

Learning to
Play
Hearthstone

J David Smith

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Challenges

Approach

Conclusions

Learning to Play *Hearthstone*

J David Smith

30 April 2015

A Common Story

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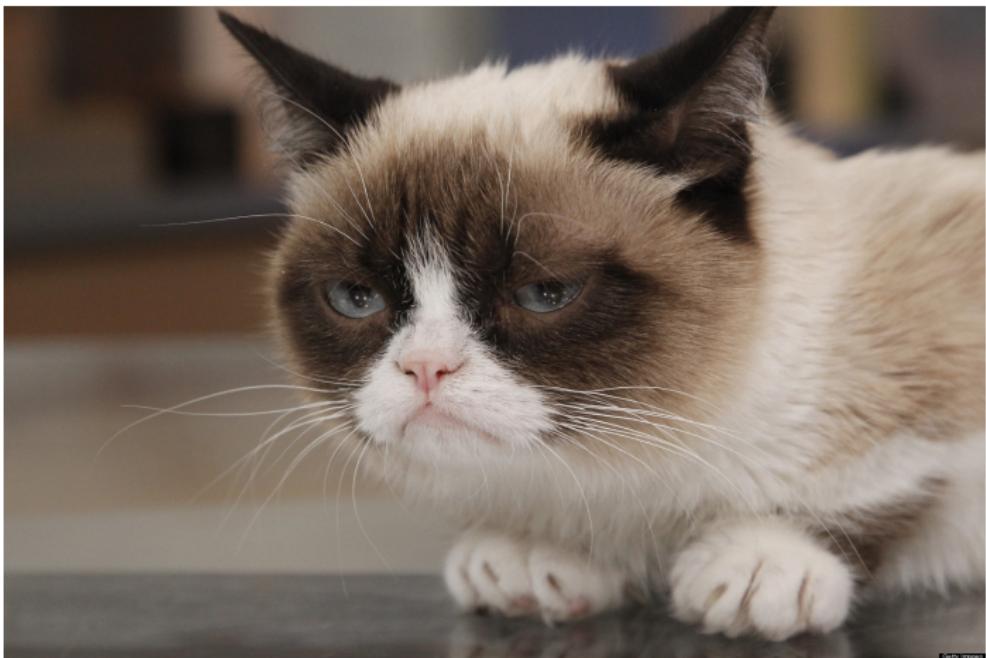
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Classify this object

A Computer Vision Goal

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Understand & interact with this scene

Another Option

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Understand & interact with this scene

Which is Easier?

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Motivation

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- Understanding the entire world is hard
- Doing so well enough to reliably & safely interact with it is harder
- Simplify the problem to make it tractable

Challenges in Understanding Video Games

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- Understanding
 - Scene Classification
 - Object Detection, Classification & Tracking
 - Action Recognition
- Interaction
 - Cause & Effect
 - Sending input

Specific Challenges

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- Frame Classification
 - *Is this frame Hearthstone?*
- Object Detection under Occlusion
 - *Where are the cards?*
- n -Class Classification, for Large Unbounded n
 - *Which card is this?*

Frame Classification

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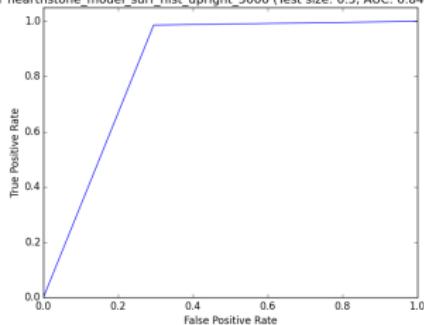
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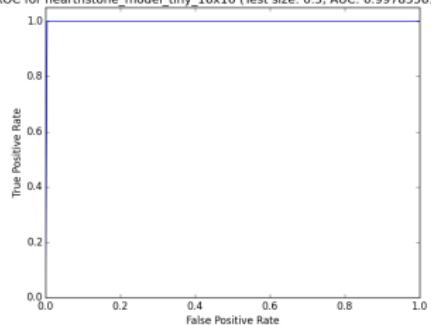
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for hearthstone_model_surf_hist_upright_5000 (Test size: 0.5, AUC: 0.8457147)



Features: SURF BoVW

ROC for hearthstone_model_tiny_16x16 (Test size: 0.5, AUC: 0.997855611151)



Features: Tiny Images

Frame Classification: Results

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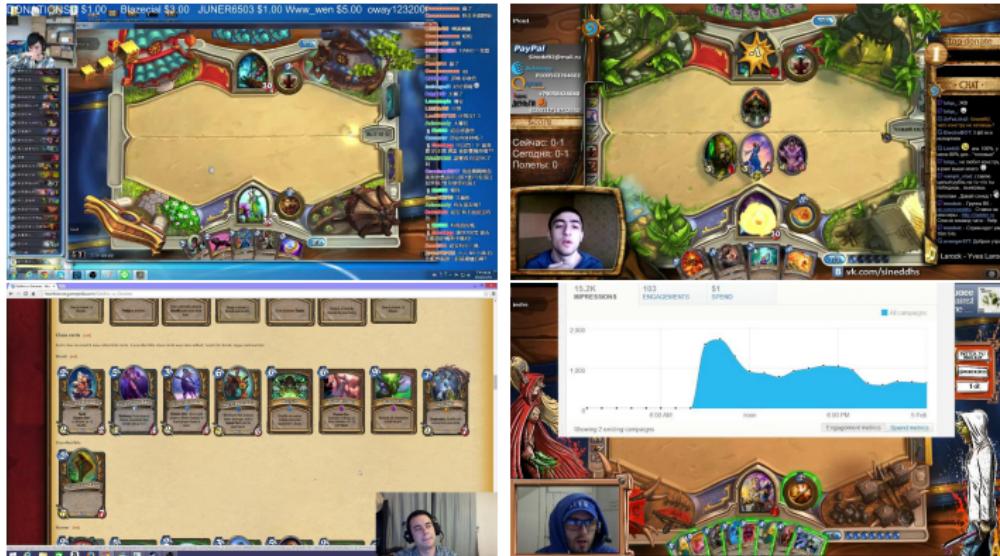
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Frames Correctly labeled as *Hearthstone* (row 1) or *Not Hearthstone* (row 2) by Tiny Images + Linear SVM

Minion Detection

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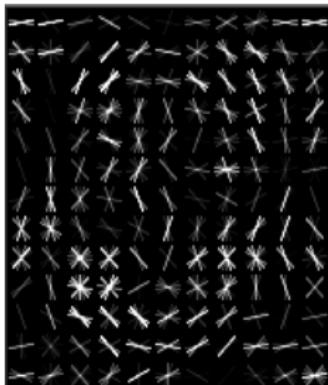
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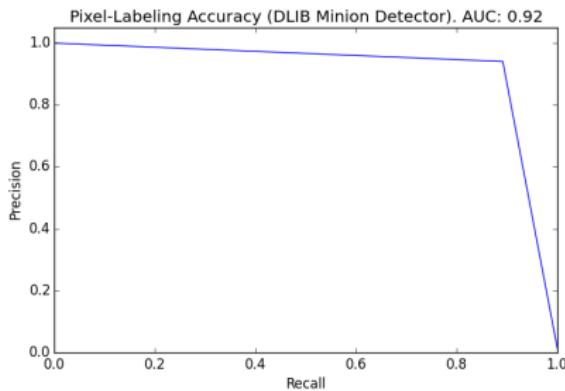
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Visualization of HOG
Mask



Precision/Recall of dlib's HOG-based Object
Detector

Minion Detection: Results

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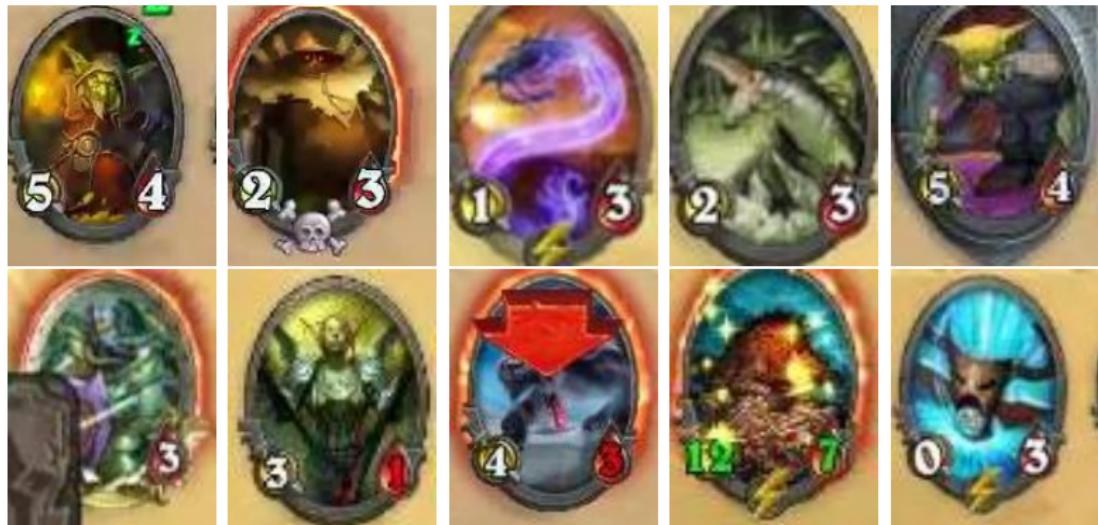
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Cutouts from Object Detector

Minion Classification

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- Problem: ≥ 500 classes and growing
- Solution: Clustering in Feature Space
 - K-Means is not usable because k must be fixed
 - Algorithms for unknown and unbounded k exist
 - Affinity Propagation
 - DBSCAN

MC Results (SIFT+FLANN, Manual)

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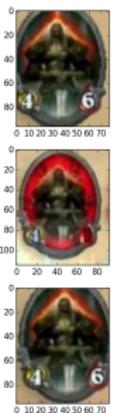
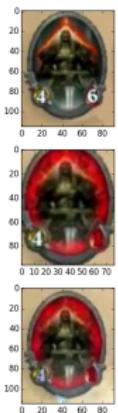
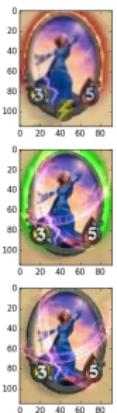
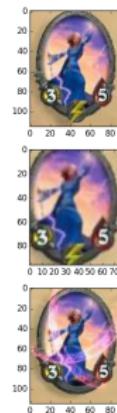
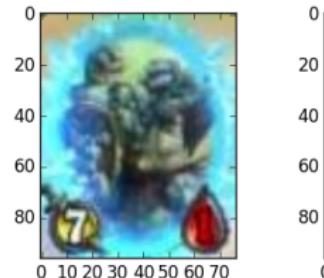
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MC Results (SIFT+FLANN, AffProp)

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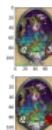
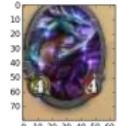
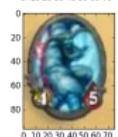
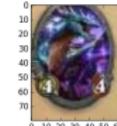
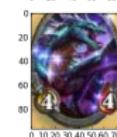
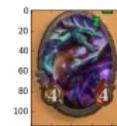
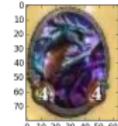
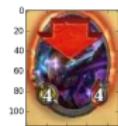
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Clusters identified by Affinity Propagation with SIFT+FLANN

MC Results (SIFT BoVW, AffProp)

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A cluster chosen using Affinity Propagation with a Bag of Visual Words build using SIFT descriptors.

Conclusion

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- Understanding video games requires many disparate methods
- Understanding video games on some level is feasible now

Future Work

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- Complete frame descriptor
- Work on modeling interaction
 - Learning to send input
 - Learning to play the game