Automated Feature Extraction for Object Recognition

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Outline

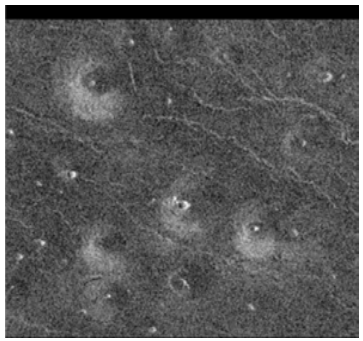
- Motivation
- System Overview
- Feature Extraction Problem
- Conclusion

MOTIVATION

Large volumes of image data

- Military
- Industrial
- Scientific
- Medical

Volcanoes on Venus



MRI image of a brain tumor

Aerial Plantation Image

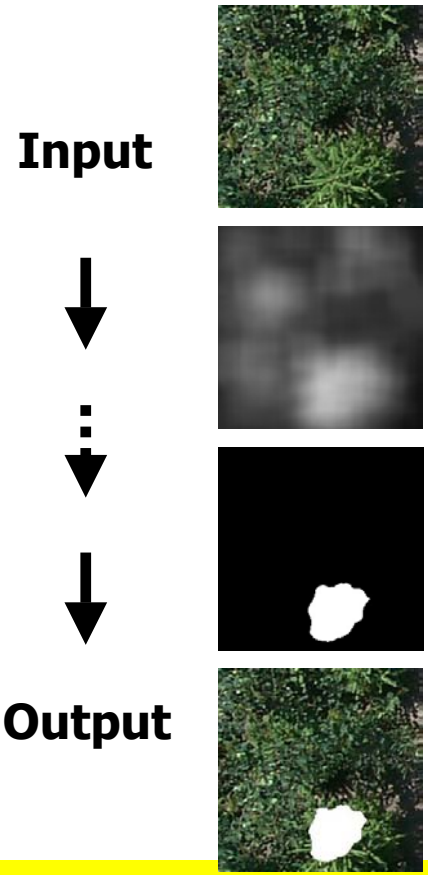
Current Approach

Domain Experts Analyze and Interpret Images

- costly
- error-prone
- tedious

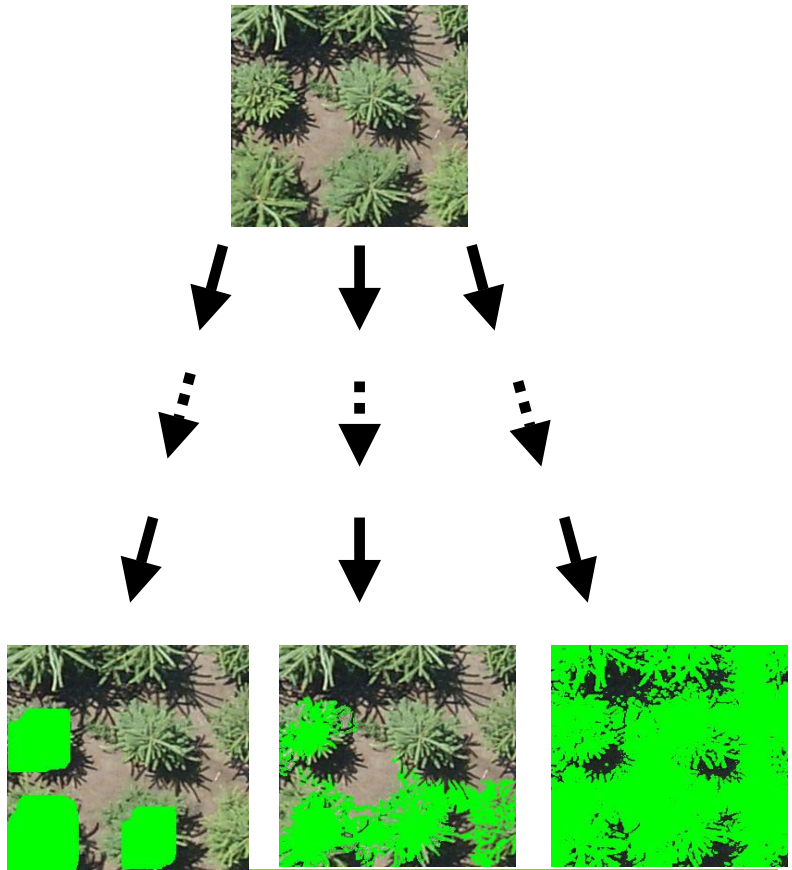
Automated Image Interpretation

Single sequence



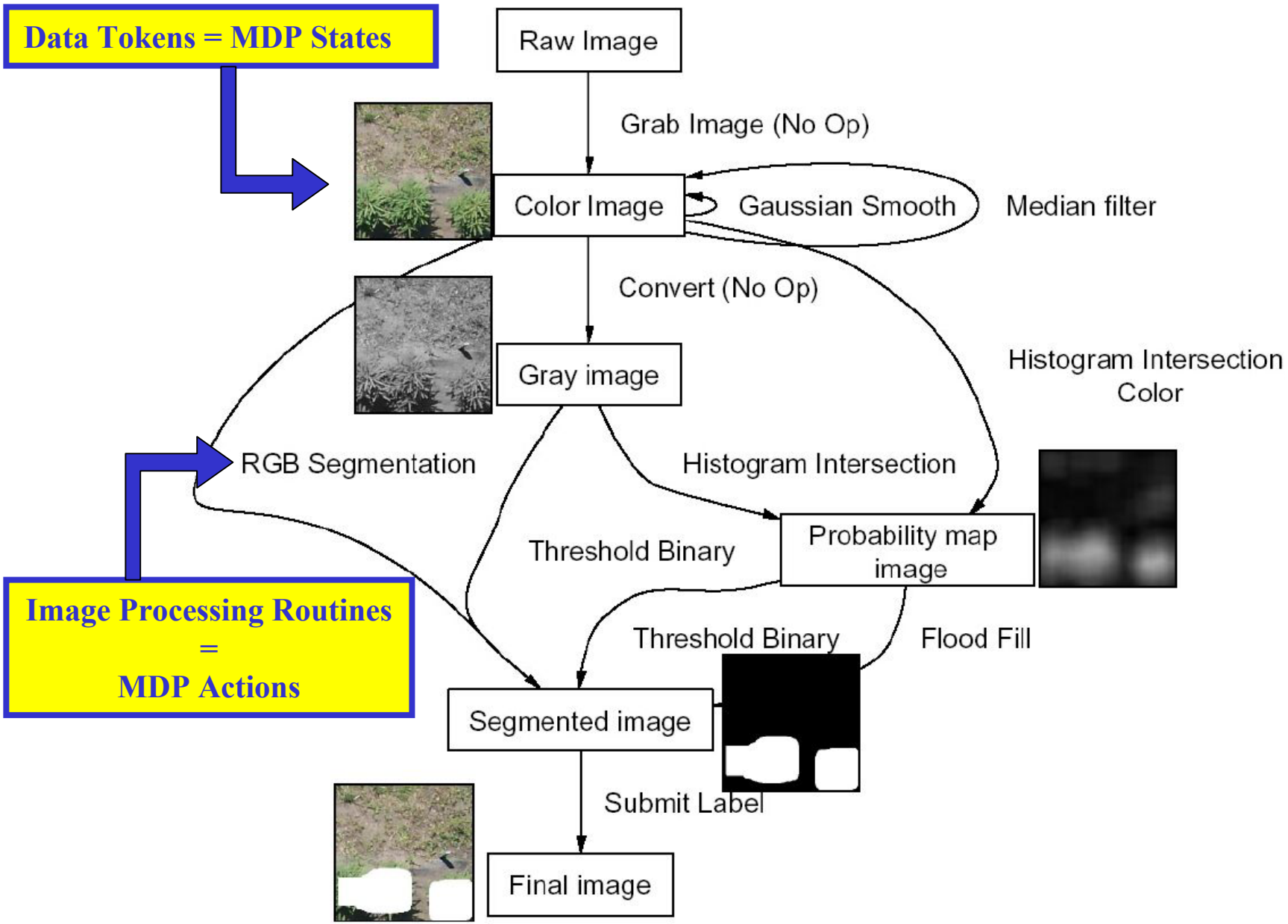
Static Sequence of Operators applied regardless of input image characteristics

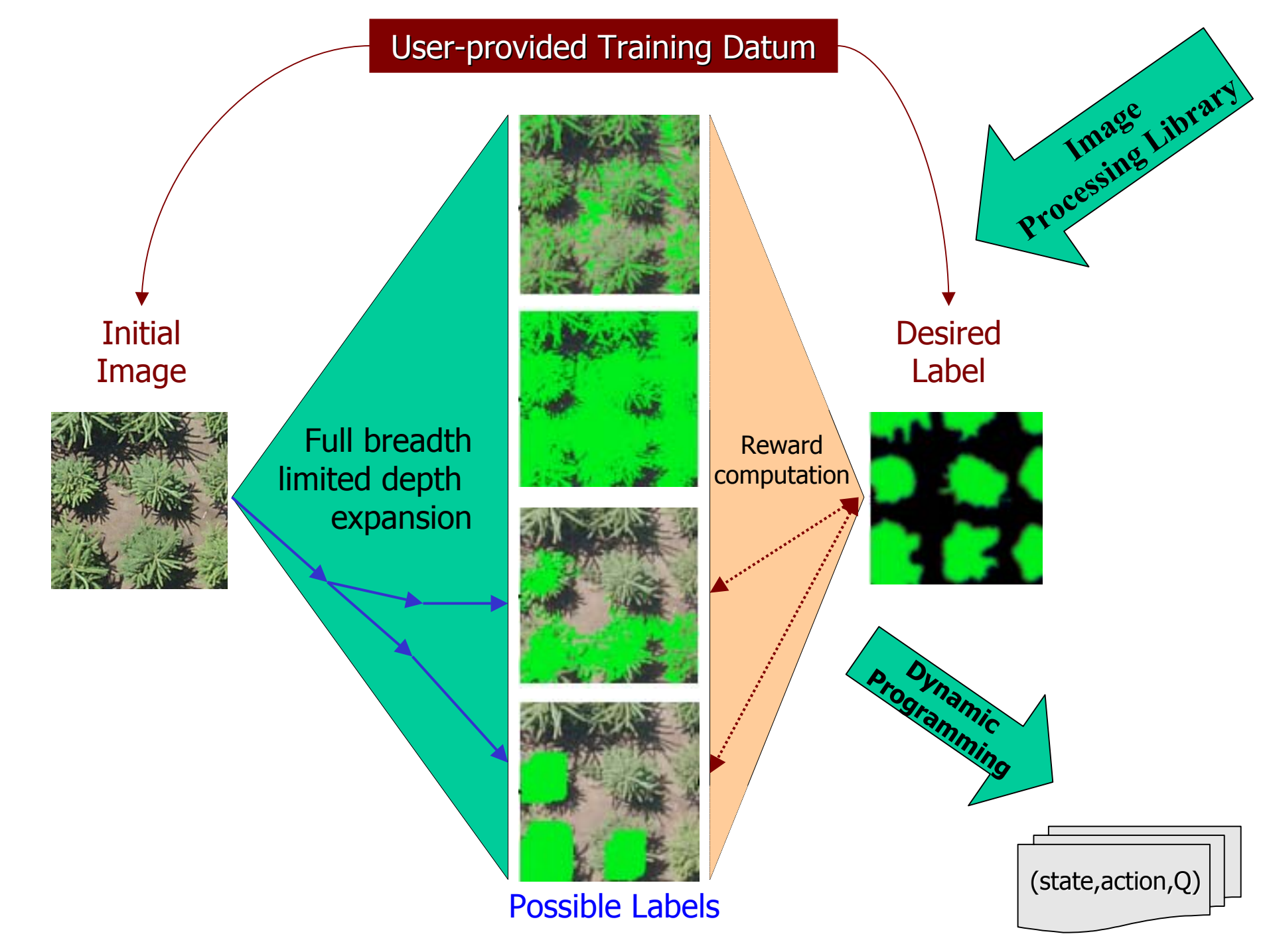
Multi-sequence



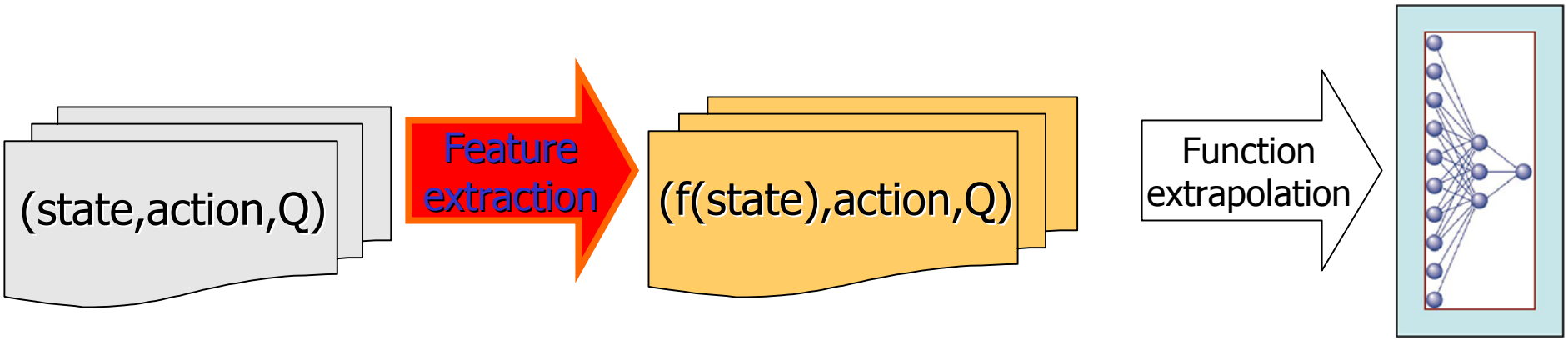
On-line Control Policy adaptively selects a sequence of operators

States, Actions and Processing Levels within ADORE




User-provided Training Datum
Image Processing Library
Initial Image
Desired Label
Full breadth limited depth expansion
Reward computation
Dynamic Programming
(state,action,Q)
Possible Labels

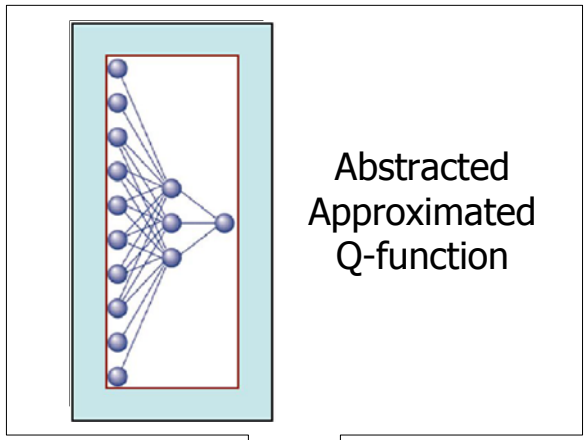
Machine Learning



Sampled Q-function

Abstracted Sampled Q-function

Abstracted Approximated Q-function

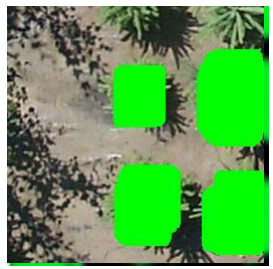


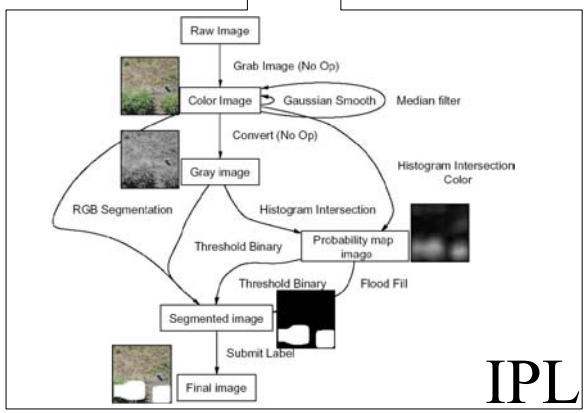
Abstracted
Approximated
Q-function

Novel
Input
Image

Control Policy

MR ADORE
Output
Label



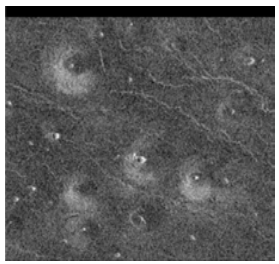


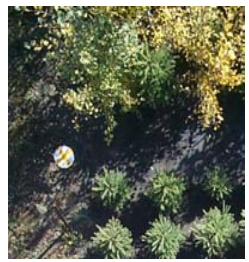
Problem

Automated Image Interpretation still requires manual feature selection

by domain and vision experts

- [Draper00]
- [Levner03a]





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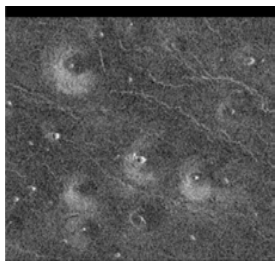
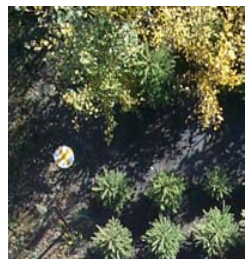




Solution

- Use dimensionality reduction techniques to compress raw data and in the process **extract relevant features**

Preliminary Experiments

Compare performance of on-line policies using:

No features.

- Classical approach using best single sequence regardless of data characteristics. (**Static)**

PCA coefficients as features

- together with 1-NN (various metrics)

Raw Pixels as features

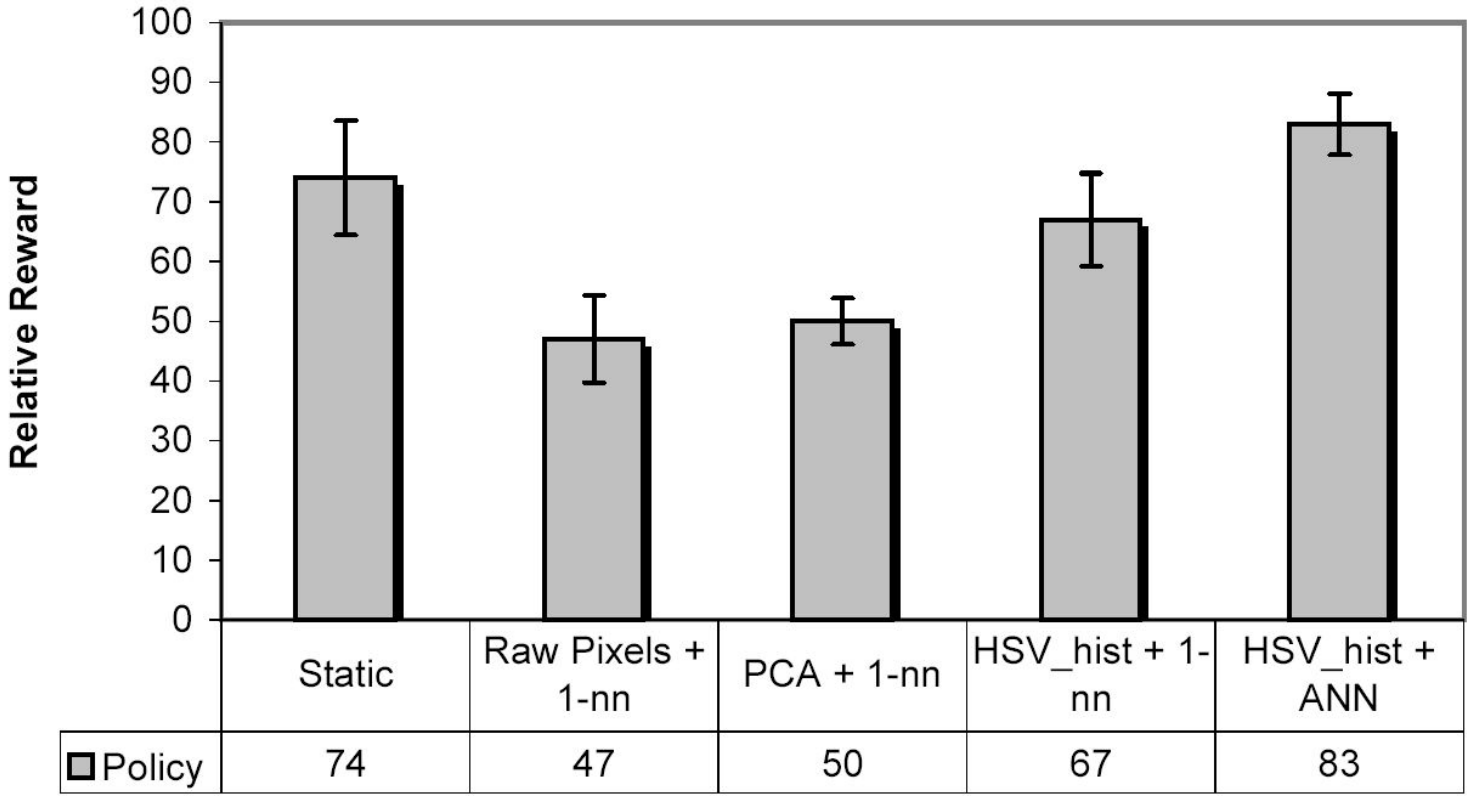
- together with 1-NN (various metrics)

Hand-Crafted features

- HSV color histograms as features showed best performance when used by artificial neural networks [Levner03a].

Results

Hand-Crafted methods still outperform automated approaches



FUTURE RESEARCH

- **Focus of Attention Processing**
  - smaller input image size
  - reduce image variance
- **Non-linear manifold learning methods**
  - -kPCA, pPCA
  - -MDS, LLE, Isomap
    - require knn + distance metric ?
- **Incremental PCA methods**
  - allow larger sample size
- Library of Feature Extractors

References

B. Draper, et al., **ADORE: Adaptive Object Recognition**.
Videre, 1(4):86–99, 2000.

I. Levner, et al., **Towards automated creation of image interpretation systems**.
In Proceedings of *Australian Joint Conference on Artificial Intelligence*, 2003.

I. Levner , et al., **Automated Feature Extraction for Object Recognition**,
In Proceedings of the *Image and Vision Computing New Zealand* conference, 2003.