Image Blob Detection: A Machine Learning Approach

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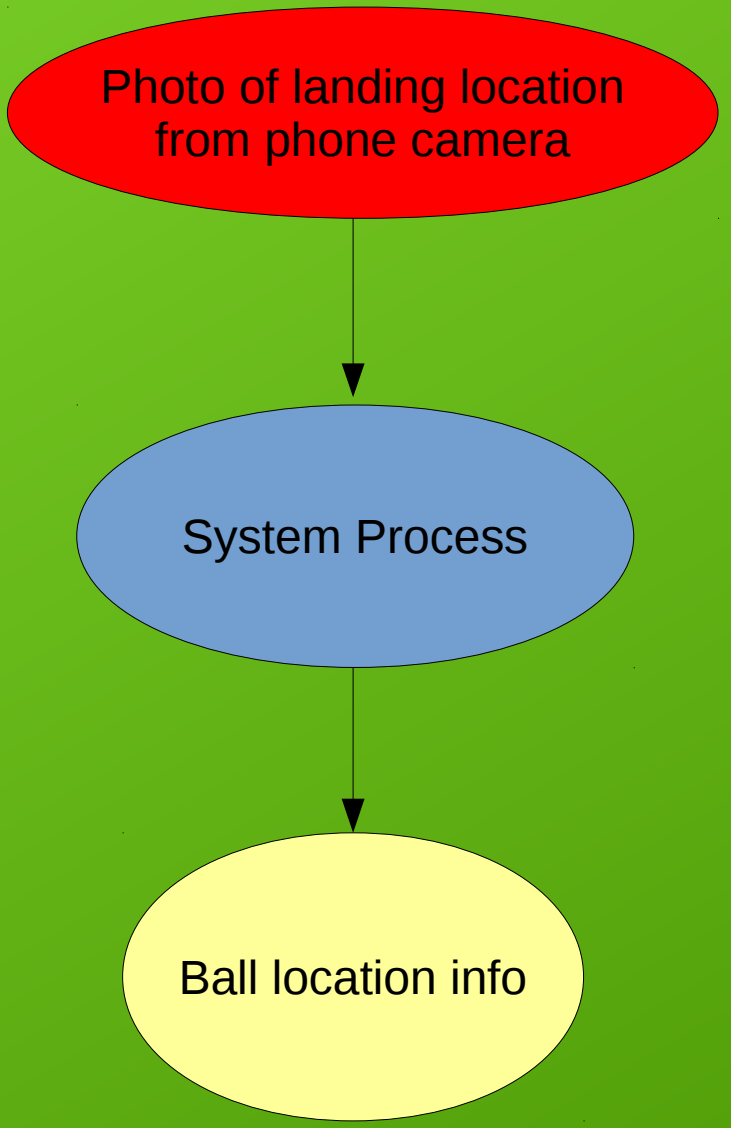
Background: Golf Ball Problem

- Finding bright white ball on a normal day is a hassle.
- Lost golf balls account for $60 million each year.
- Smartphones contain software and hardware that can solve this problem.



Background: Alternative Solutions

- GPS tracking
  - The RadarGolf System
- Special coating
  - The Ballfinder Scout
- Fixed cameras
  - SwingShot Golf

    Video Cameras

Background: Related Research

Self-Driving Cars

- Image processed based on pixel values
- Output of first process is input for classification learning model

Blob Detection

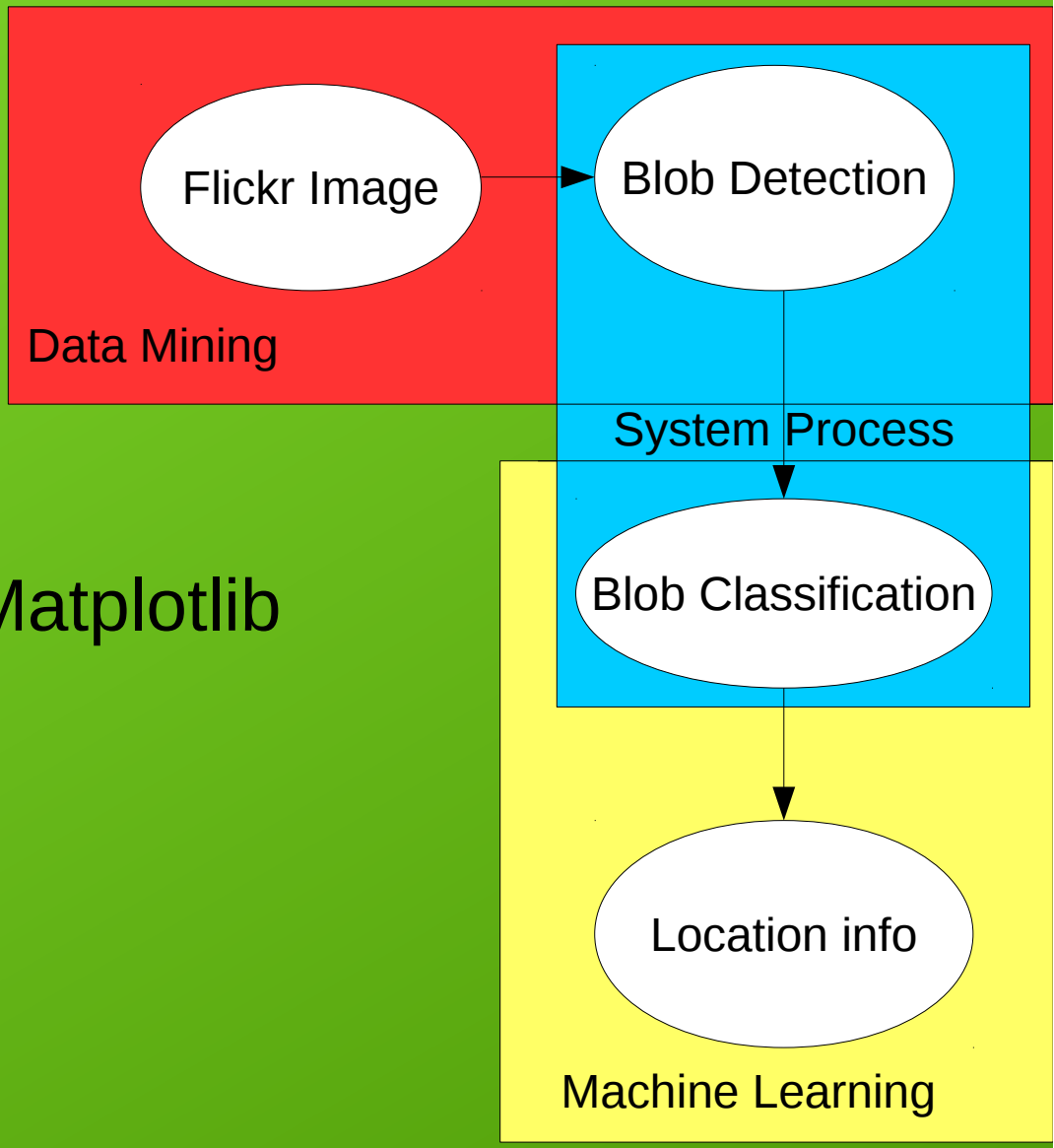
- Picture analyzed for local maxima
  - Several types of averages taken

Research Evolution

- Initial: R and ImageJ
  - Issues with R: ease of use, portability, ecosystem
  - Issues with ImageJ: API limitations
- Making the switch to Python
    - Automatic training set generation
    - Image: automatically drawing circles with PIL
- Machine Learning Process
  - Neural networks
  - Scikit-learn
- Blob detection refinement
  - Tweaking settings for coherent blobs
  - Experimentation with different blob detection algorithms

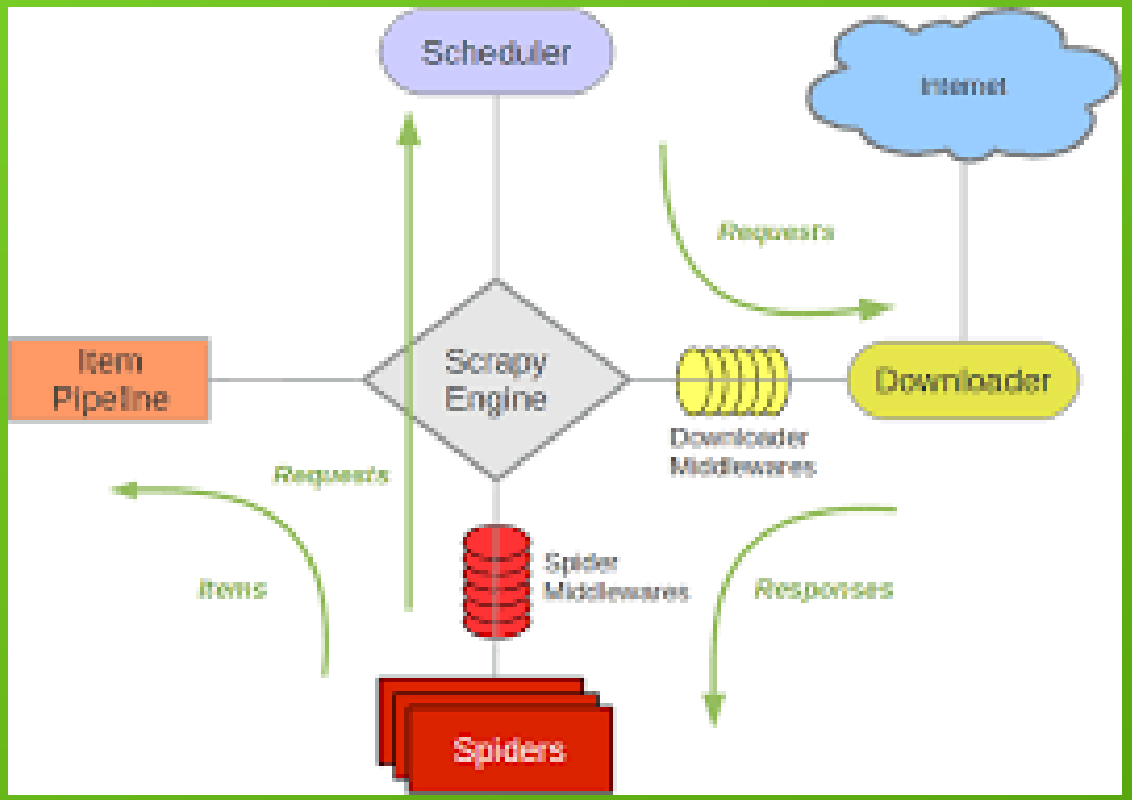
System Process

- Data Mining
  - Flickr, ImageJ
  - Python: Scrapy, PIL
- Blob Detection
  - Python: Scikit-Image, Matplotlib
- Blob Classification
  - Java: weka



Data Mining

- Scrapy
  - Dataflow:
    - Items
    - Spiders
    - Pipelines
  - Spider:
    - FlickrAPI
    - PIL
  - Pipeline:
    - ARFF format

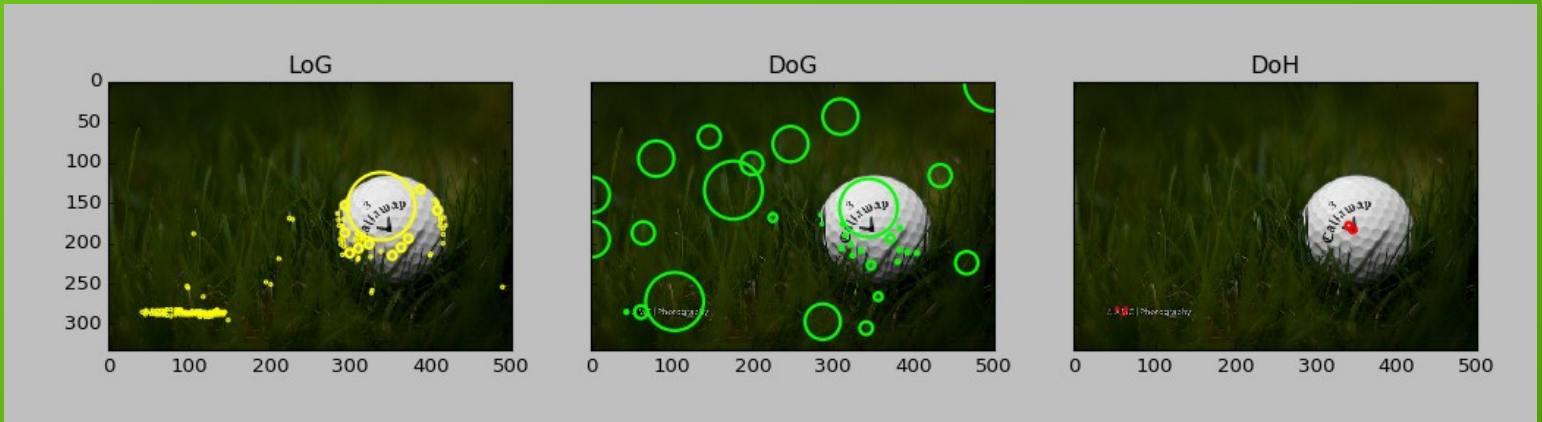


Blob Detection I

- Goal: Find 'blobs' of like pixels based on:
  - Contiguousness
  - Contrast
  - Statistics
- Input: Array of pixels
- Output: several (y, x, radius) coordinates

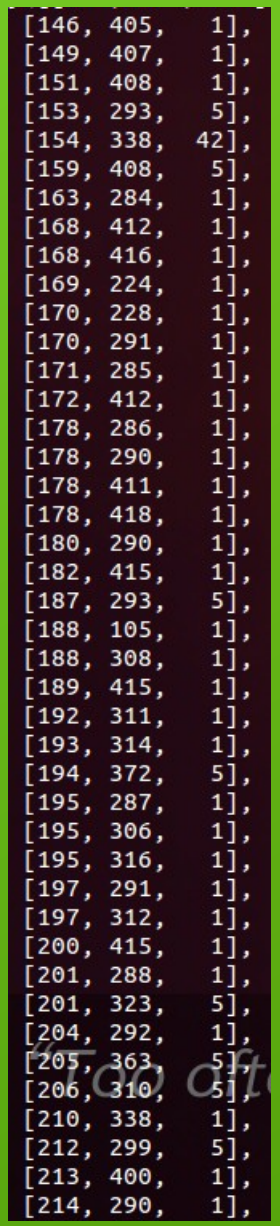
Blob Detection II

- Types of Blob Detection
  - Laplacian of Gaussian
    - blob_log(image_gray, min_sigma=15, max_sigma=50, num_sigma=10, threshold=.1, overlap=0.8)
  - Determinant of Gaussian
  - Determinant of Hessian
- Tools used:
  - Python
    - Numpy
    - Scikit-Image
    - Matplotlib



Data I

- Training data
  - ImageJ
- Flickr data
  - Query
  - Sort conditions



Data II

- Attributes
  - Class
  - X-center
  - Y-center
  - Mean-px
  - Median-px
  - Mode-px
  - Radius
  - Radius-height-pct
  - Radius-width-pct

Classification I

- Broad definition: Use statistics to find patterns in data
  - Classification, Association, Clustering
  - Supervised vs Unsupervised
- Classification: Put various instances into distinct types, or 'classes'
  - Types of classification algorithms
    - Tree based
    - Naive Bayes
    - Neural Network

Classification II

- Weka
  - Inputs
  - Outputs
- Types of algorithms used
  - Cross validation(10x)
  - Top performer: Random Forest
  - Bottom performer: Naive Bayes

Results I


100
90
80
70
60
50
40
30
20
10
0
Zero-R
One-R
JRip
J48
IBk
Naive Bayes
Random Forest
Percent Correct

Results II

Random Forest

```
=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances         138               90.1961 %
Incorrectly Classified Instances        15                9.8039 %
Kappa statistic                          0.7807
Mean absolute error                      0.1349
Root mean squared error                  0.2527
Relative absolute error                 29.4901 %
Root relative squared error             52.8691 %
Total Number of Instances              153
Ignored Class Unknown Instances                 61
```

Naive Bayes

```
Correctly Classified Instances         131               85.6209 %
Incorrectly Classified Instances        22               14.3791 %
Kappa statistic                          0.6742
Mean absolute error                      0.1431
Root mean squared error                  0.344
Relative absolute error                 31.281  %
Root relative squared error             71.9723 %
Total Number of Instances              153
Ignored Class Unknown Instances                 61
```

Next Steps

- Expand training set
- Create cloud-based I/O platform
- Write mobile app that interfaces with cloud

Questions?