Computer Vision to Aid in Wildlife Surveillance

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Overview

- The Problem
- Background
    - Computer Vision
    - Volunteer Computing
    - Machine Learning
- Methods
- Preliminary Results
- Conclusion
- Questions

The Problem

- How are humans impacting wildlife?
- Sensors are unreliable.
- Over 20,000 hours of avian video.
- Time consuming classification.

How can Computer Vision and Machine Learning help solve this classification problem?

T. Desell, R. Bergman, K. Goehner, R. Marsh, R. VanderClute, and S. Ellis-Felege, "Wildlife@ home: Combining crowd sourcing and vol- unteer computing to analyze avian nesting video," in *eScience (eScience), 2013 IEEE 9th International Conference on*. IEEE, 2013, pp. 107–115.

Background: Computer Vision

- Mimicking human vision with computers.
- Used to make a decision based on high level image or video contents.
    - Does the image contain a person?
    - Does it depict a horizon?

Reinhard Klette (2014). *Concise Computer Vision*. Springer. ISBN 978-1-4471-6320-6.

Background: Computer Vision

- Object Recognition
- Motion Tracking
- Scene Reconstruction

Background: Volunteer Computing

- Allows users to volunteer their computers to research projects.
- Distributes resource requirements.
- Allows hundreds of computers to each complete a portion of the project.

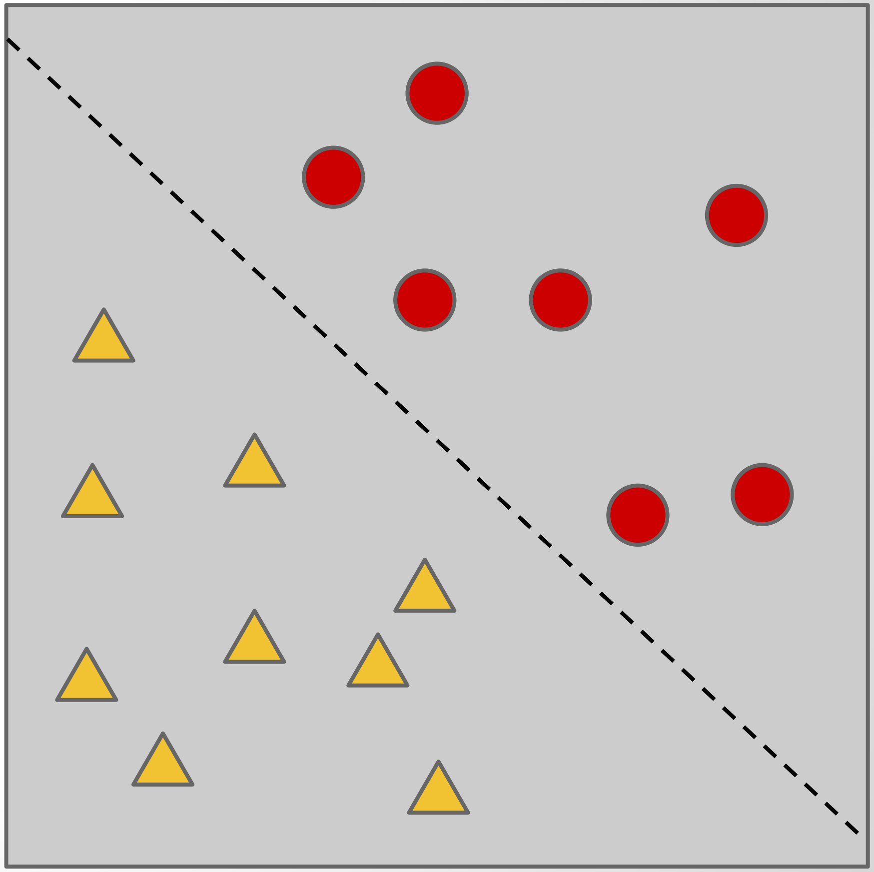
Background: Machine Learning

- Artificial Intelligence Technique.
- Used for large data processing.
- Used for data classification and pattern recognition.
  - Spam filters
  - Price prediction
  - News feed filters

Christopher M. Bishop (2006) *Pattern Recognition and Machine Learning*, Springer ISBN 0-387-31073-8.

Background: Machine Learning

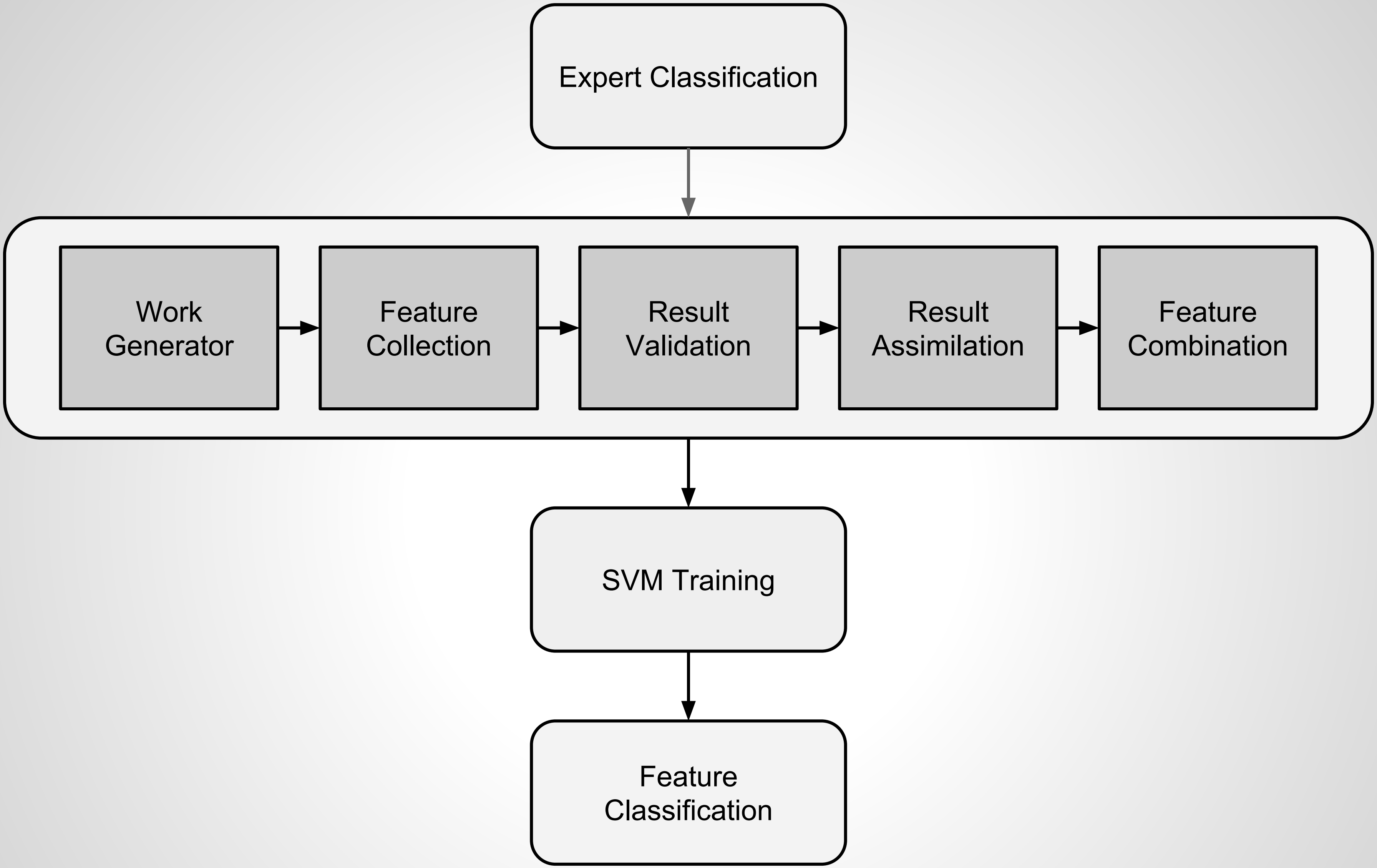
- Support Vector Machine (SVM)
  - Used to find maximum boundary between two sets of data.
  - Can be used with multidimensional data.



Cristianini, Nello; and Shawe-Taylor, John; *An Introduction to Support Vector Machines and other kernel-based learning methods*, Cambridge University Press, 2000. ISBN 0-521-78019-5

Methods

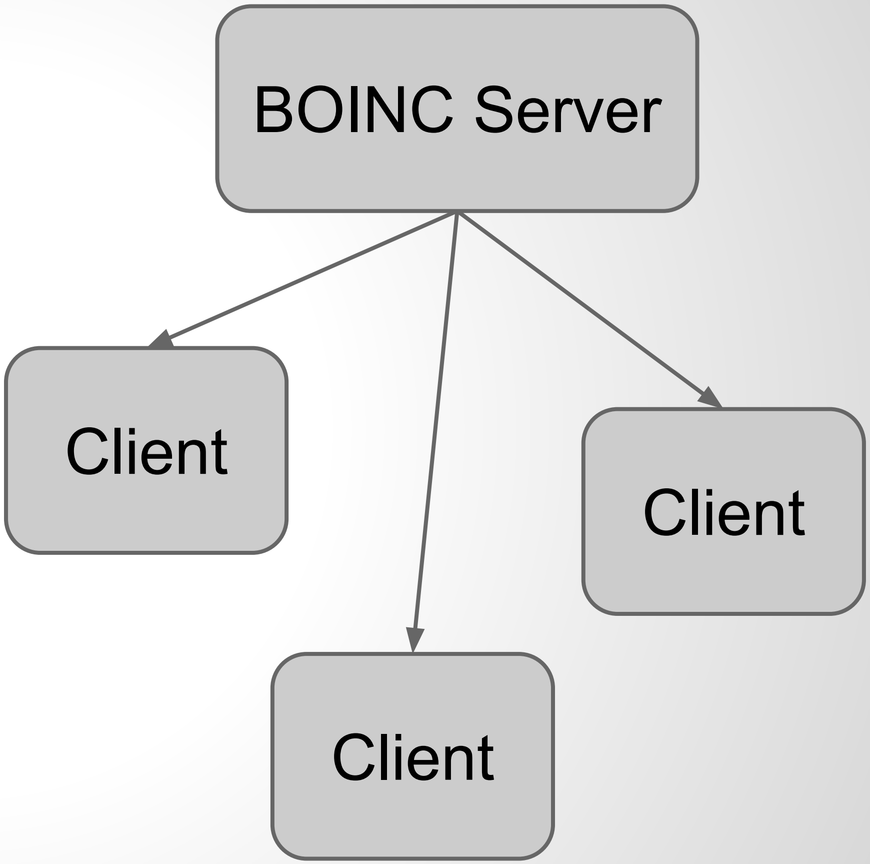
- Use expert classified videos to identify training events.
- Collect features from each frame and label them.
- Use collected features to train SVM.
- Use SVM to classify features from another expert classified video.
- Measure error and re-train the SVM.



Wildlife@Home Workflow

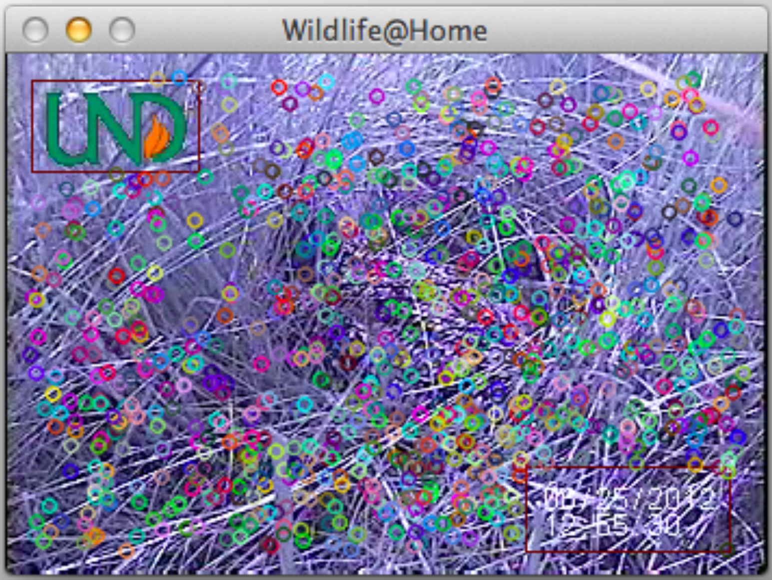
Methods

- Using BOINC for Volunteer Computing.
- Each volunteer collects features from a video file.



Methods

- Feature Detection.
  - SURF
- Redundancy Detection.
  - Euclidian distance in 64 dimensions.
  - Use standard deviation to calculate outliers.



Sharp-Tailed Grouse Example

Methods

- BOINC Results are combined from single video results into event groups for SVM classification.
  - Both a training set and a testing set.
  - We used Leave-One-Out cross validation.

Methods

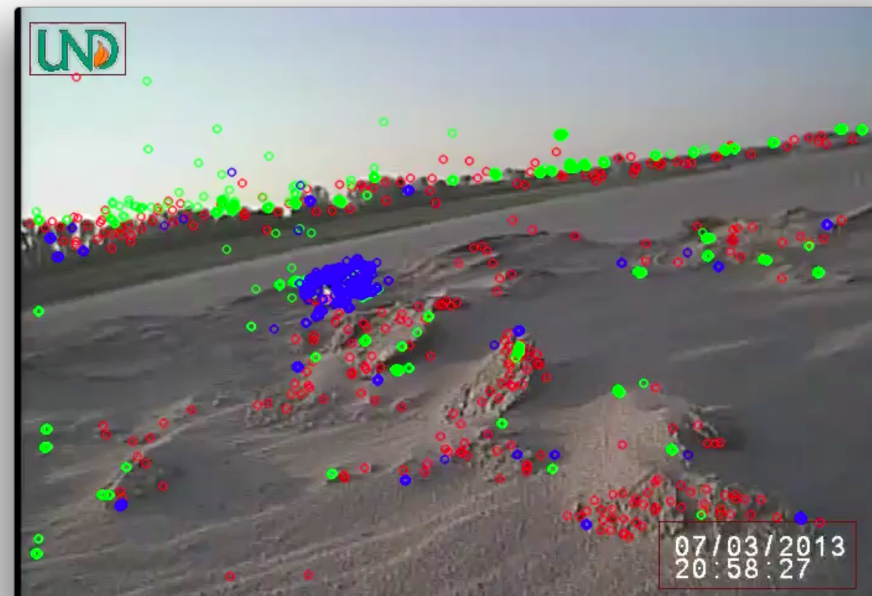
- The SVM is then trained.
  - Using a Gaussian Kernel.
  - Gamma was set between 0.5 and 10.0.
  - Cost modifier was set between 0.1 and 50.0.
  - Class weights were also adjust between 0.1 and 50.0 for each class.

Methods

- Tested against both the training set and testing set.
  - Reporting both training error and testing error.
- The best results were then used to predict whether or not new features are associated with the target event.

Preliminary Results

Beginning of Test Video



End of Test Video

Training Points

SVM Classified Positive

SVM Classified Negative

Preliminary Results

- Training features are accurate with a high concentration on training target.
- Detection Rate with SVM is not yet satisfactory.
    - Cause is likely due to underfitting of the training data in this case. Other results show signs of overfitting in which the majority of points are reported positive by the SVM.

Future Work

- Improve the SVM training data with a grid search or evolutionary algorithm.
- Test N-Fold cross validation against Leave-One-Out for SVM training.
- Utilize UND supercomputer for faster SVM training.
- Compare SVM results with a Neural Network approach.

References

- T. Desell, R. Bergman, K. Goehner, R. Marsh, R. VanderClute, and S. Ellis-Felege, “Wildlife@ home: Combining crowd sourcing and vol- unteer computing to analyze avian nesting video,” in *eScience (eScience), 2013 IEEE 9th International Conference on*. IEEE, 2013, pp. 107–115.
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- Cristianini, Nello; and Shawe-Taylor, John; *An Introduction to Support Vector Machines and other kernel-based learning methods*, Cambridge University Press, 2000. ISBN 0-521-78019-5

Questions?

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