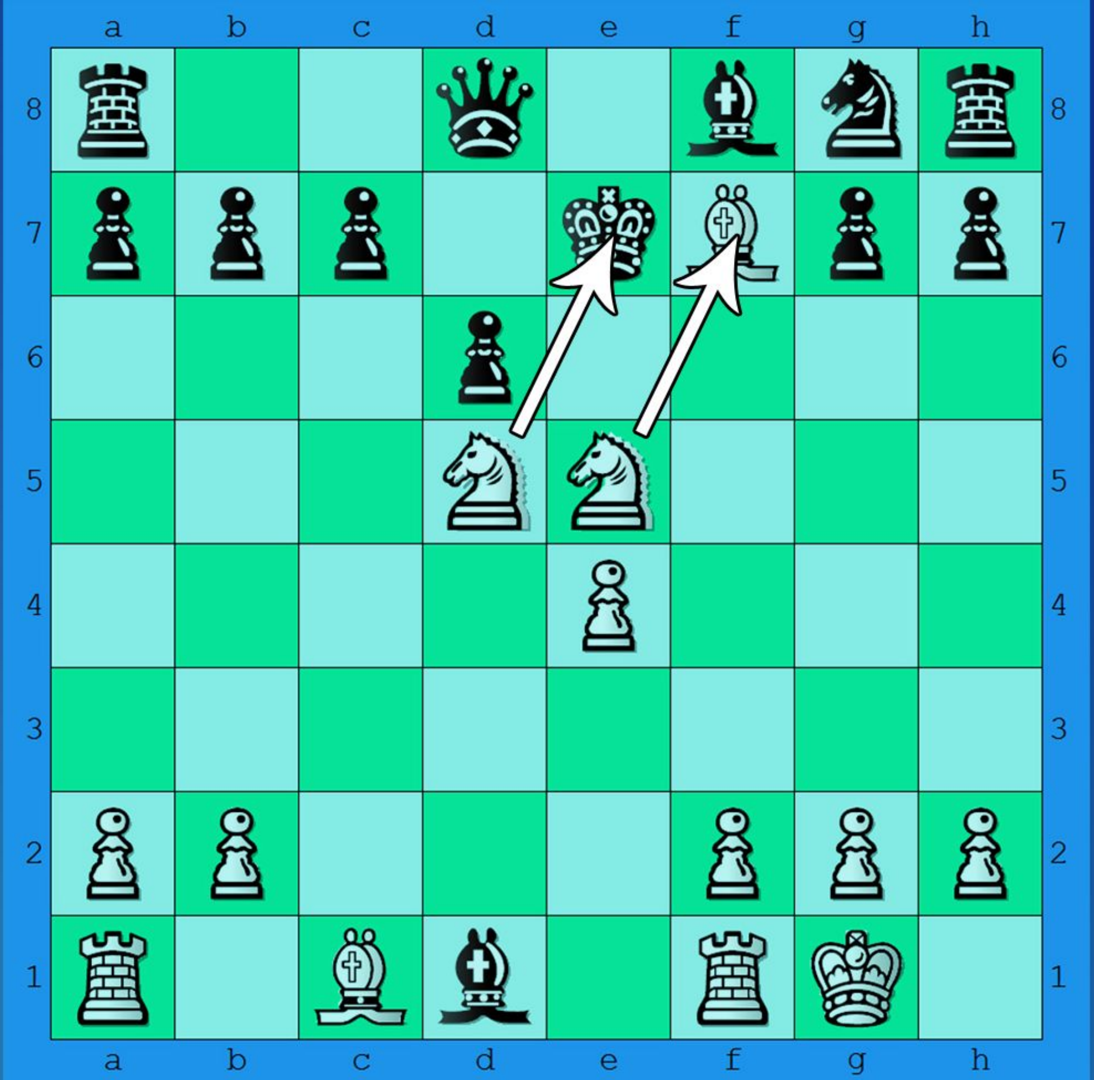
TD AI?
☑
☐
☐
☐
☑
☐
☐

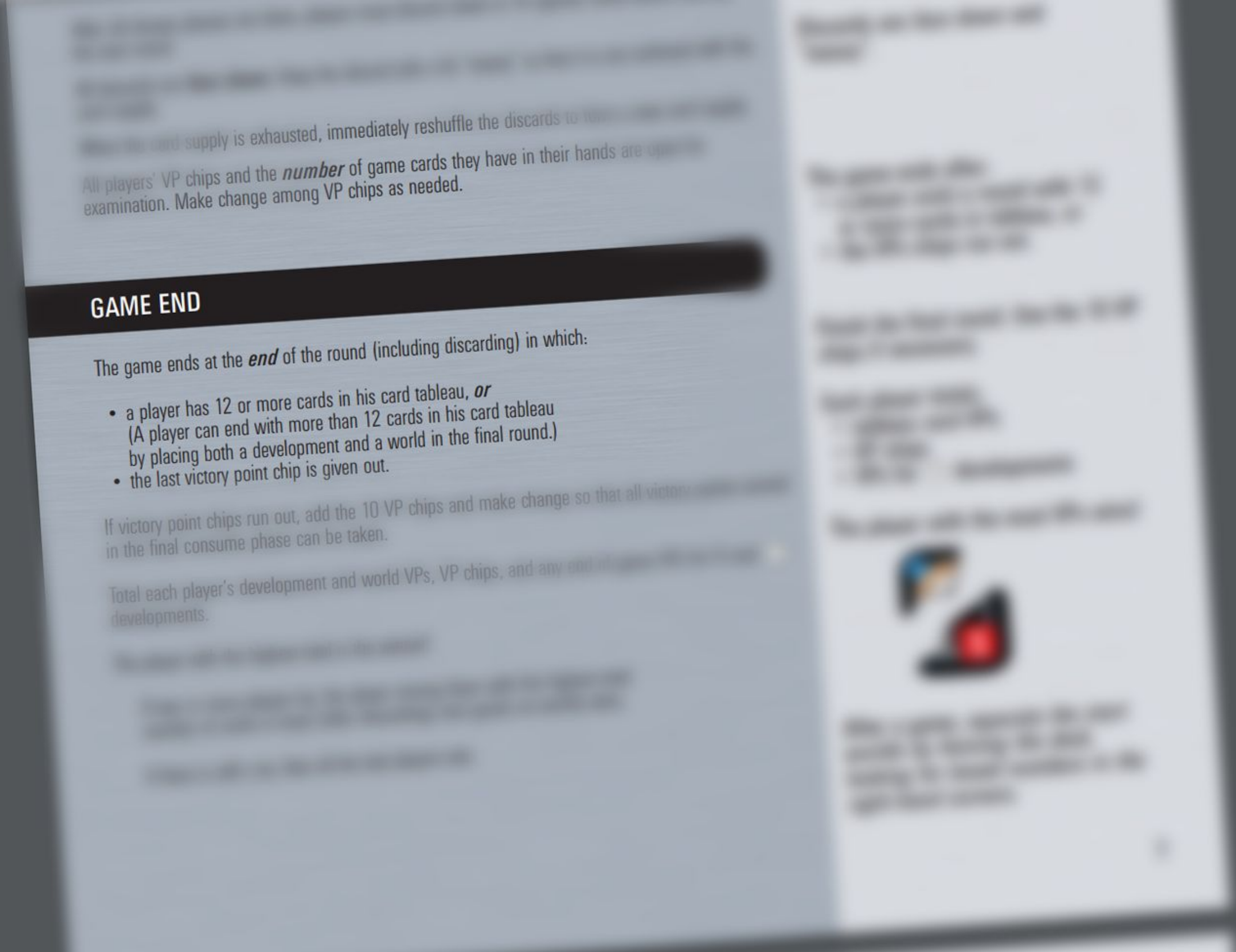
MACHI KORO
LETTER TYCOON
KARUBA
Smash Up
VIRAL
IMHOTEP
Istanbul
Plague Inc
CTHULHU
Caylus
TOWER
PANDEMIC
The Big Book
KING OF TOKYO
FORBIDDEN DESERT
TAVARUA
CACAO
Burgundy
DUNGEON PETZ
TWILIGHT STRUGGLE
Caverna
AVALON
WEREWORDS

8
16
2
3
4
9
11



Smooth


a
b
c
d
e
f
g
h
8
7
6
5
4
3
2
1



[illegible] supply is exhausted, immediately reshuffle the discards [illegible]

All players' VP chips and the ***number*** of game cards they have in their hands are [illegible] examination. Make change among VP chips as needed.

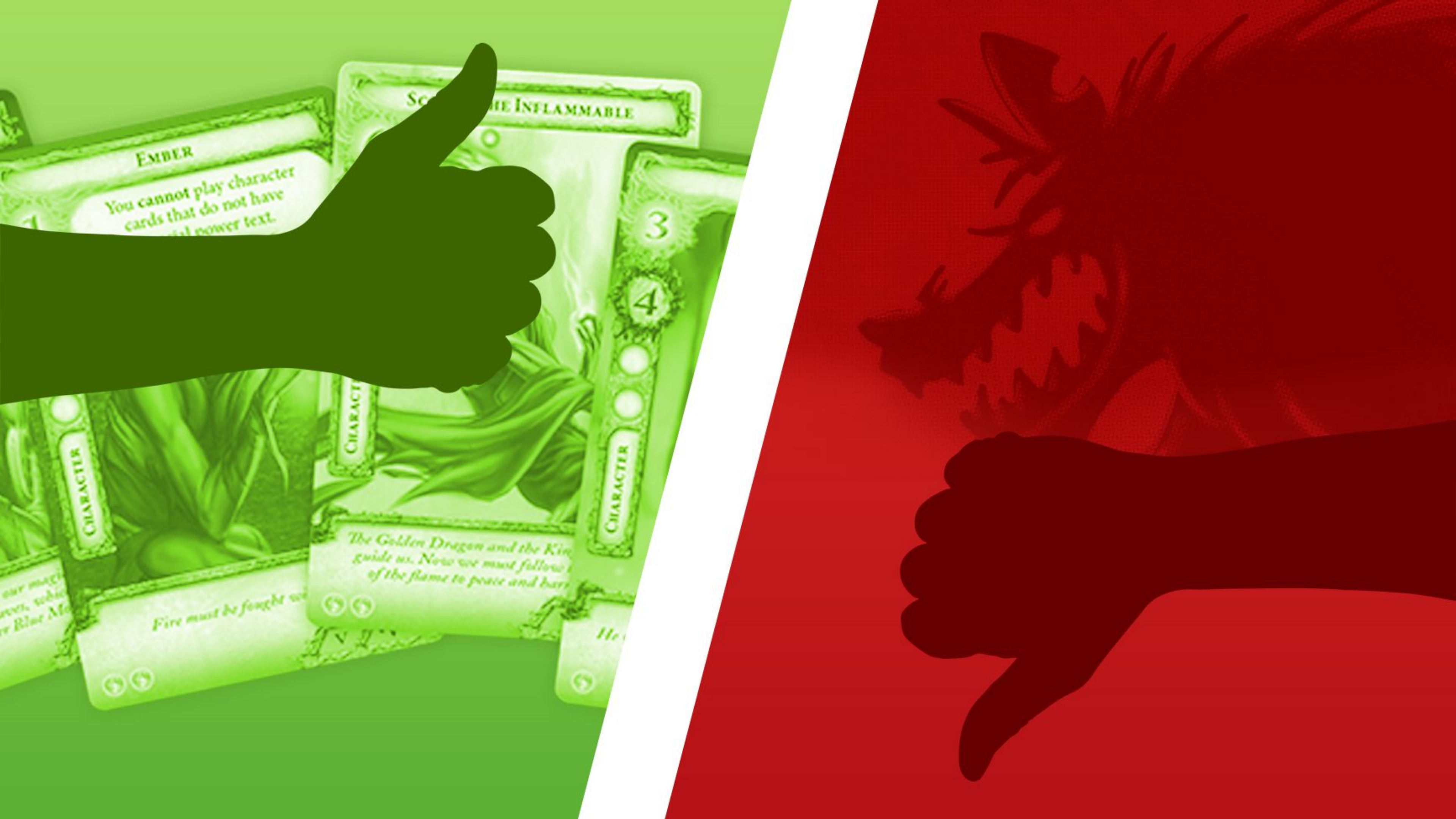
GAME END

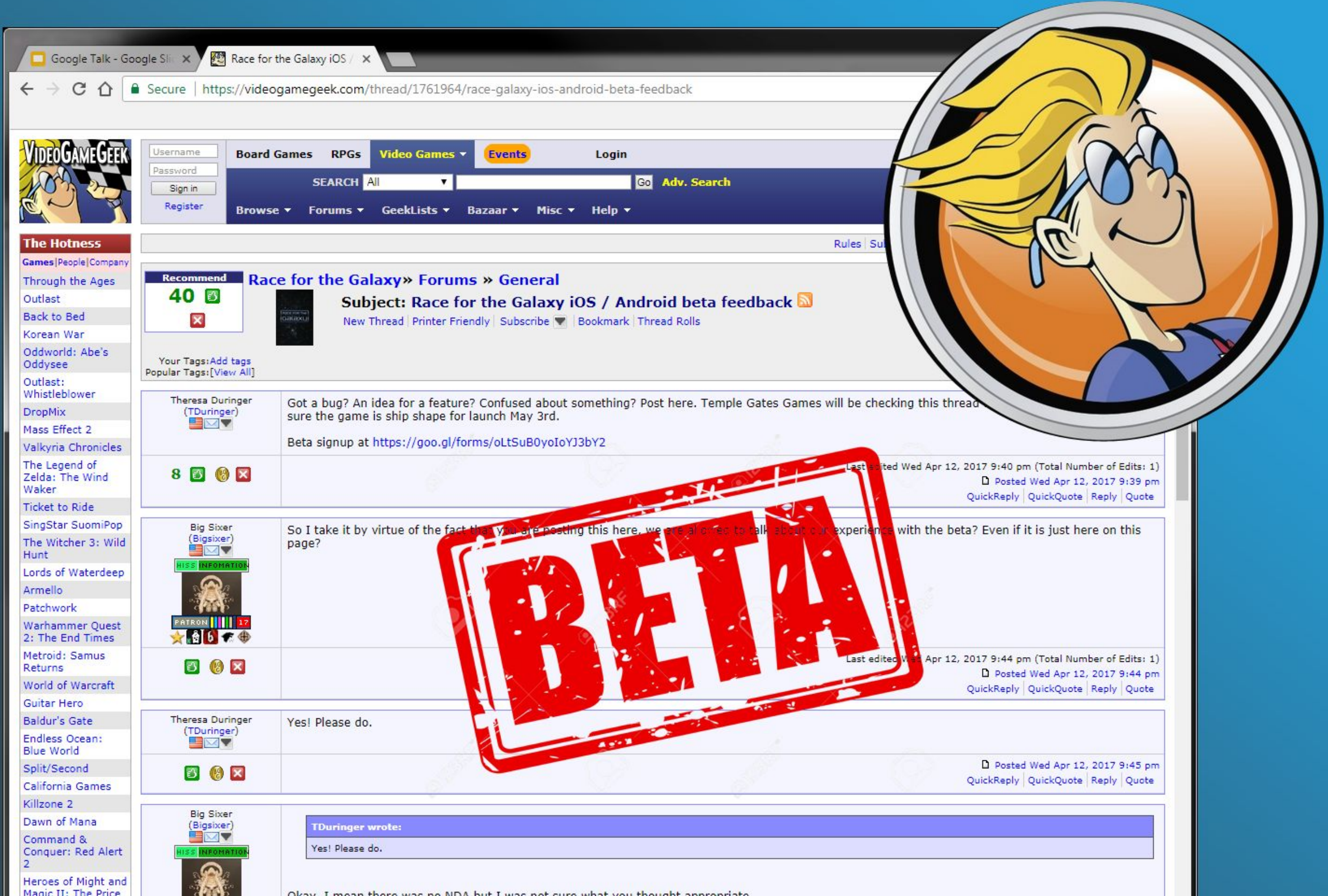
The game ends at the ***end*** of the round (including discarding) in which:

- a player has 12 or more cards in his card tableau, ***or***
  (A player can end with more than 12 cards in his card tableau by placing both a development and a world in the final round.)
- the last victory point chip is given out.

If victory point chips run out, add the 10 VP chips and make change so that all [illegible] in the final consume phase can be taken.

Total each player's development and world VPs, VP chips, and any [illegible] developments.


Ember
You cannot play character cards that do not have
al power text.
Sc
he Inflammable
3
4
Character
Character
Character
The Golden Dragon and the Ki
guide us. Now we must follow
of the flame to peace and har
Fire must be fought w
He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Login
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All
Go
Adv. Search
Browse
Forums
GeekLists
Bazaar
Misc
Help
Rules
The Hotness
Games | People | Company
Through the Ages
Outlast
Back to Bed
Korean War
Oddworld: Abe's Oddysee
Outlast: Whistleblower
DropMix
Mass Effect 2
Valkyria Chronicles
The Legend of Zelda: The Wind Waker
Ticket to Ride
SingStar SuomiPop
The Witcher 3: Wild Hunt
Lords of Waterdeep
Armello
Patchwork
Warhammer Quest 2: The End Times
Metroid: Samus Returns
World of Warcraft
Guitar Hero
Baldur's Gate
Endless Ocean: Blue World
Split/Second
California Games
Killzone 2
Dawn of Mana
Command & Conquer: Red Alert 2
Heroes of Might and Magic II: The Price
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Popular Tags: [View All]
8
QuickReply
QuickQuote
Reply
Quote
BETA

Subject: Race for the Galaxy iOS / Android beta feedback

Theresa Duringer (TDuringer)

Got a bug? An idea for a feature? Confused about something? Post here. Temple Gates Games will be checking this thread
sure the game is ship shape for launch May 3rd.

Beta signup at https://goo.gl/forms/oLtSuB0yoIoYJ3bY2

Last edited Wed Apr 12, 2017 9:40 pm (Total Number of Edits: 1)
Posted Wed Apr 12, 2017 9:39 pm

Big Sixer (Bigsixer)

So I take it by virtue of the fact that you are posting this here, we are allowed to talk about our experience with the beta? Even if it is just here on this page?

Last edited Wed Apr 12, 2017 9:44 pm (Total Number of Edits: 1)
Posted Wed Apr 12, 2017 9:44 pm

Theresa Duringer (TDuringer)

Yes! Please do.

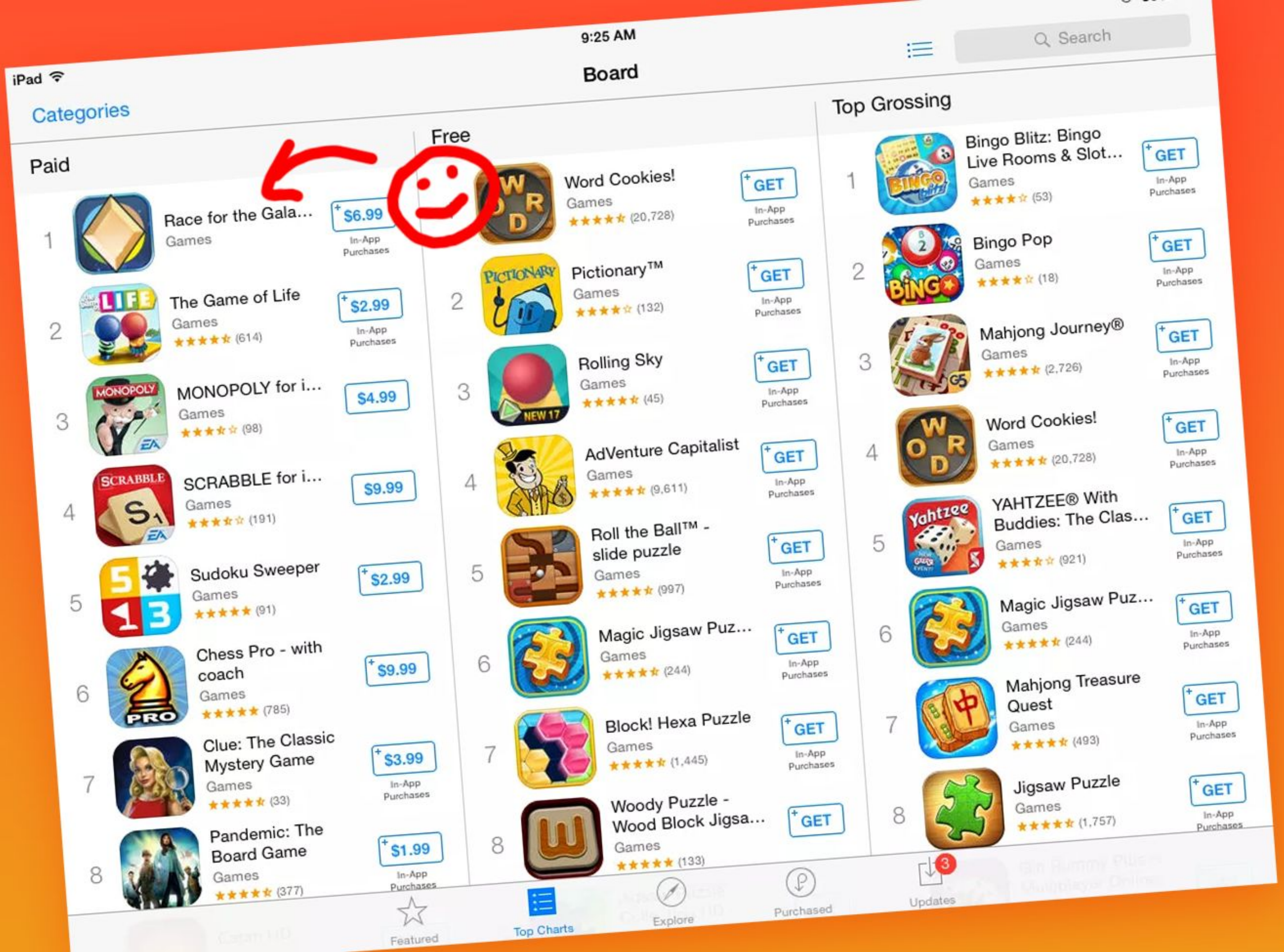
Posted Wed Apr 12, 2017 9:45 pm

Big Sixer (Bigsixer)

> **TDuringer wrote:**
> Yes! Please do.

Okay. I mean there was no NDA but I was not sure what you thought appropriate.

ROLL FOR THE
galaxy



iPad 9:25 AM Search

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Race for the Galaxy:

A Neural Network in Production

RACE FOR THE
Galaxy

@Tduringer