Identifying Avatar Aliases in Starcraft 2

Unscrambling confusion matrices of behavioural classifiers

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Being or not a sport...

League of Legends – NA LCS Summer Final
Madison Square Garden in New York, NY (19 August 2015)

... competitive gaming is raising drastically

- Video game is a lucrative industry
- People enjoy watching other playing (streaming via Twitch.tv)
- E-sports: professional *cyberathletes* with teams, commentators, sponsors, cash prizes, ... ; between sport and pure marketing

G. Cheung and J. Huang.
Starcraft from the stands: understanding the game spectator.
In *SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2011, pp. 763–772.

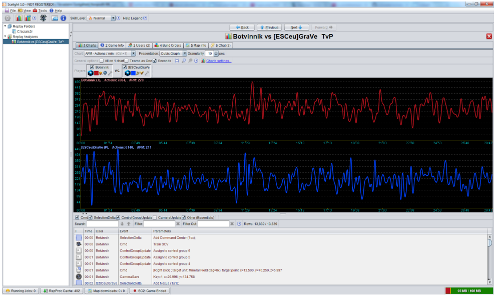
M. Kaytoue, A. Silva, L. Cerf, W. Meira Jr. et C. Raïssi
Watch me playing, i am a professional: a first study on video game live streaming.
In *WWW 2012 (Companion Volume), pages 1181–1188. ACM*, 2012.

T. L. Taylor
Raising the Stakes:E-Sports and the Professionalization of Computer Gaming.
In *MIT Press*, 2012.

A lot of challenges

Millions of games played on a daily basis

- Security issues
- Bugs, cheaters
- Balance issues
- Fun vs challenging agents
- Profiling & prediction
- Match preparation
- Playground for AI research



Arthur von Eschen
Machine Learning and Data Mining in Call of Duty (invited industrial talk).
European Conference on Machine Learning and Knowledge Discovery in Databases, ECML/PKDD, Nancy, France, Sept. 2014)

S. Ontanon, G. Synnaeve, A. Uriarte, F. Richoux, D. Churchill, and M. Preuss,
A survey of real-time strategy game ai research and competition in starcraft.
Computational Intelligence and AI in Games, IEEE Transactions on, vol. 5, no. 4, pp. 293–311, 2013.)

Our concern today

Players and teams observe game records of others

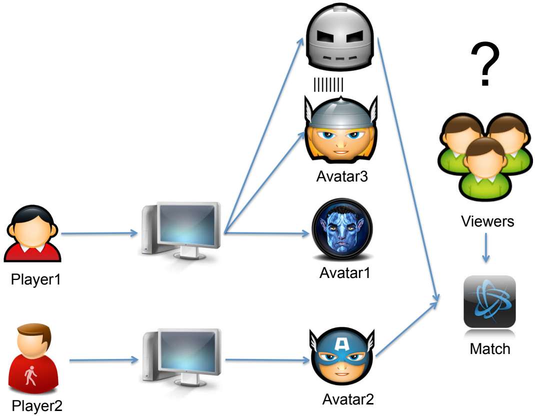
- Complete game logs are available
- Global ranking as well (such as ATP in tennis)

More and more players use several [un-]official accounts to hide their games and not being studied by the others

http://leagueoflegends.wikia.com/wiki/Smurf

https://www.reddit.com/r/starcraft/comments/3gkfso/sc2_who_is_that_smurf/

The problem



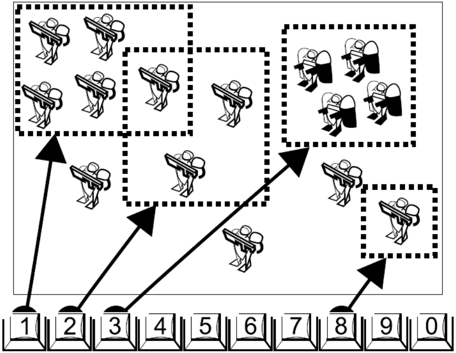
Can we identify if two avatars belong to the same player?

We have huge amounts of behavioural data!

Behavioural data as replay files

The RTS game StarCraft 2: to improve strategy execution, players

- assign control groups to units and buildings,
- bind them to keyboard hotkeys (1, 2, ..., 9, 0),
- use them intensively along with the mouse.



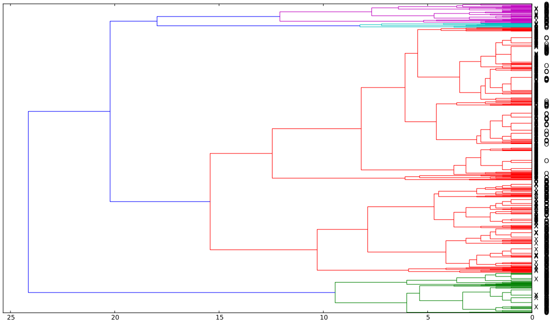
Source: Yan et al., SIGCHI2015

Avatar	Game trace	Outcome
`Ror0`	s,s,hotkey4a,s,hotkey3a,s,hotkey3s, ...	Lose
`TAiLS`	Base,hotkey1a,s,hotkey1s,s,hotkey1s, ...	Win

Keyboard usage patterns

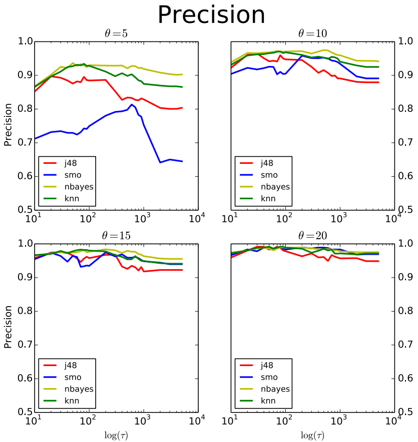
Hypothesis

A player cannot hide behavioural patterns when changing avatars



Dendogram of a hierarchical clustering from 708 traces from 354 games: each color denotes a unique avatar

Predictive models with high accuracy



Hotkeys hide unique patterns

- 20 first seconds of the game are enough
- 20 games are enough

We found a similar result, but considering on purpose dataset without avatar aliases, since precision drastically drops

Eddie Q. Yan, Jeff Huang, Gifford K. Cheung.
Masters of Control: Behavioral Patterns of Simultaneous Unit Group Manipulation in StarCraft2.
In *CHI 2015, Crossings, Seoul, Korea 37–11*, 2015.

Notations

A prediction model $\rho : T \rightarrow L$ is learned

- T a set of **traces**
- L a set of trace **labels** (the avatars)
- T_l the set of traces generated by avatar $l \in L$

The model is evaluated (e.g. cross-validation)

- $\rho(t) \in L$ return the model prediction for the trace $t \in T$
- **Confusion matrix** $\tilde{C}^{\rho} = [c_{i,j}/|T_{l_i}|]$ with $c_{i,j} = |\{t \in T_{l_i} \ s.t. \ \rho(t) = l_j\}|$

	l_1	l_2	l_3	l_4	l_5
l_1	0.6	0.4	0	0	0
l_2	0.4	0.55	0.05	0	0
l_3	0	0	0.8	0.15	0.05
l_4	0	0.05	0	0.7	0.25
l_5	0	0	0	0.5	0.5

Objectives

Idea: two avatars of the same player should draw a high confusion

	l_1	l_2	l_3	l_4	l_5
l_1	**0.6**	**0.4**	0	0	0
l_2	**0.4**	**0.55**	0.05	0	0
l_3	0	0	**0.8**	0.15	0.05
l_4	0	0.05	0	**0.7**	**0.25**
l_5	0	0	0	**0.5**	**0.5**

We are searching for pairs of labels that concentrate the fusion (arbitrary sets are left for later)

- $\tilde{C}^{\rho}_{ij} \simeq \tilde{C}^{\rho}_{ji} \simeq \tilde{C}^{\rho}_{ii} \simeq \tilde{C}^{\rho}_{jj}$
- $\tilde{C}^{\rho}_{ij} + \tilde{C}^{\rho}_{ji} + \tilde{C}^{\rho}_{ii} + \tilde{C}^{\rho}_{jj} \simeq 2$

	...	l_i	l_j	...
...		...		
l_i	...	$C_{i,i}$	$C_{i,j}$	...
l_j	...	$C_{j,i}$	$C_{j,j}$	...
...		...		

Method (1/2): extract fuzzy concepts

Formal Concept Analysis (FCA) with a fuzzy set intersection

- Each label (row) is considered as a fuzzy set
- Labels and their (fuzzy) intersections $\sqcap$ form a semi-lattice
- Closed sets are extracted and scored (monotone constraint possible)

M. Kaytoue, V. Codocedo, A. Buzmakov, J. Baixeries, S.O. Kuznetsov, A. Napoli:
Pattern Structures and Concept Lattices for Data Mining and Knowledge Processing.
ECML/PKDD 2015, Nectar track

Example

	l_1	l_2	l_3	l_4	l_5
l_1	0.6	0.4	0	0	0
l_2	0.4	0.55	0.05	0	0
l_3	0	0	0.8	0.15	0.05
l_4	0	0.05	0	0.7	0.25
l_5	0	0	0	0.5	0.5

$$\delta(l_1) = \{l_1^{0.6}, l_2^{0.4}, l_3^{0}, l_4^{0}, l_5^{0}\}$$

$$\delta(l_2) = \{l_1^{0.4}, l_2^{0.55}, l_3^{0.05}, l_4^{0}, l_5^{0}\}$$

$$d = \delta(l_1) \sqcap \delta(l_2) = \{l_1^{0.4}, l_2^{0.4}, l_3^{0}, l_4^{0}, l_5^{0}\}$$

$$support(d) = \{l_1, l_2\}$$

$$s(\mathrm{d}) = \sum_{j=1}^{|L|} \mathrm{d}^j = 0.8$$

The pair (l_1, l_2) is an avatar alias candidate

Method (2/2): rank and filter pairs

Candidate pairs are scored

- A cosine similarity is used, the highest the better

$$cluster\_score(a_i, a_j) = cosine(\langle \tilde{C}^{\rho}_{ii}, \tilde{C}^{\rho}_{ij} \rangle, \langle \tilde{C}^{\rho}_{jj}, \tilde{C}^{\rho}_{ji} \rangle)$$

	...	l_i	l_j	...
...	...			
l_i	...	$C_{i,i}$	$C_{i,j}$	...
l_j	...	$C_{j,i}$	$C_{j,j}$	...
...	...			

- Why?

	a_i	a_j
a_i	1	0
a_j	1	0

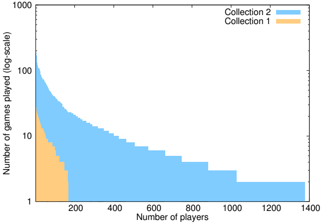
$$cosine(\langle 1, 0 \rangle, \langle 0, 1 \rangle) = 0$$

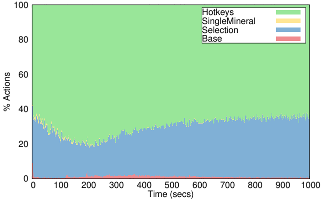
Candidates are ranked; the list is cut with a threshold if necessary

Experimental settings

Datasets

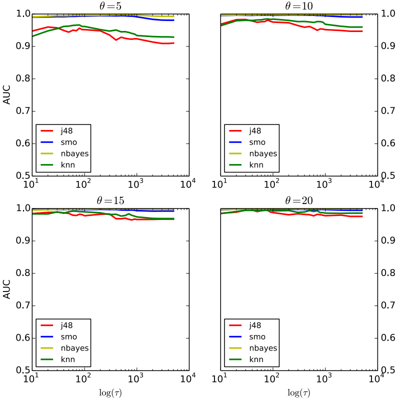
- Collection 1 - 2014 World Championship Series: 955 one-versus-one high level games and 171 unique players
- Collection 2 - *Spawning Tool* Website crawl July 2014: 10,108 one-versus-one games and 3,805 players



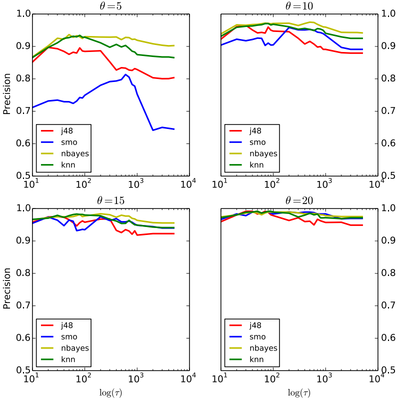


Chosen features allow powerful prediction

AUC



Precision



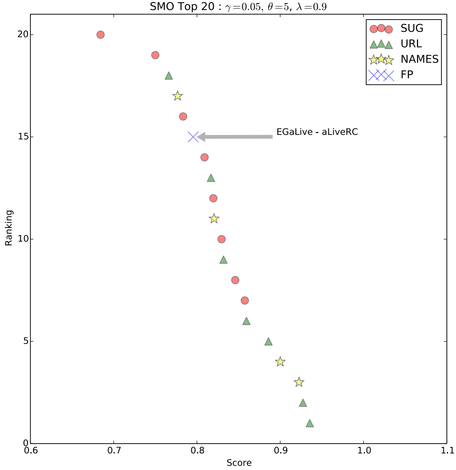
Building a ground truth and evaluating aliases retrieval

Idea: each class is split into several; can we retrieve them?

Parameters:: $\gamma = 0.2$, $\theta = 20$, $\lambda = 0.9$, $\tau = 90$						
Surrogates						
Classifier	F1	MAP	Recall	AUC	Precision	P@10
j48	0.468	0.824	0.805	0.904	0.33	1.0
naivebayes	0.226	0.740	0.390	0.915	0.16	0.8
smo	0.312	0.971	0.536	0.993	0.22	1.0
knn	0.567	0.822	0.976	0.882	0.4	0.9
Surrogates & URLS						
Classifier	F1	MAP	Recall	AUC	Precision	P@10
j48	0.588	0.907	0.606	0.866	0.57	1.0
naivebayes	0.443	0.857	0.457	0.864	0.43	1.0
smo	0.257	0.912	0.266	0.945	0.25	1.0
knn	0.670	0.937	0.691	0.874	0.65	1.0
Surrogates & URLS & Names						
Classifier	F1	MAP	Recall	AUC	Precision	P@10
j48	0.689	0.983	0.606	0.935	0.8	1.0
naivebayes	0.560	0.943	0.492	0.906	0.65	1.0
smo	0.258	0.949	0.227	0.960	0.3	1.0
knn	0.758	0.967	0.667	0.792	0.88	1.0

About false positive

- Some FP are not (same unique id hidden for the experiments)
- Some FP with high score are actually the avatars we are looking for!



Conclusion

Take away facts

- Games traces hide individual patterns
- In StarCraft 2, via customizable keyboard usage
- When avatar aliases are present, one needs to unscramble the confusion matrix
- We proposed a method rooted in formal concept analysis with promising results
- More details to be found (Cavadenti et al., DSAA15)

O. Cavadenti, V. Codocedo, J.-F. Boulicaut, M. Kaytoue
When Cyberathletes Conceal Their Game: Clustering Confusion Matrices to Identify Avatar Aliases.
IEEE International Conference on Data Science and Advanced Analytics, Paris, France, October 2015

- Next: other games ; other methods

Thanks for listening!