Drafting Territories in the Board Game Risk

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Joint Work With: Neesha Desai and Richard Zhao

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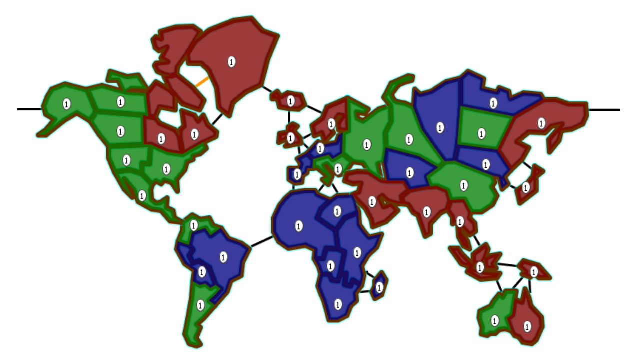
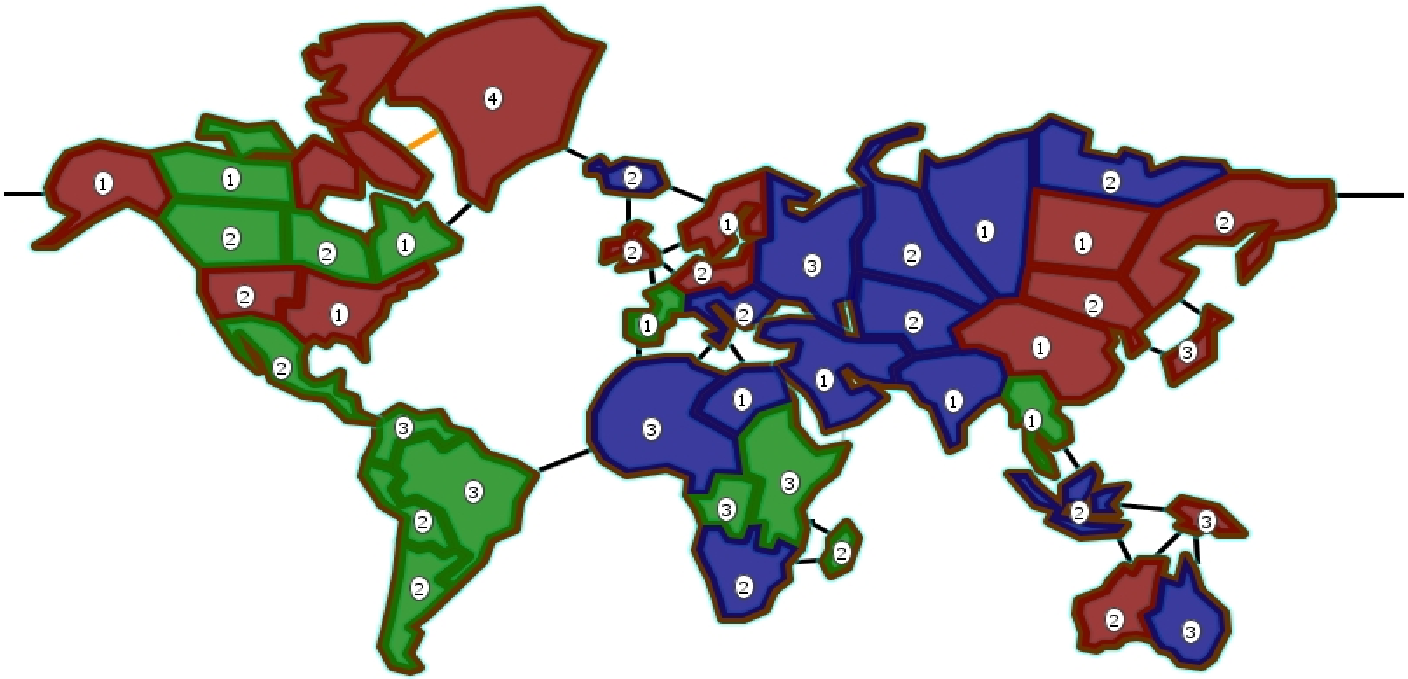


Outline

- Risk
  - Drafting territories
- How to draft territories in Risk?
  - UCT + machine-learned evaluation function
- Empirical results
- Conclusions + Future Work

Risk



http://sillysoft.net/lux

- Classic multi-player board game
- A number of computer implementations, including Lux Delux by Sillysoft Games
- Popular!

Risk

- Researchers are also interested:
  - *Using multi-agent system technology in risk bots*, Johansson and Olsson, 2006.
  - *Mixing search strategies for multi-player games,* Zuckerman, Felner, and Kraus, 2009.
- Both papers use non-standard variant where territories assigned randomly to begin the game.

Drafting Territories in Risk

http://sillysoft.net/lux

- Players take turns selecting territories until all 42 territories are owned.

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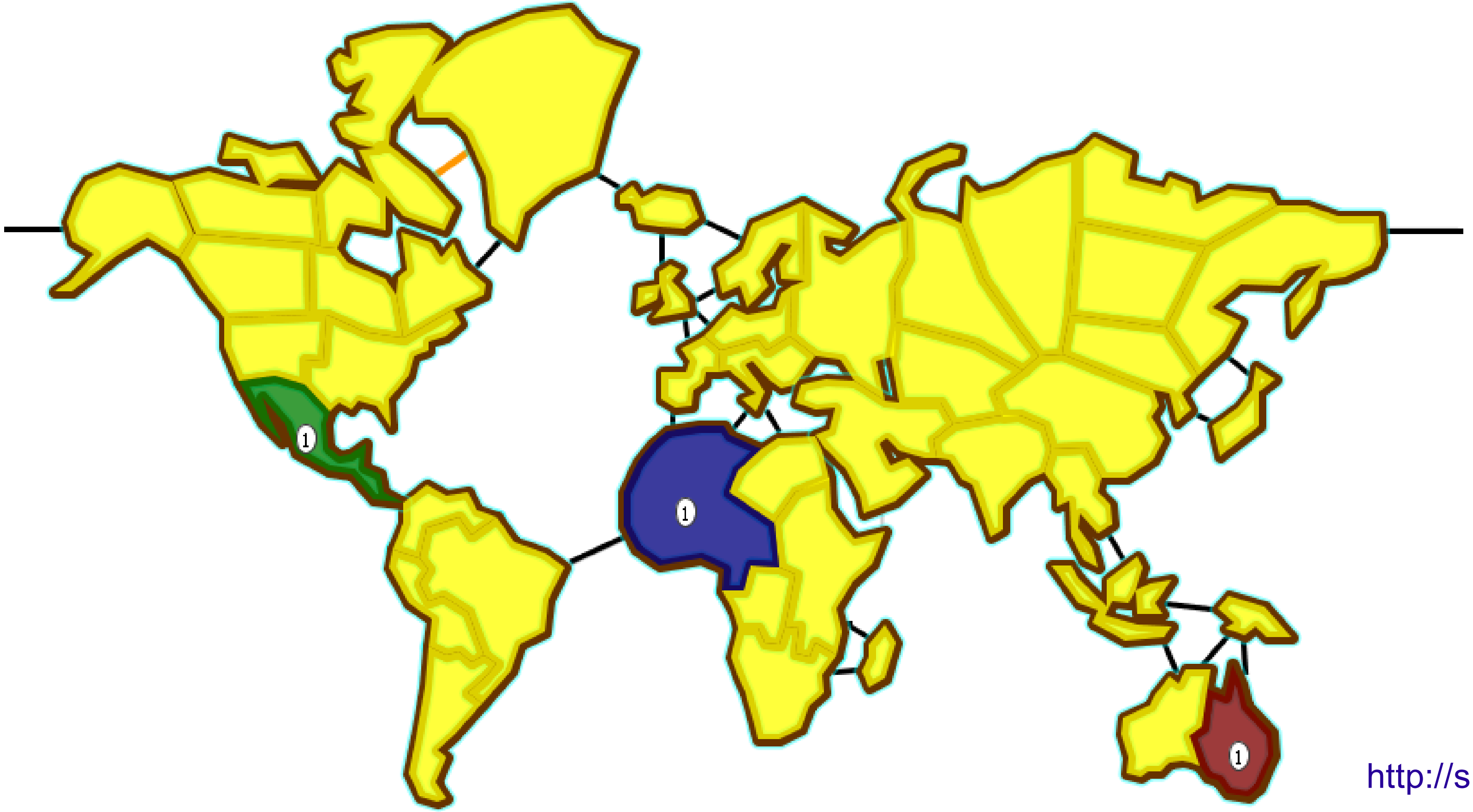

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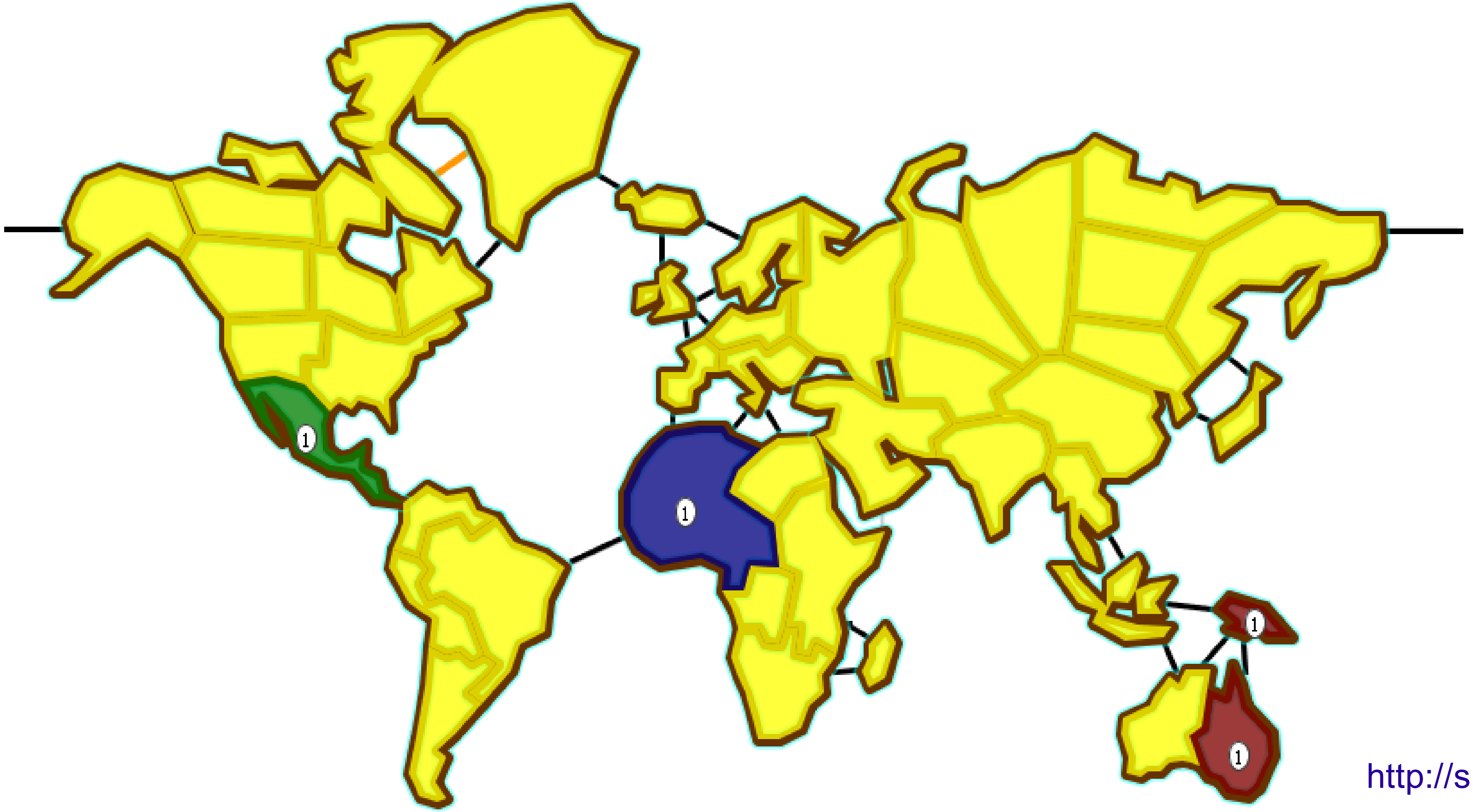

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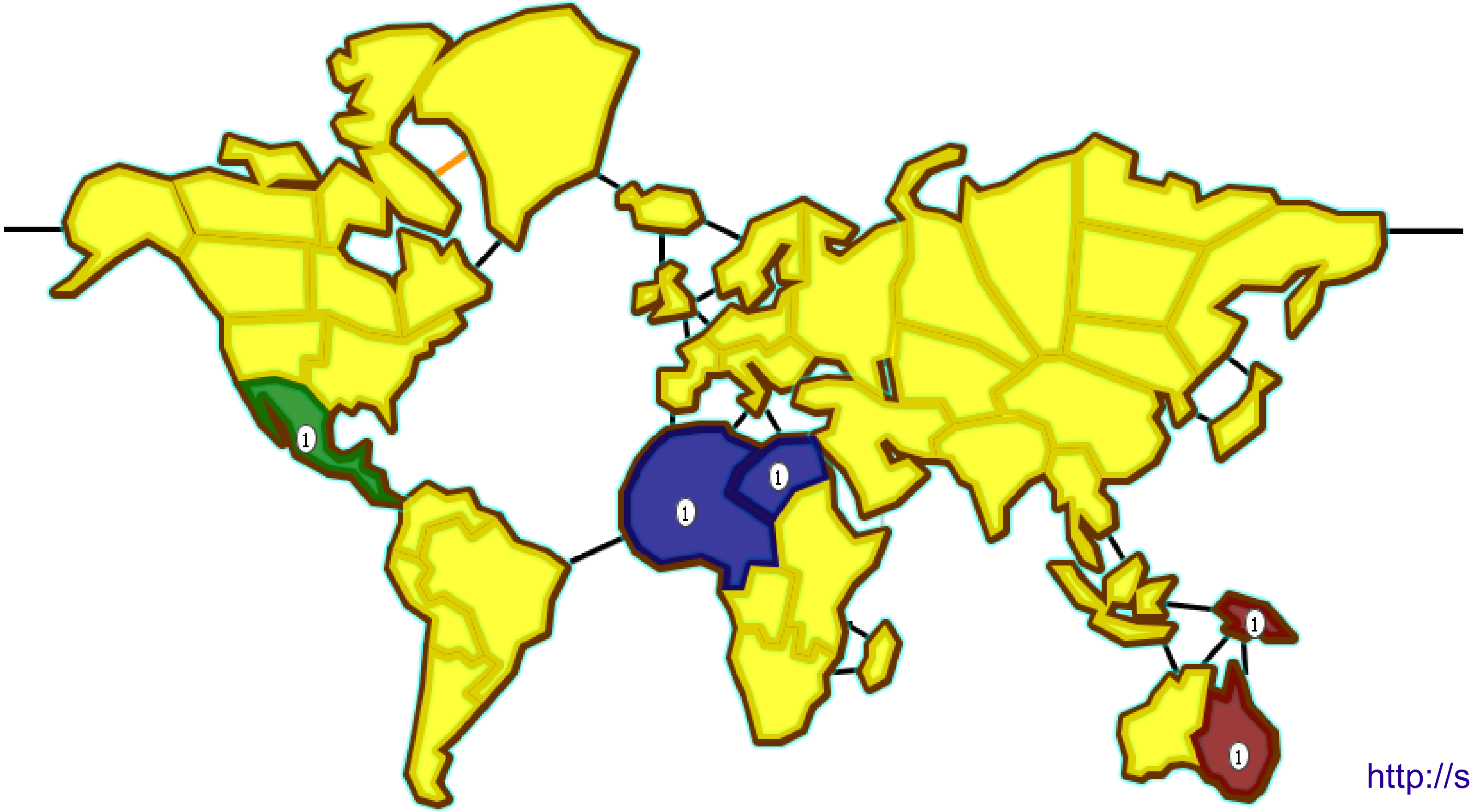

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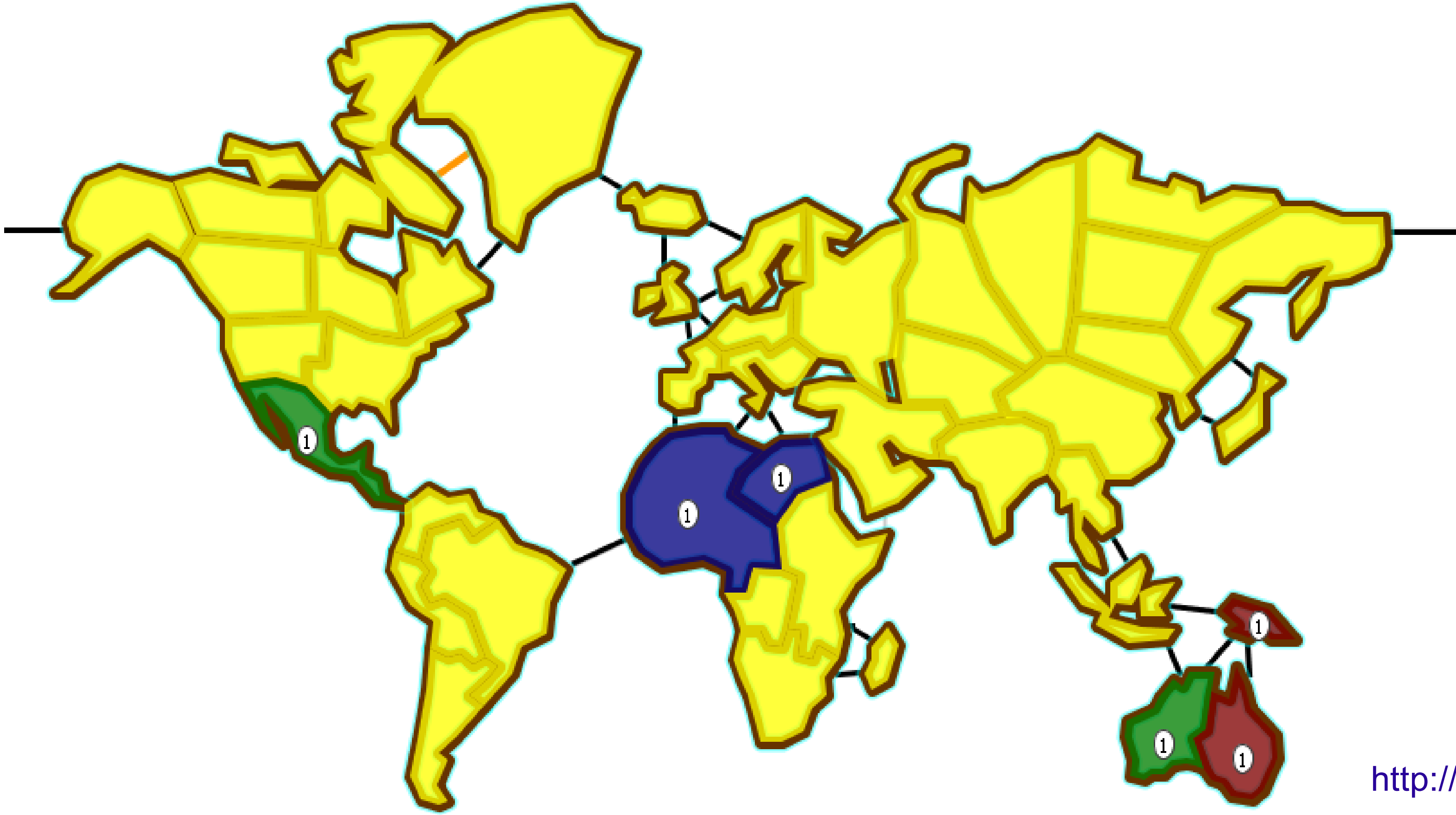

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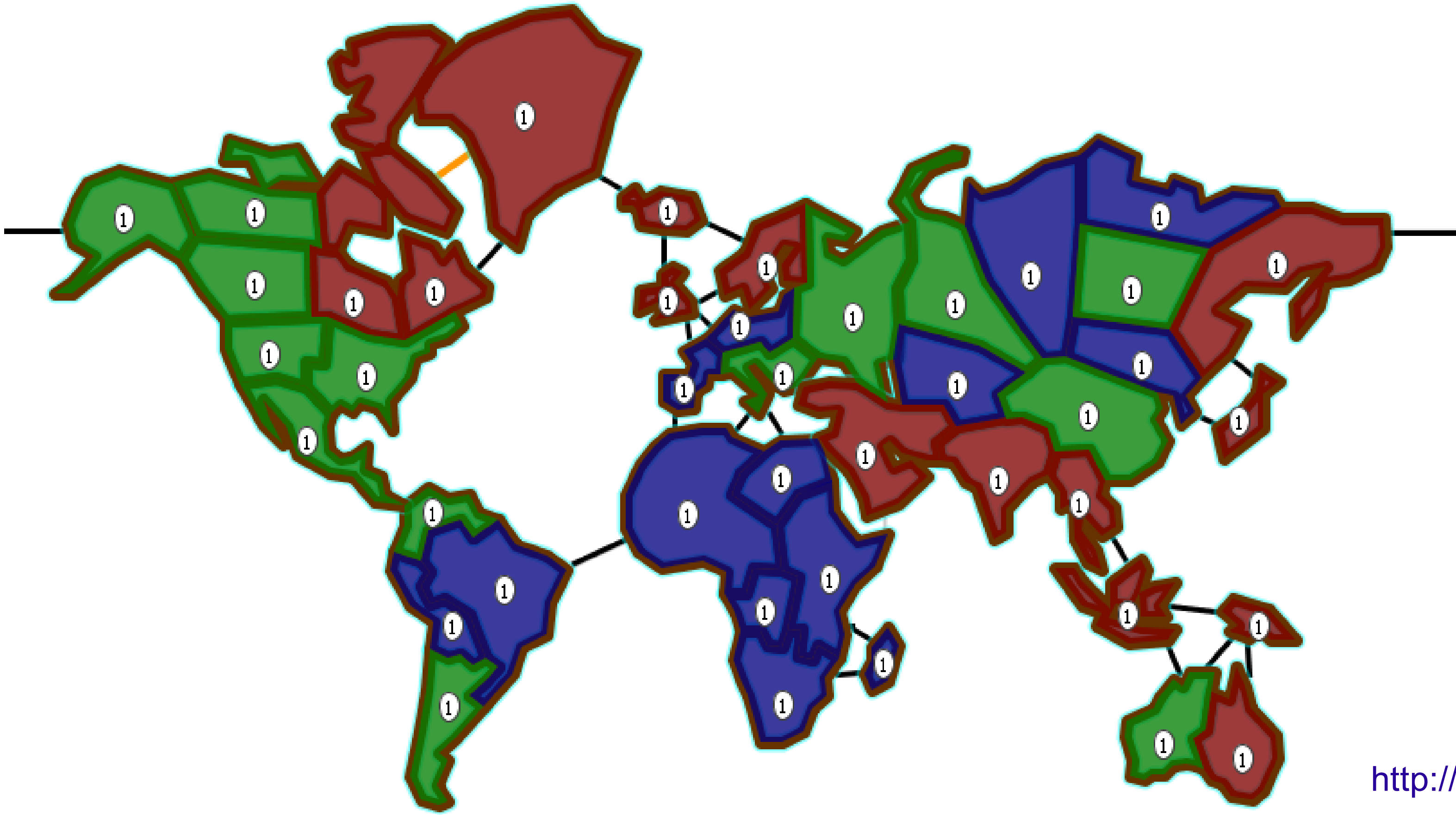

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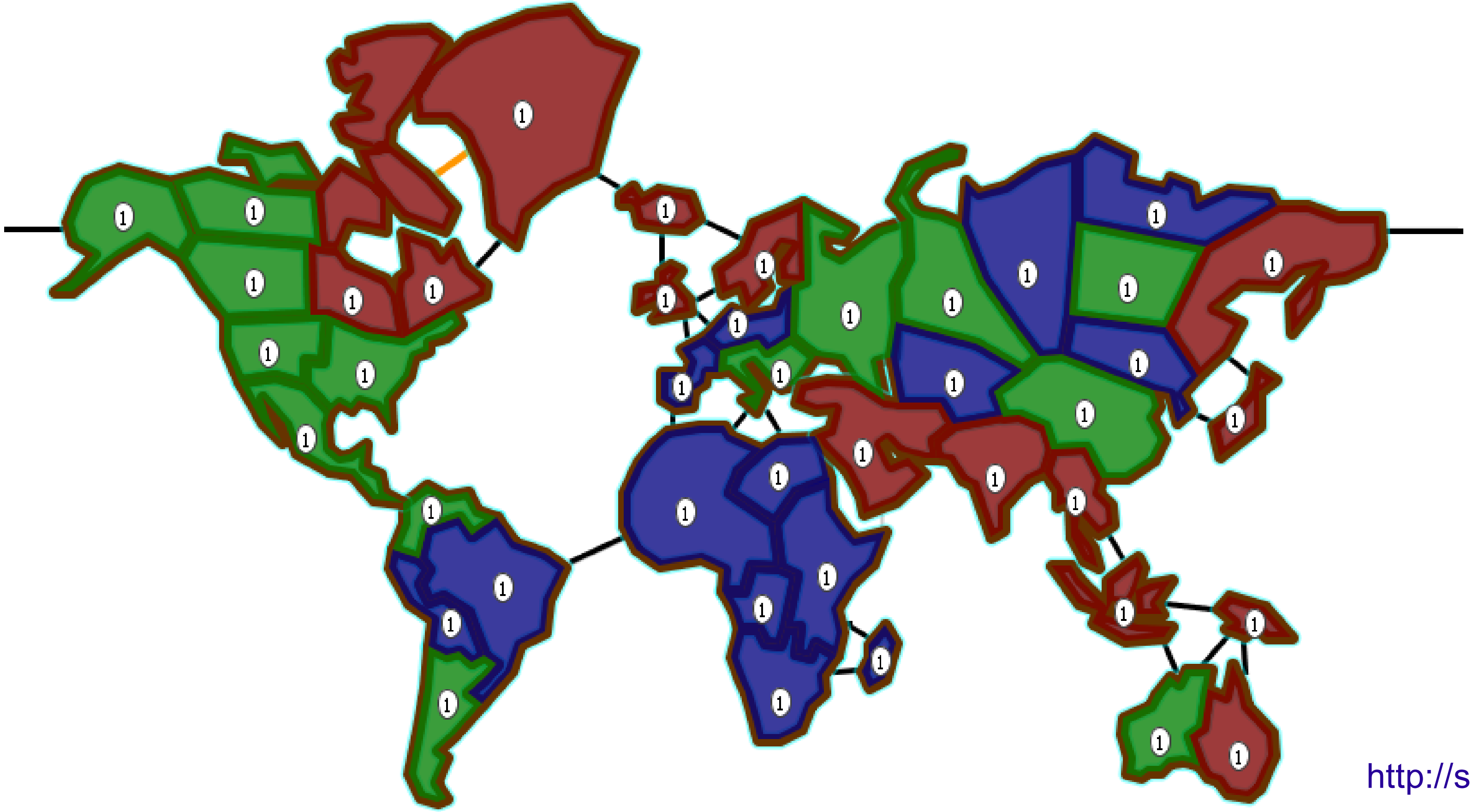

http://sillysoft.net/lux

- Players take turns selecting territories until all 42 territories are owned.

- Problem: How should we draft territories?

Drafting Territories in Risk

- Does territory drafting even matter?

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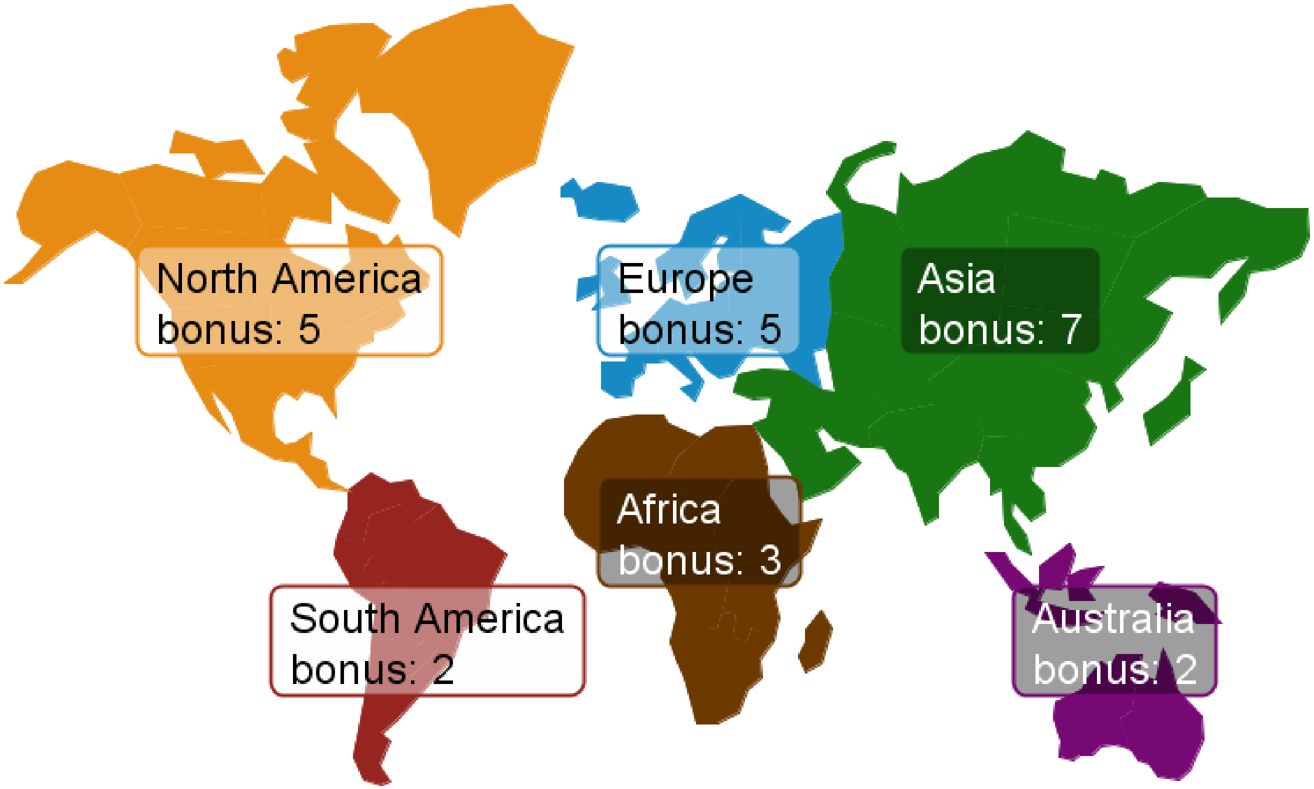
Drafting Territories in Risk

- Does territory drafting even matter?



http://sillysoft.net/lux

- Still, does territory drafting really matter?

Drafting Territories in Risk

- What about the rest of the game after the draft?
  - Lux Delux provides several Risk bots.
  - We will use the “Quo” bot for all post-draft play and replace its drafting algorithm with our own.
- Others have worked on how to play the rest of the game, but all ignore the drafting phase.
  - Territory drafting is all we care about here.
- We are only going to play 3-player Risk.

How to Draft Territories in Risk?

- Rule-based:

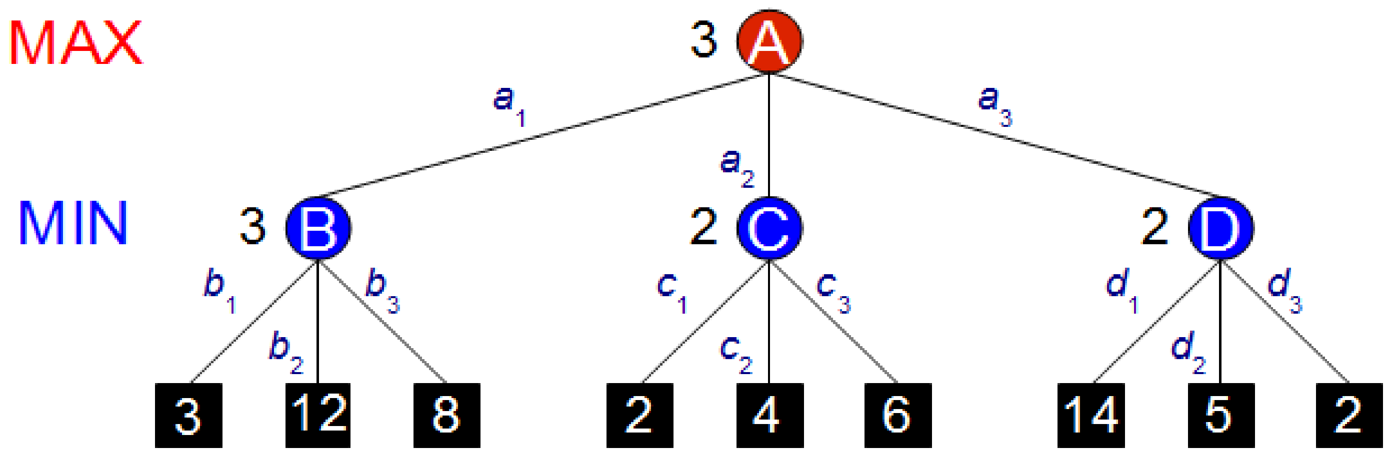
http://sillysoft.net/lux

Go for Australia, no matter what!

- All bots supplied with Lux Delux are rule-based drafters.

How to Draft Territories in Risk?

- Minimax search?



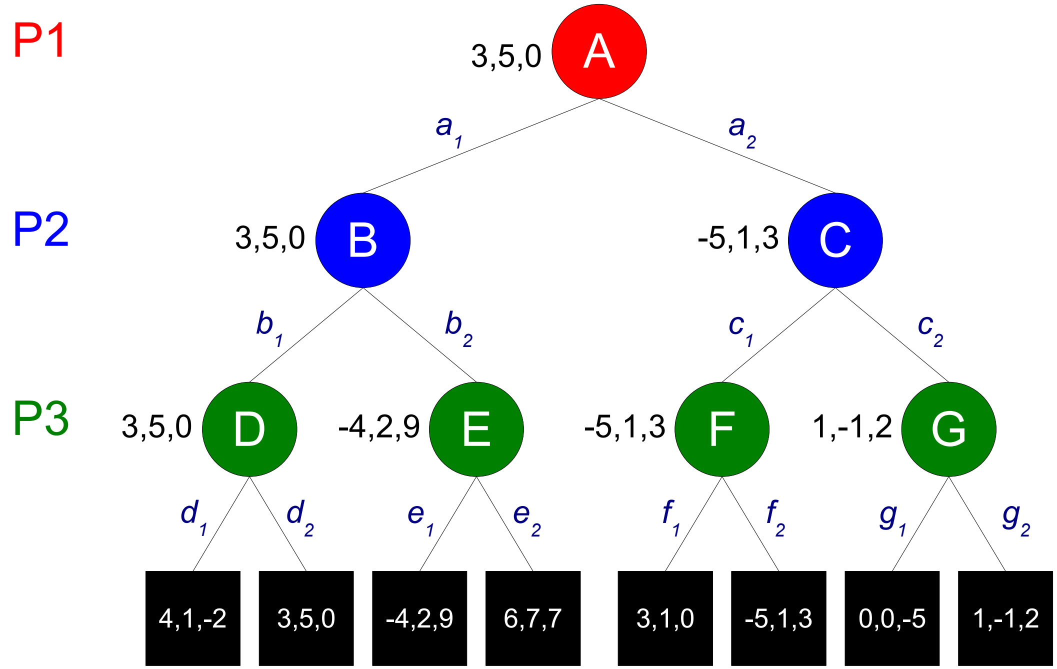
Artificial Intelligence: A Modern Approach, Russell and Norvig, 2003.

- Really only applies to 2-player games...

How to Draft Territories in Risk?

- $\max^n$ search?

An algorithmic solution of n-person games, Luckhart and Irani, 1986.



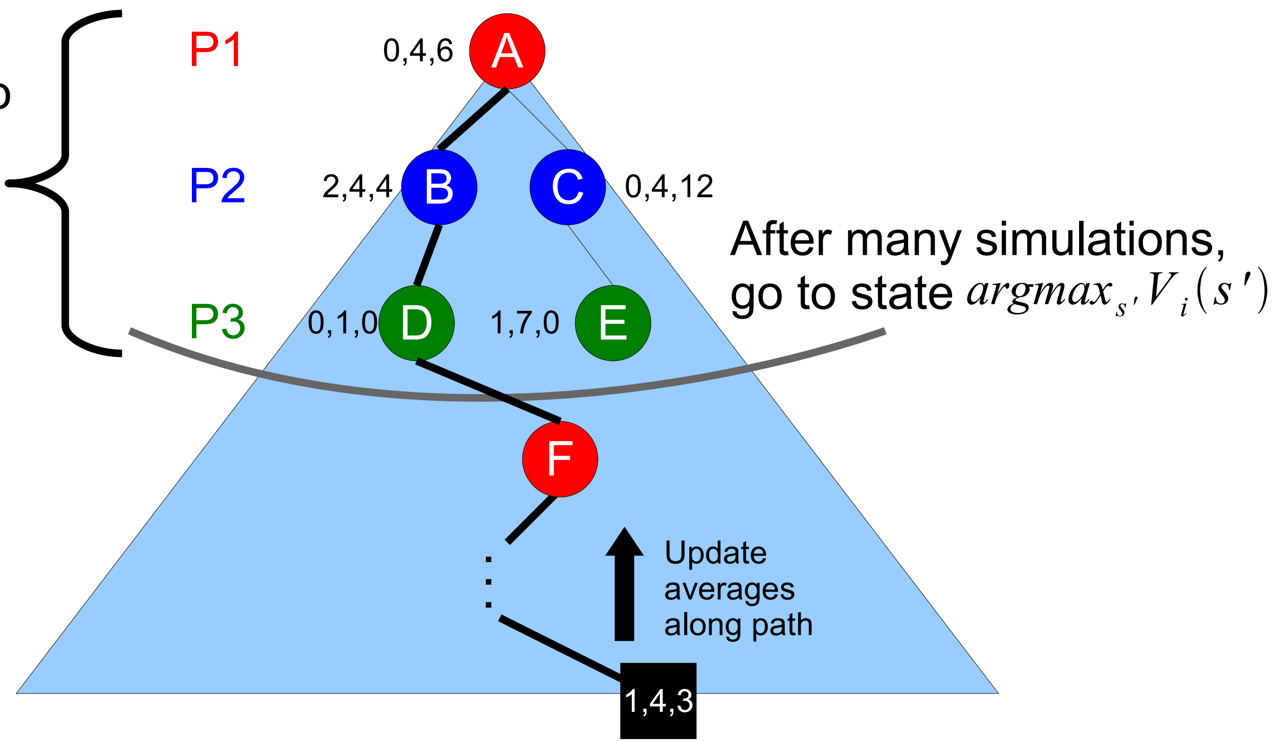
- Large branching factor (42, then 41, then 40, etc.)
- Would require good evaluation function of all draft states

How to Draft Territories in Risk?

- UCT? (Upper Confidence Bounds applied to Trees)

Simulate action from state s to state $argmax_{s'}\left(V_i(s')+c\sqrt{\frac{\log n(s)}{n(s')}}\right)$

Simulate actions randomly



Bandit based Monte-Carlo planning, Kocsis and Szepesvari, 2006.

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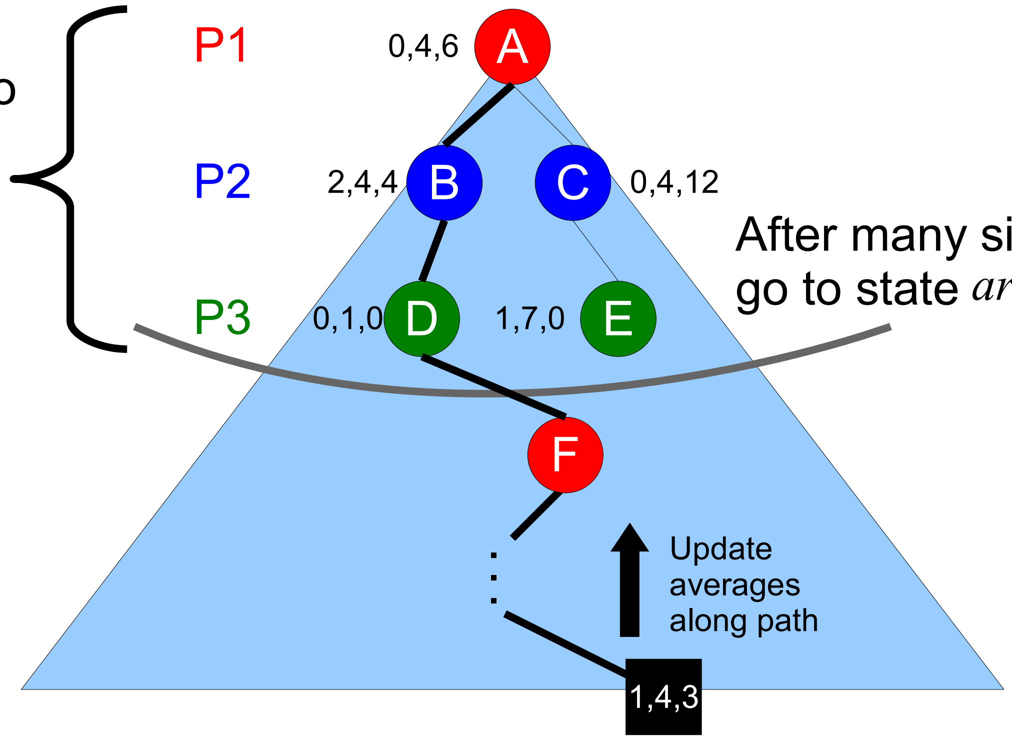


After many simulations, go to state $argmax_{s'} V_i(s')$

Bandit based Monte-Carlo planning, Kocsis and Szepesvari, 2006.

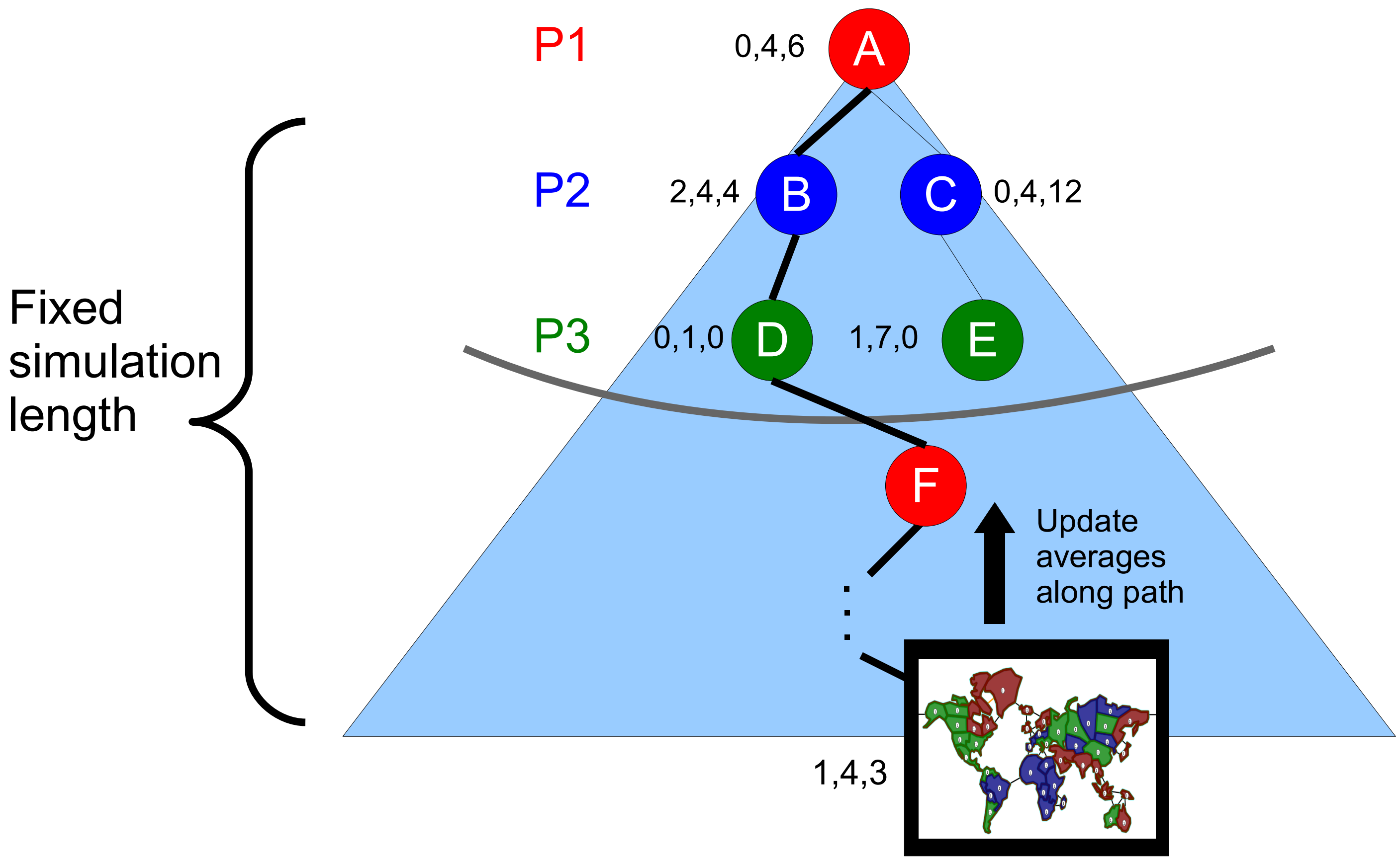
- Better at handling large branching factor
- Typically requires no evaluation function

Applying UCT to Risk Drafting

- Typically with UCT, the more simulations that are run to completion, the more informative the decision.
- Big Problem: Risk can be a very long game
  - Game may never end through random play, and so we may not even complete one simulation.

Applying UCT to Risk Drafting

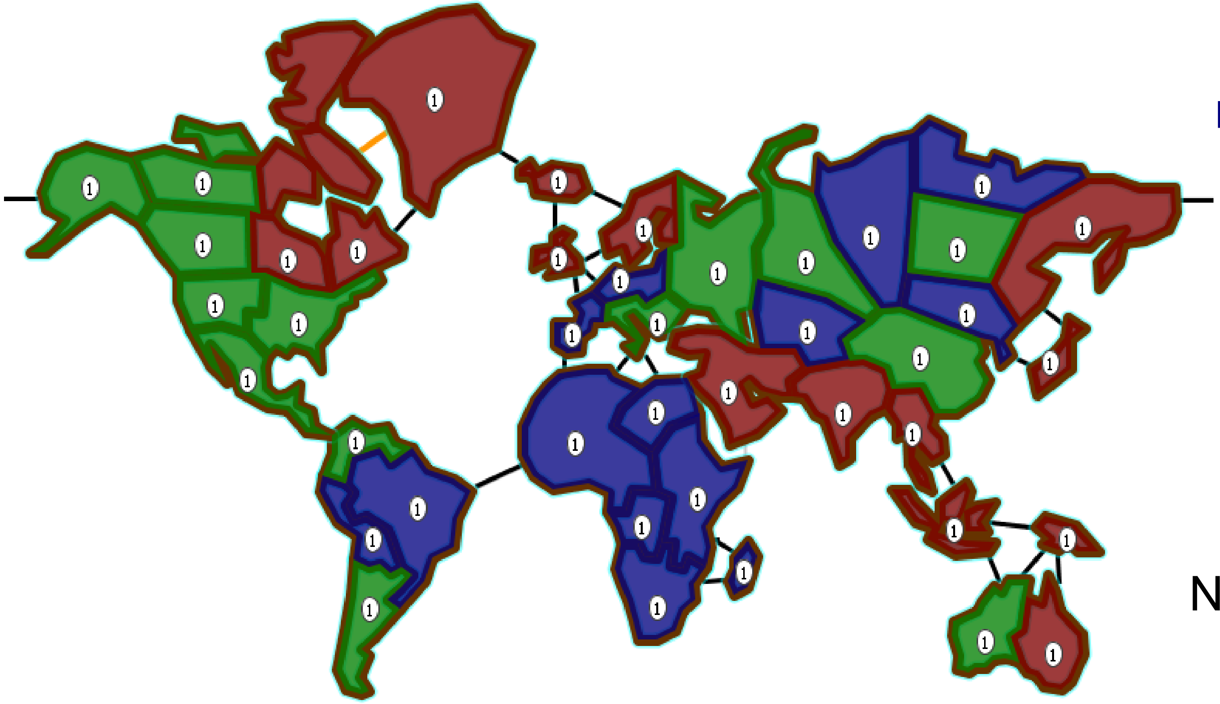
- Solution: Terminate simulations at draft end.



- All terminal states are "simple" ➡ easier to evaluate

Evaluating Draft Outcomes

- For any draft outcome, define feature set S_i for player *i* by just 4 types of features:



http://sillysoft.net/lux

$$S_2 = (\underbrace{\text{Aus-0, SA-2, Afr-6, NA-0, Eur-2, Asia-4}}_{\text{Continent counts}}, \text{Pos-2}, 13, 15)$$

Enemy Neighbours

Turn order

Friendly Neighbours

Evaluating Draft Outcomes

- For any draft outcome, define feature set S_i for player i by just 4 types of features:
  - The number of territories owned in each continent
  - The player's position in the turn order
  - The number of distinct enemy neighbours
  - The number of friendly neighbours

Evaluating Draft Outcomes

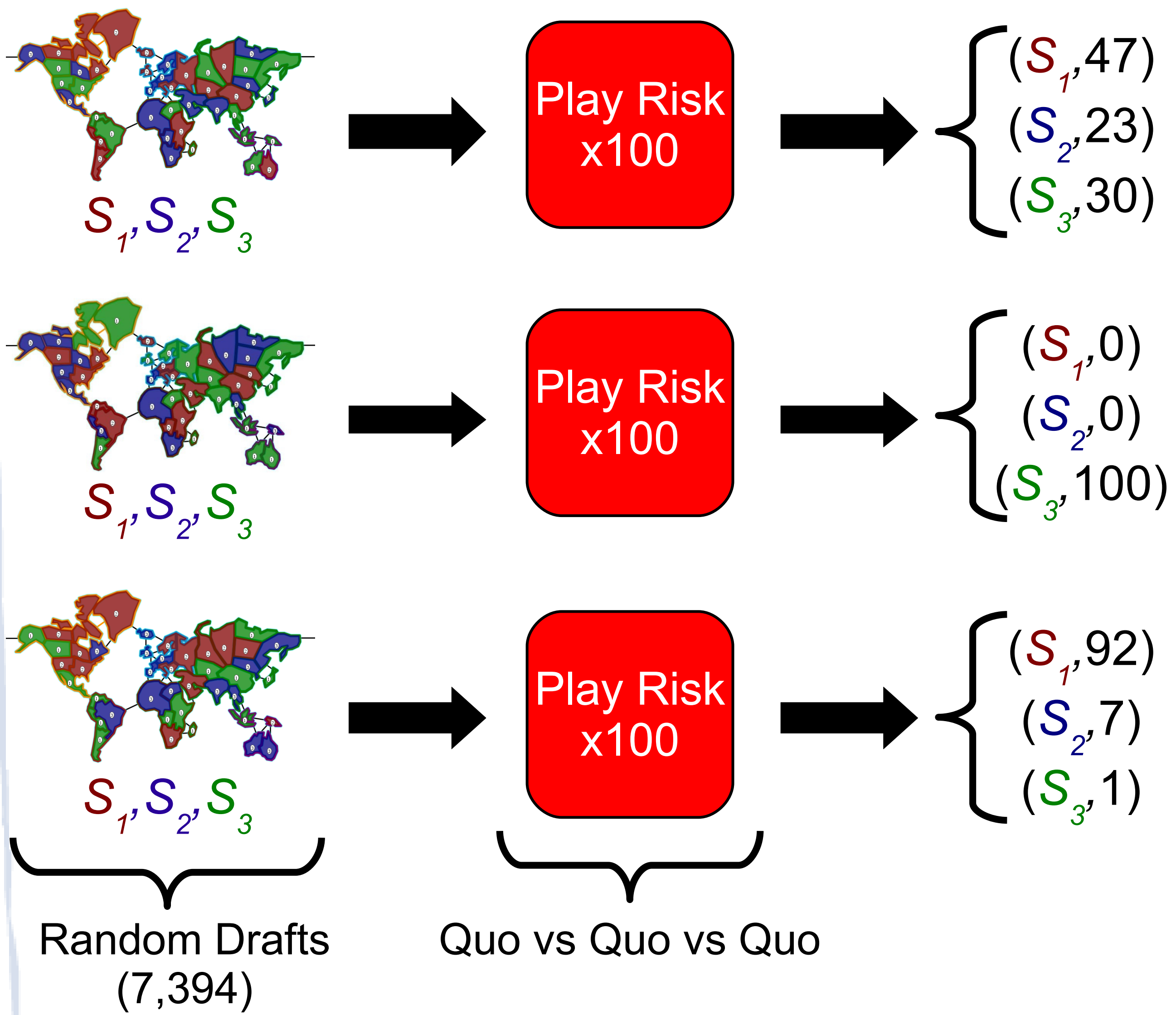
S_1, S_2, S_3

S_1, S_2, S_3

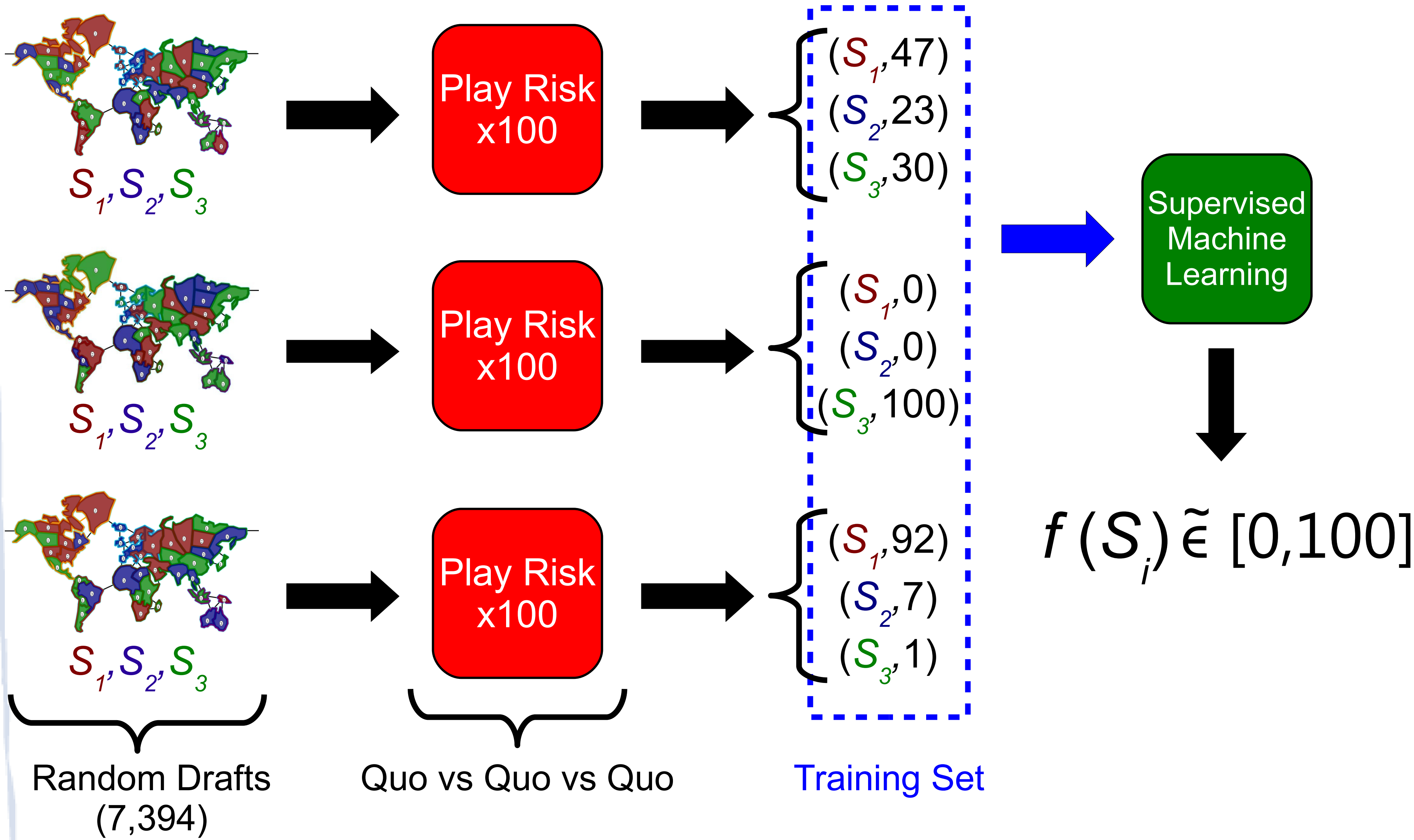
S_1, S_2, S_3

Random Drafts
(7,394)

Evaluating Draft Outcomes



Evaluating Draft Outcomes



Adapted from *Automated action set selection in Markov decision processes*, Lee, 2004.

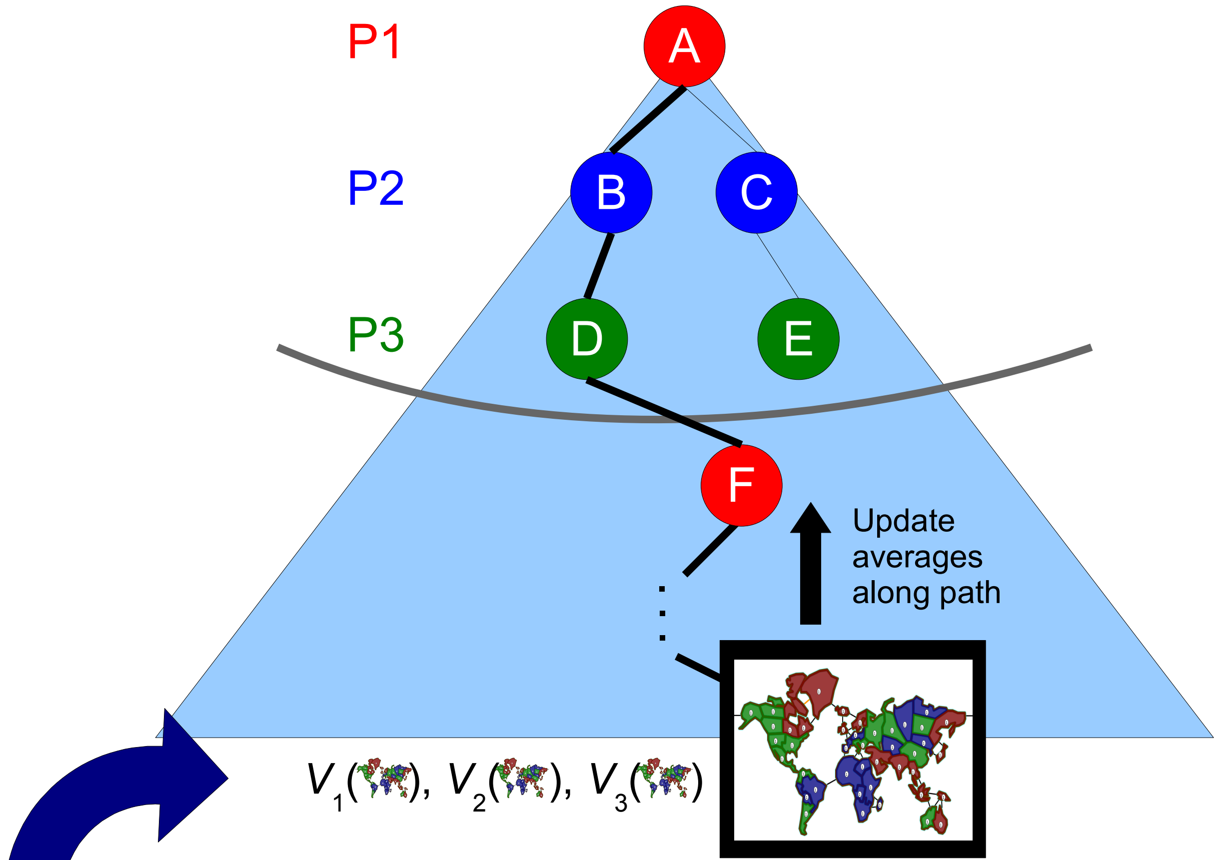
Evaluating Draft Outcomes

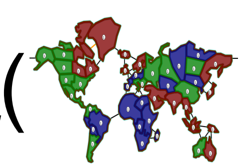
- Used linear regression to obtain *f*
- Final evaluation function:

$V_i($  $) = \dfrac{f^{+}(S_i)}{f^{+}(S_1) + f^{+}(S_2) + f^{+}(S_3)}$

where $f^{+}(S_i) = \max\{\, 0,\ f(S_i)\,\}$

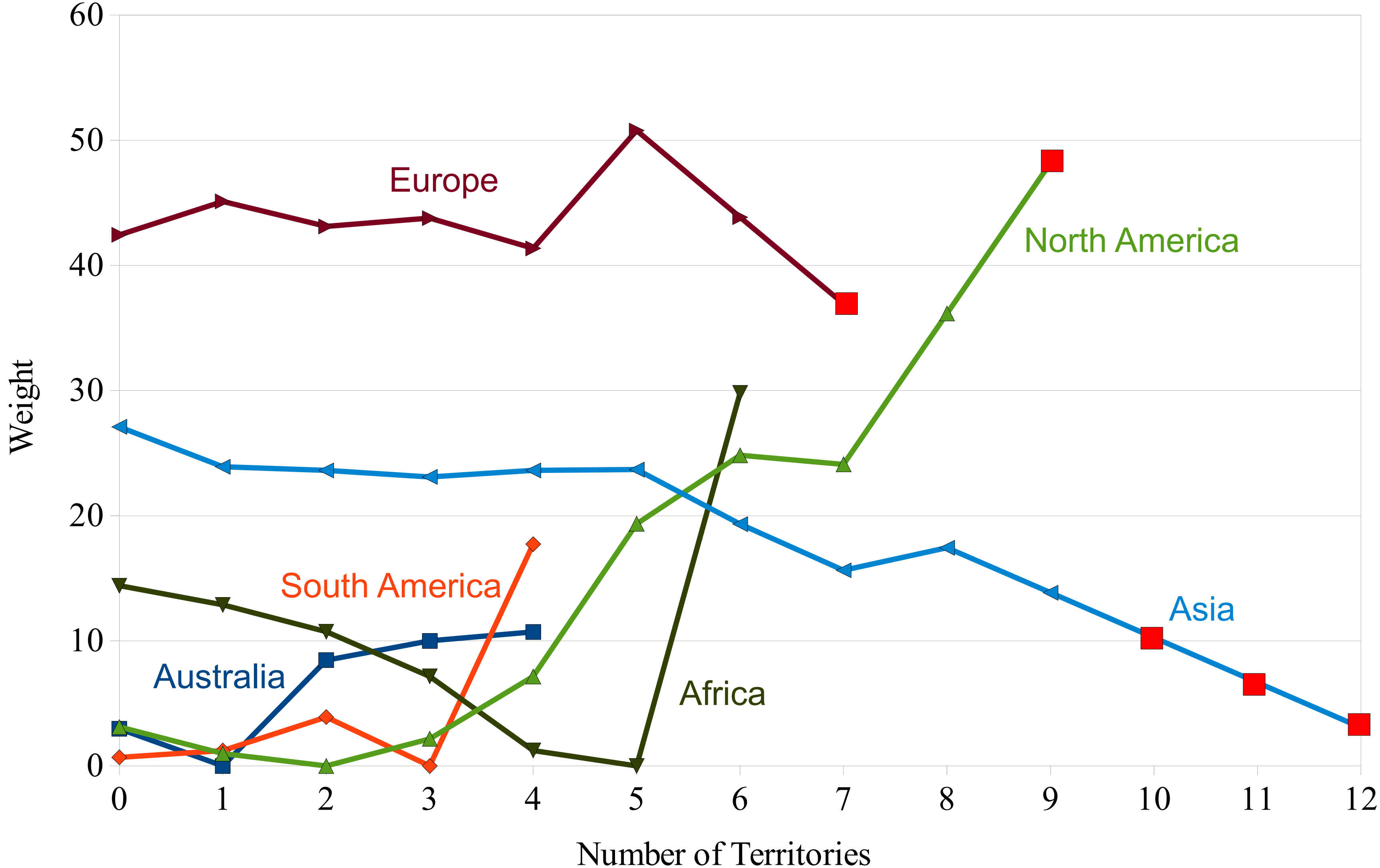
Evaluating Draft Outcomes



$V_i($  $) = \dfrac{f^+(S_i)}{f^+(S_1) + f^+(S_2) + f^+(S_3)}$

Evaluating Draft Outcomes

- Weights of features from linear regression:



Evaluating Draft Outcomes

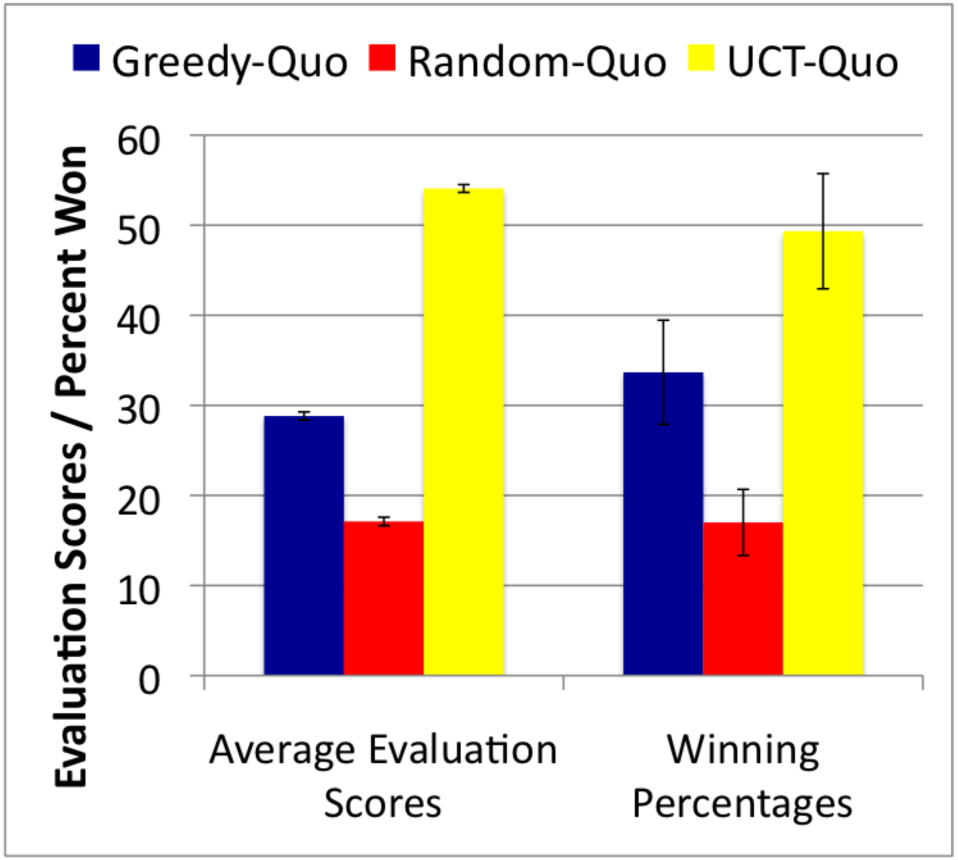
- Weights of features from linear regression:

Feature	Weight
First to play	13.38
Second to play	5.35
Third to play	0.00
Enemy neighbours (multiplier)	-0.07
Friendly neighbours (multiplier)	0.48

Empirical Evaluation

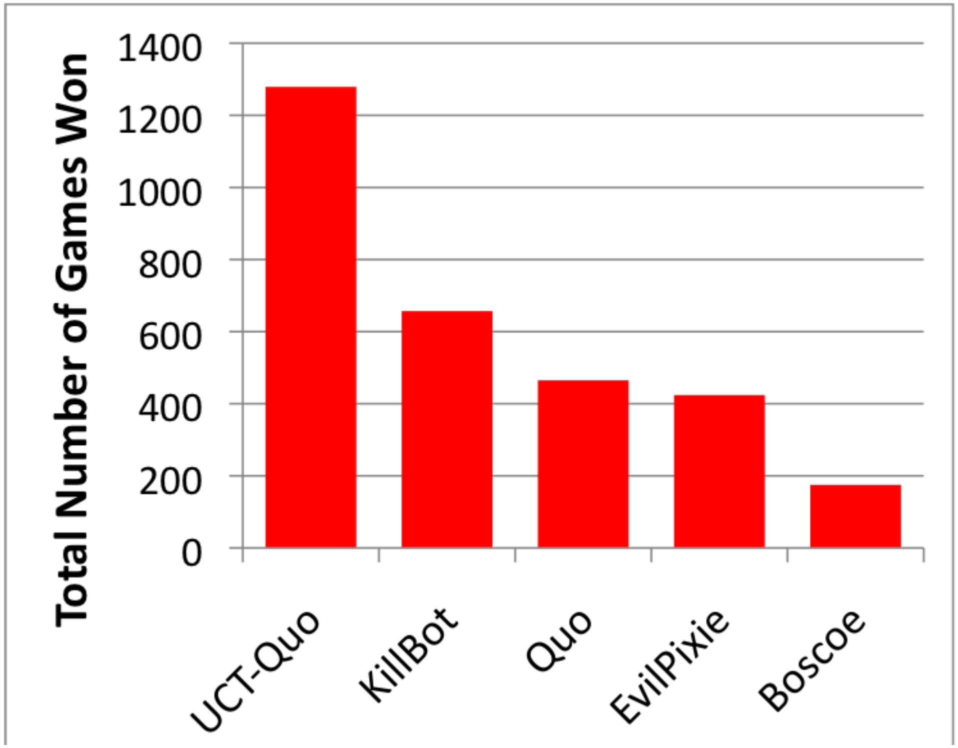
- The good guy:
  - UCT-Quo: UCT + ML evaluation function ➡ Quo
- The bad guys (most difficult bots in Lux Delux):
  - Killbot: Directs attacks/defence at viable continents
  - Quo: Tries to slowly expand a cluster of territories
  - EvilPixie: Similar to Killbot, different parameters
  - Boscoe: Similar to Quo, plus targets runaway leaders
- Some other guys:
  - Greedy-Quo: 1-ply max^n + ML evaluation function ➡Quo
  - Random-Quo: Drafts randomly ➡ Quo

Empirical Evaluation



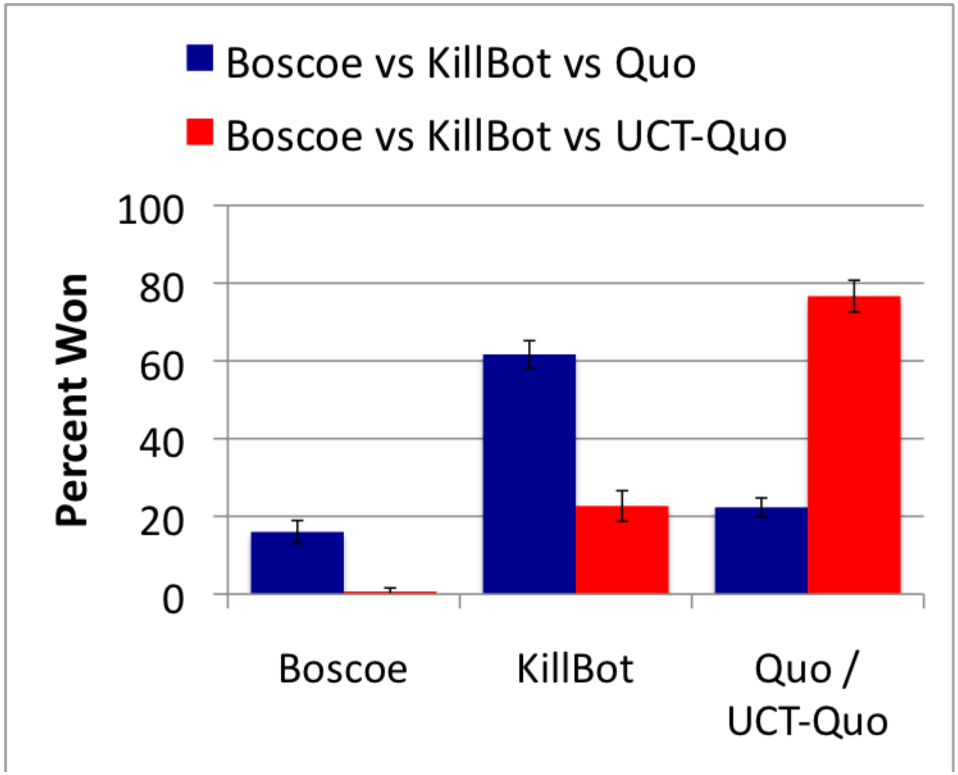
- 50 rounds played, 6 games per round (all 3! orderings)
- UCT runs 3000 simulations with exploration constant c = 0.01 in less than 1 second on personal laptop

Empirical Evaluation



- Round robin tournament (all 10 3-player match-ups), 50 rounds per match-up, 6 games per round (all 3! orderings)
- UCT runs 3000 simulations with exploration constant $c = 0.01$ in less than 1 second on personal laptop

Empirical Evaluation



- 50 rounds played, 6 games per round (all 3! orderings)
- UCT runs 3000 simulations with exploration constant $c = 0.01$ in less than 1 second on personal laptop

Conclusions

- Simple machine-learned evaluation function can generalize fairly well
- Combining UCT with a machine-learned evaluation function works well for drafting territories in Risk
  - Our UCT-Quo bot outperforms all of the strongest bots supplied with Lux Delux
- Territory drafting is an important stage in Risk
- Our approach could be appealing to commercial Risk AI programmers
  - Makes good decisions very quickly

Future Work

- Generalize the evaluation function to more players
- Adapt to other types of games, perhaps those that involve drafting-type scenarios
- In particular, apply to drafting in sports leagues
  - Real-life rookie / waiver / expansion drafts
  - Video games
  - Fantasy sports

Real-Life Sports League Drafts

Wikimedia Commons – Alexander Laney

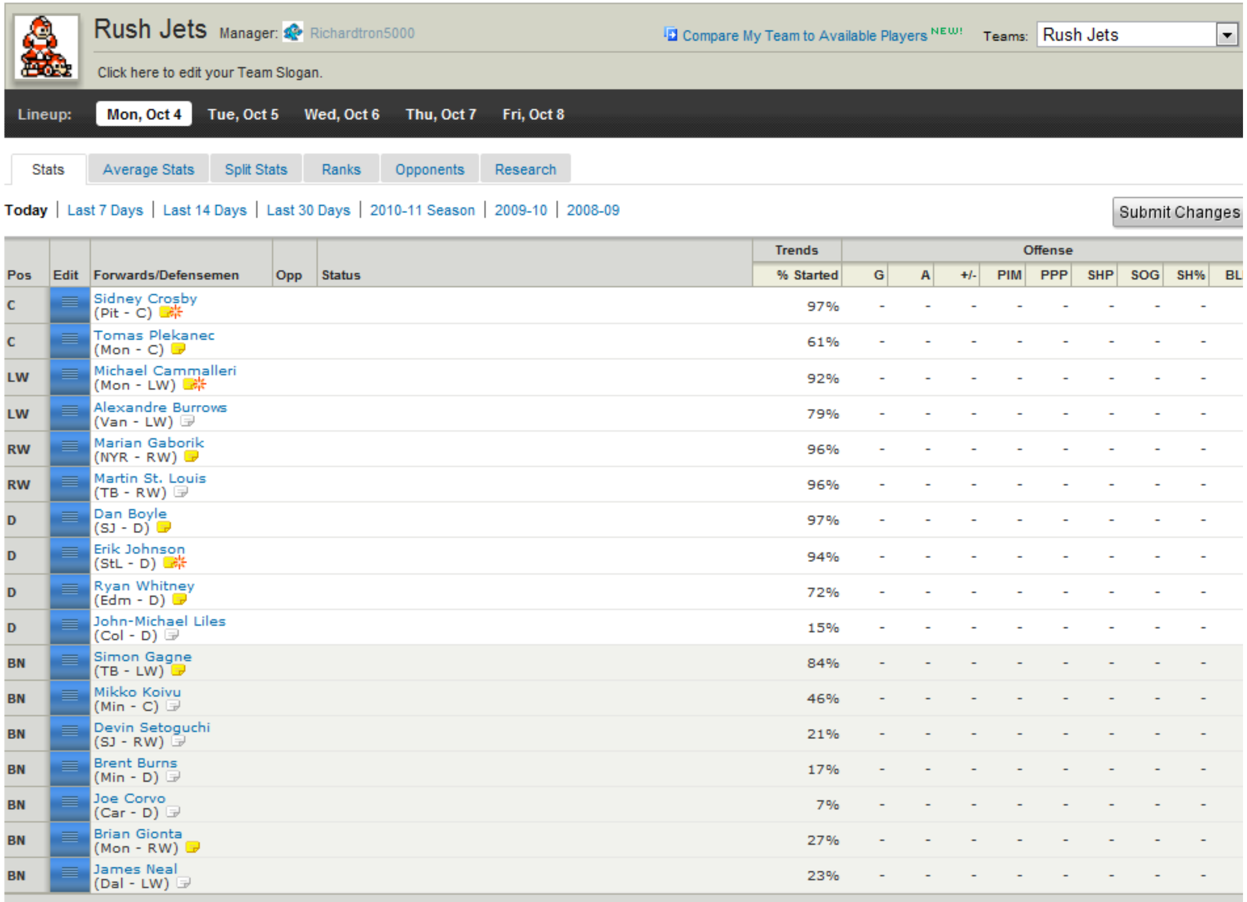
- Teams take turns selecting players from a pool
- Create an automated draft assistant?
- Mock drafts against automated opponents?

Drafting in Video Games

EA Sports “NHL 10”

- Create more intelligent computer opponents to draft against?

Fantasy Sports Drafts



Rush Jets Manager: Richardtron5000

Compare My Team to Available Players NEW!

Teams: Rush Jets

Click here to edit your Team Slogan.

Lineup: Mon, Oct 4 | Tue, Oct 5 | Wed, Oct 6 | Thu, Oct 7 | Fri, Oct 8

Stats | Average Stats | Split Stats | Ranks | Opponents | Research

Today | Last 7 Days | Last 14 Days | Last 30 Days | 2010-11 Season | 2009-10 | 2008-09

Submit Changes

					Trends	Offense								
Pos	Edit	Forwards/Defensemen	Opp	Status	% Started	G	A	+/-	PIM	PPP	SHP	SOG	SH%	BL
C		Sidney Crosby (Pit - C)			97%	-	-	-	-	-	-	-	-	
C		Tomas Plekanec (Mon - C)			61%	-	-	-	-	-	-	-	-	
LW		Michael Cammalleri (Mon - LW)			92%	-	-	-	-	-	-	-	-	
LW		Alexandre Burrows (Van - LW)			79%	-	-	-	-	-	-	-	-	
RW		Marian Gaborik (NYR - RW)			96%	-	-	-	-	-	-	-	-	
RW		Martin St. Louis (TB - RW)			96%	-	-	-	-	-	-	-	-	
D		Dan Boyle (SJ - D)			97%	-	-	-	-	-	-	-	-	
D		Erik Johnson (StL - D)			94%	-	-	-	-	-	-	-	-	
D		Ryan Whitney (Edm - D)			72%	-	-	-	-	-	-	-	-	
D		John-Michael Liles (Col - D)			15%	-	-	-	-	-	-	-	-	
BN		Simon Gagne (TB - LW)			84%	-	-	-	-	-	-	-	-	
BN		Mikko Koivu (Min - C)			46%	-	-	-	-	-	-	-	-	
BN		Devin Setoguchi (SJ - RW)			21%	-	-	-	-	-	-	-	-	
BN		Brent Burns (Min - D)			17%	-	-	-	-	-	-	-	-	
BN		Joe Corvo (Car - D)			7%	-	-	-	-	-	-	-	-	
BN		Brian Gionta (Mon - RW)			27%	-	-	-	-	-	-	-	-	
BN		James Neal (Dal - LW)			23%	-	-	-	-	-	-	-	-	

Yahoo! Sports Fantasy Hockey

- Fantasy sports are a multi-billion dollar business
- Implement a drafting coach?

References

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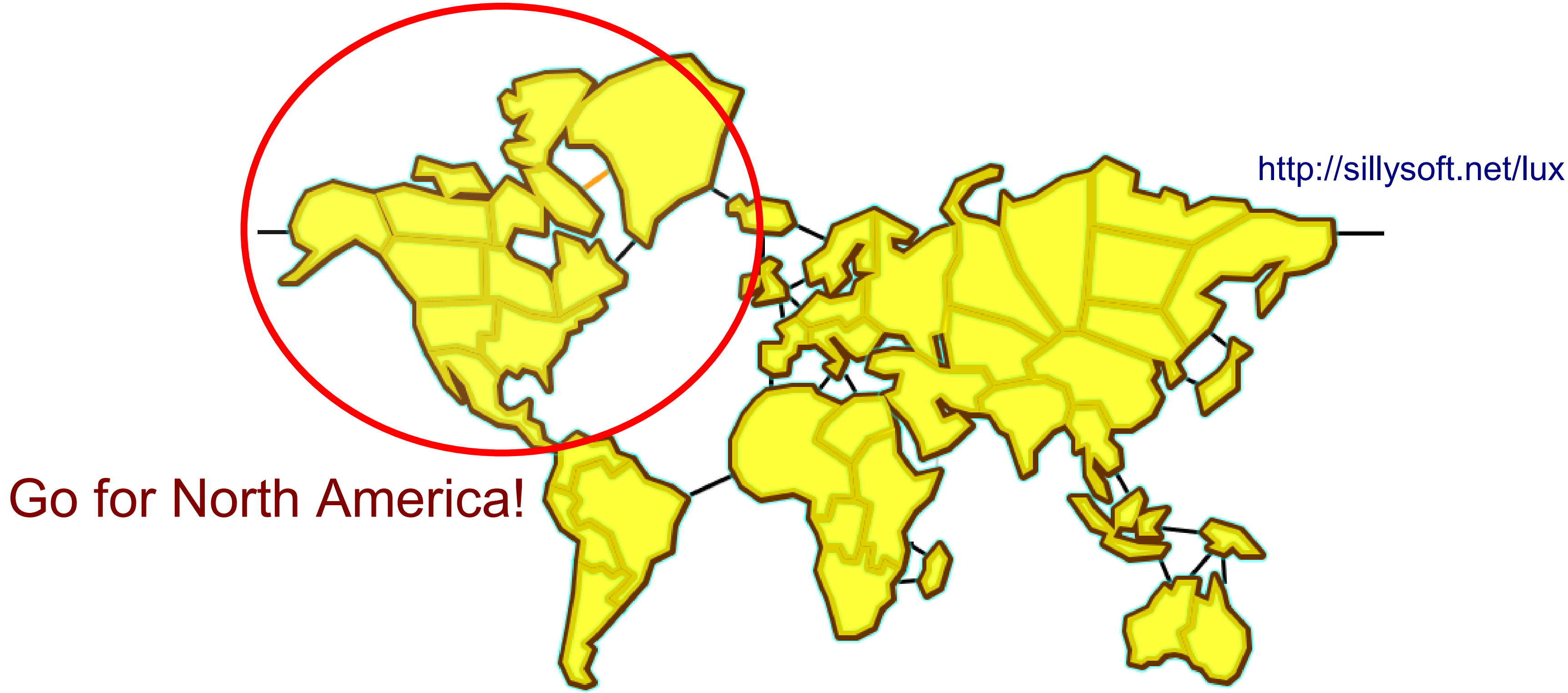
  - Funding provided by NSERC and iCore, now part of Alberta Innovates – Technology Futures.

Thanks for Listening!



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