

# SEMANTIC VISION

TEAM AMERICA

UNITED STATES NAVAL ACADEMY

Midshipmen: MIDN 1 /C Kinkade

MIDN 1 /C Felps

MIDN 1 /C Fick

Advisors: Assoc. Professor Piepmeier

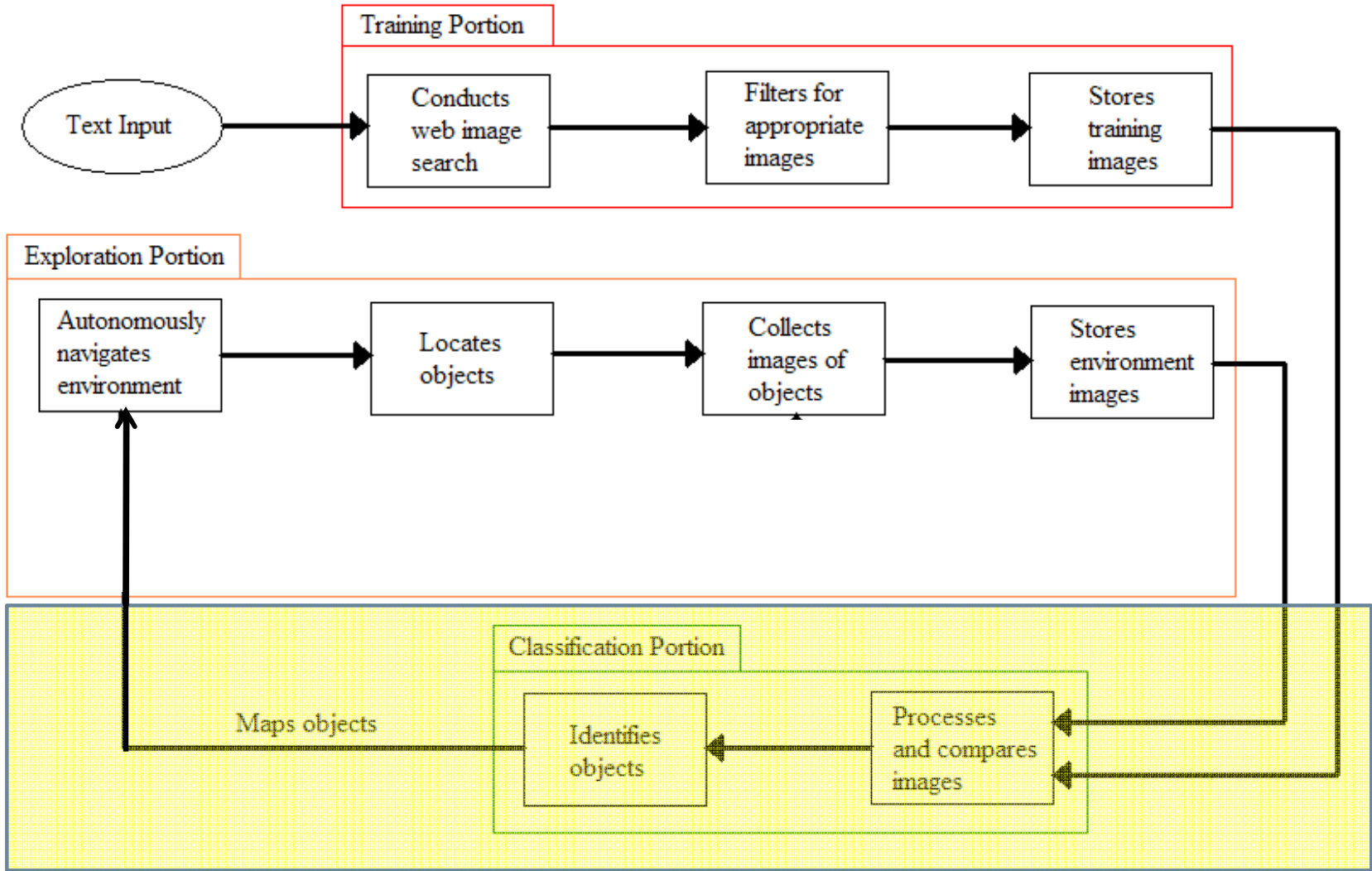
LT Searock, USN

# Semantic Vision



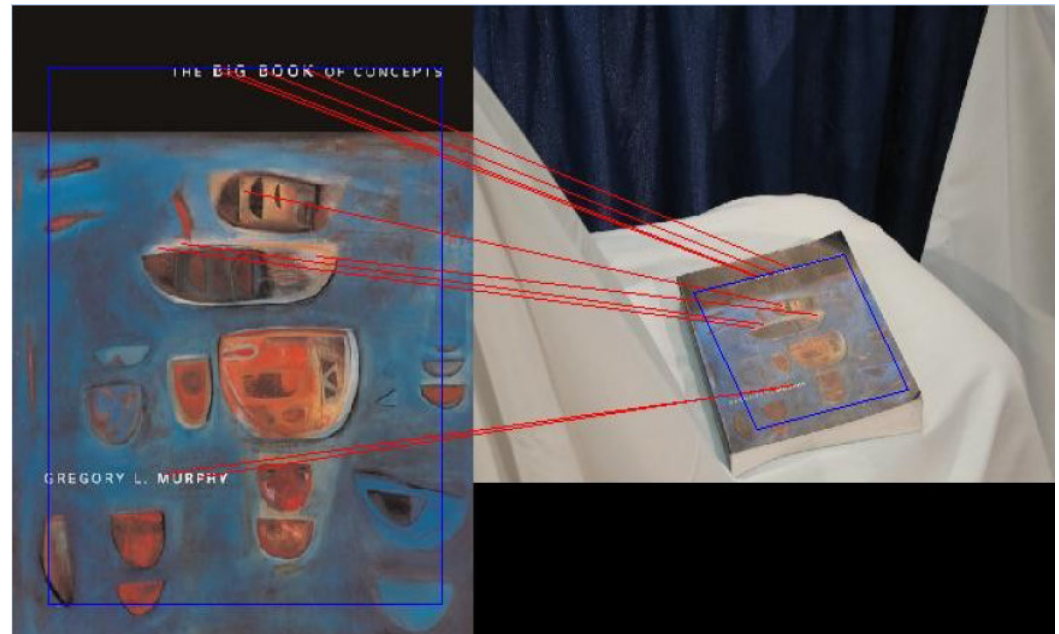
- The implementation of matching images from a training set to objects within a 3-dimensional setting.
- 3 Part Process
  - ▣ 1. Gathering Of Information
  - ▣ 2. Filtering of Information
  - ▣ 3. Detecting Object

# Functional Block Diagram



# Object Recognition - SIFT

- An algorithm to detect and describe local features in images
  - ▣ Finds key points
- Solves problem of object scale and rotation
- Key points of two images can be compared



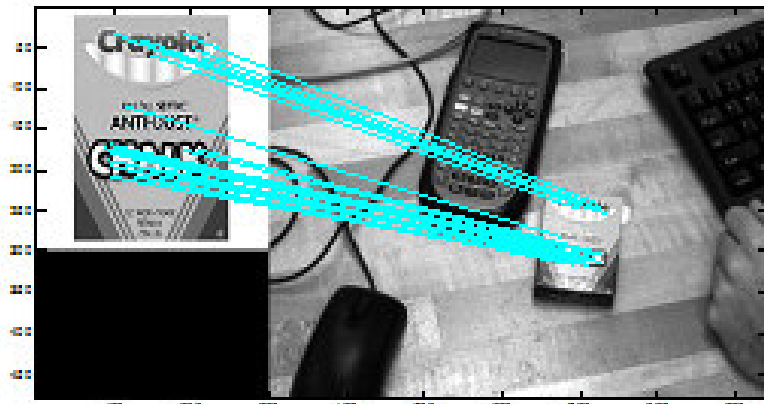


Figure 1. Initial Sift

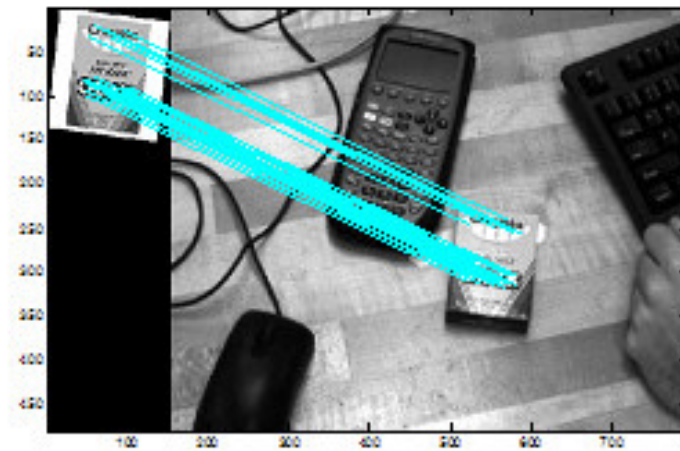


Figure 2. Transformation

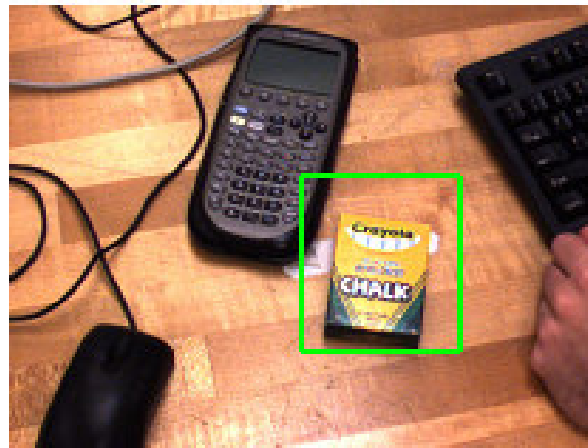
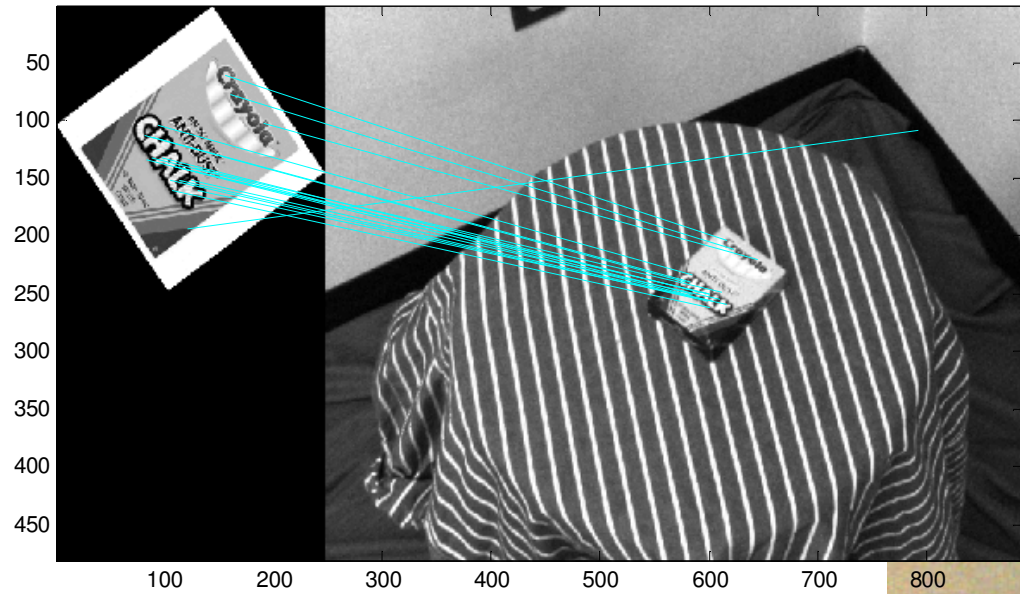


Figure 3. Object Identification

# Elimination of Bad Matches



# Testing Results

## Results Summary:

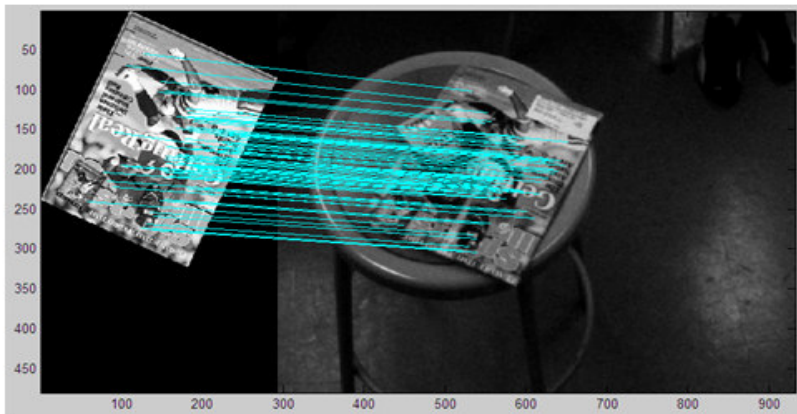
Total Objects in environment – 8

Objects captured – 5; 62.5%

Objects recognized – 3; 37.5%

Objects with good bounding box – 2; 25%

Recognized Sports Illustrated; good box



**Recognized Chalk: Poor box**



**Recognized Popcorn: Good box**



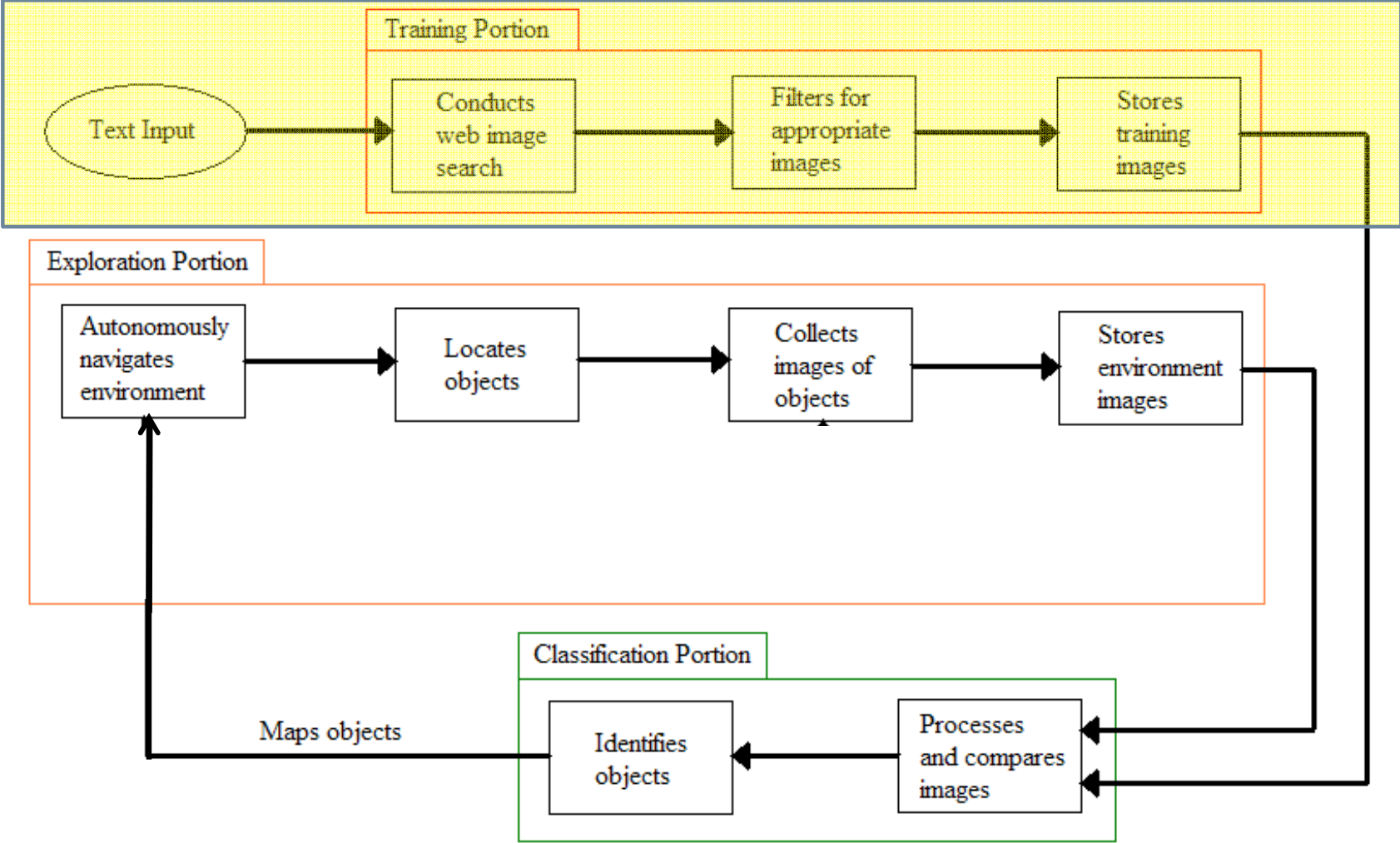
**Recognition strengths:**

- Recognizes detailed objects very well
- Object scale and orientation are a non-issue

**Recognition weaknesses:**

- Difficulties with generic objects with little detail
- Extremely busy environment images can affect bounding box accuracy

# Functional Block Diagram



# Filtering: Semantic/Visual Coherence



Image A.) Peach

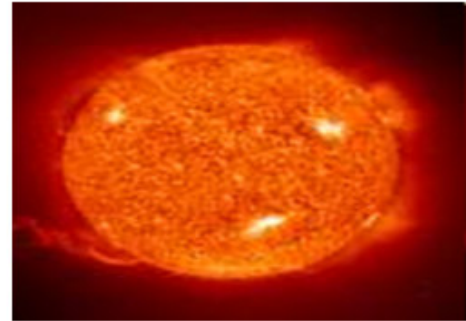


Image B.) Sun



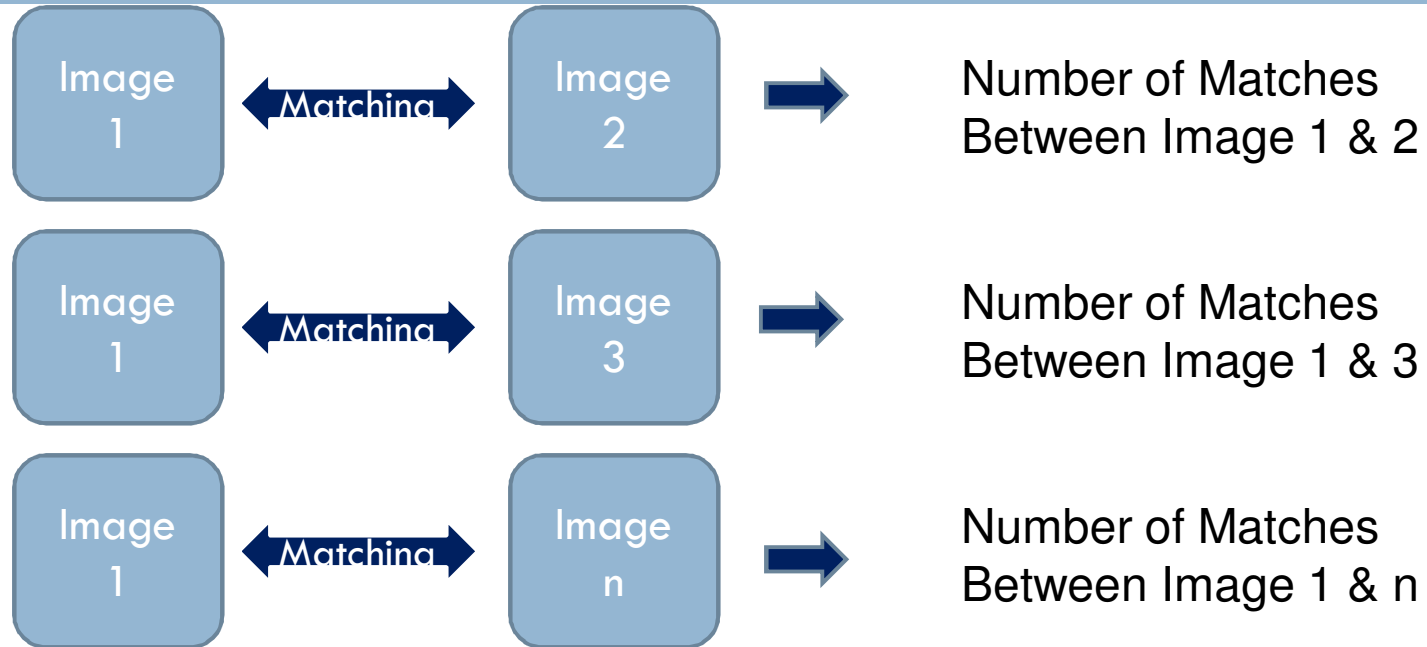
Image C.) Peach



Image D.) Peach

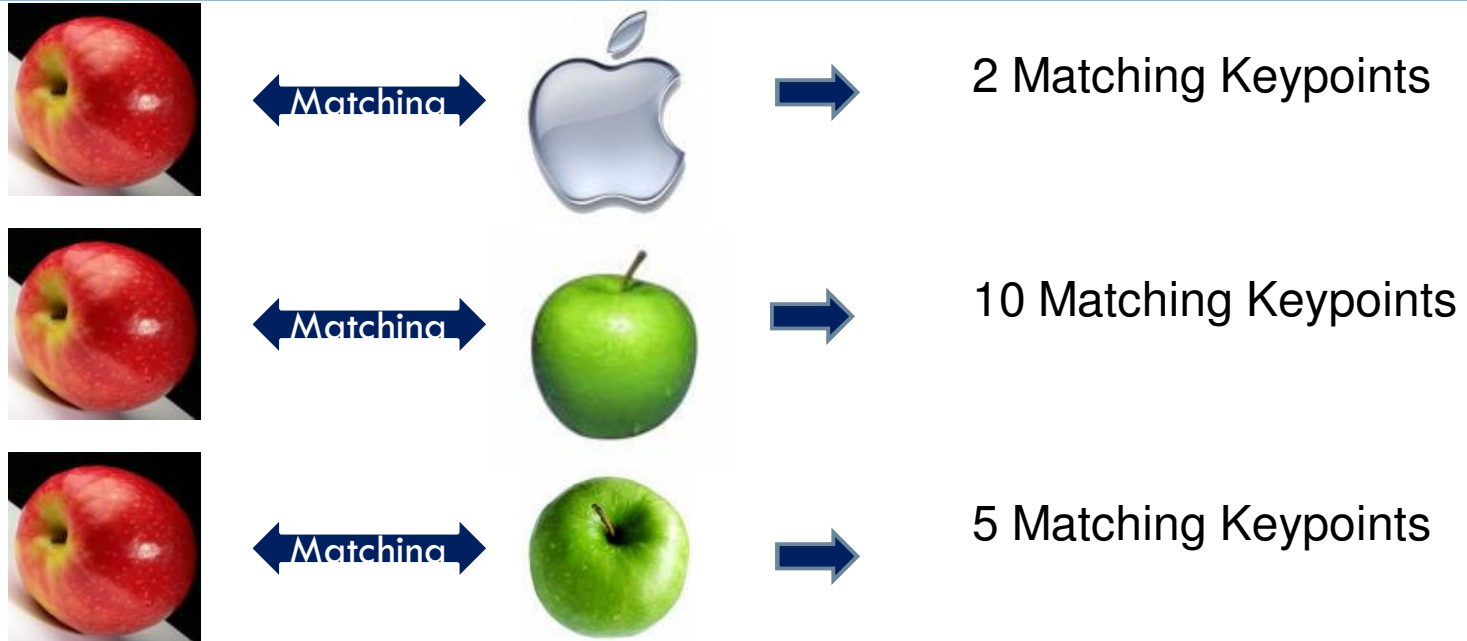
Fig. 1: Semantic VS Visual Coherence. From: T. Mei, Y. Wang, X. Hua, S. Gong, and S. Li, "Coherent Image Annotation by Learning Semantic Distance," *IEEE Computer Vision and Pattern Recognition, CVPR 2008*.

# Filtering Algorithm



- Average Number of Matches for Each Image
- Create Array of Images Based on Average Number of Matches

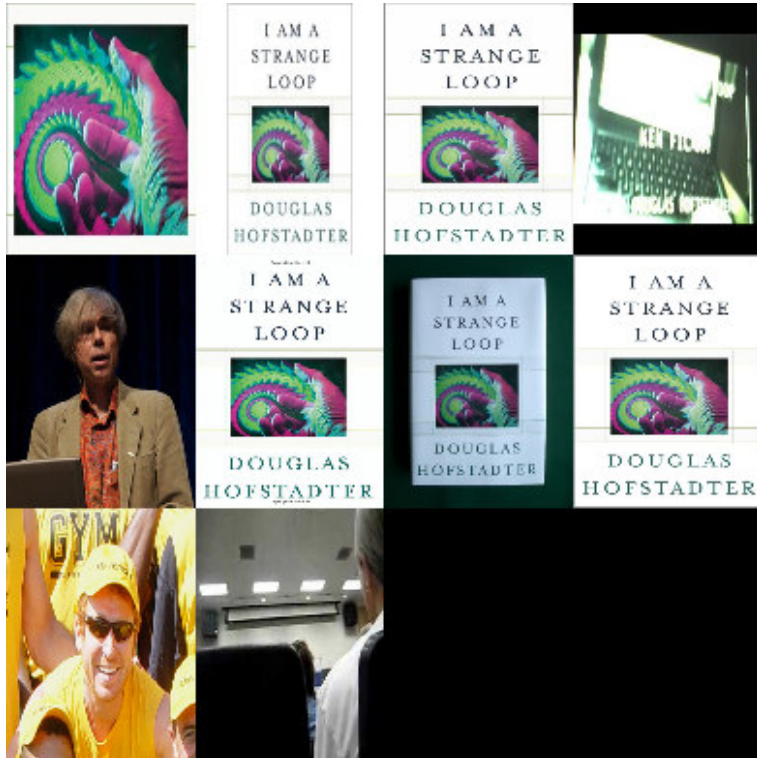
# Filtering Algorithm Example:



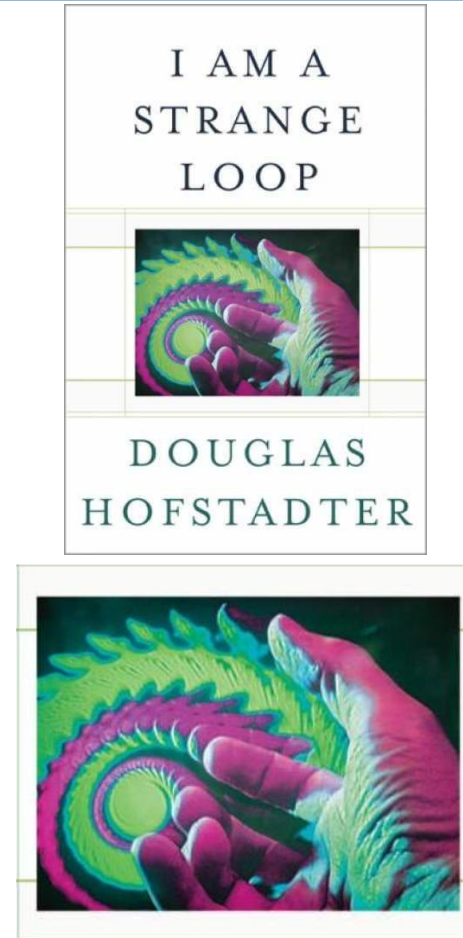
--Total Number of Matches: 17 Matches

--Average Number of Matches: 4.25

# Filtering Results: “I Am A Strange Loop”



Downloaded Images of Book



Filtered Images of Book

# Filtering Results: Downloaded Data



- Attempted 10 images / object:
  - Number Of Images Downloaded- 141
  - Number Of Good Images Downloaded- 108
  - Number Of Bad Images- 33
- Total Time ~ 50 minutes

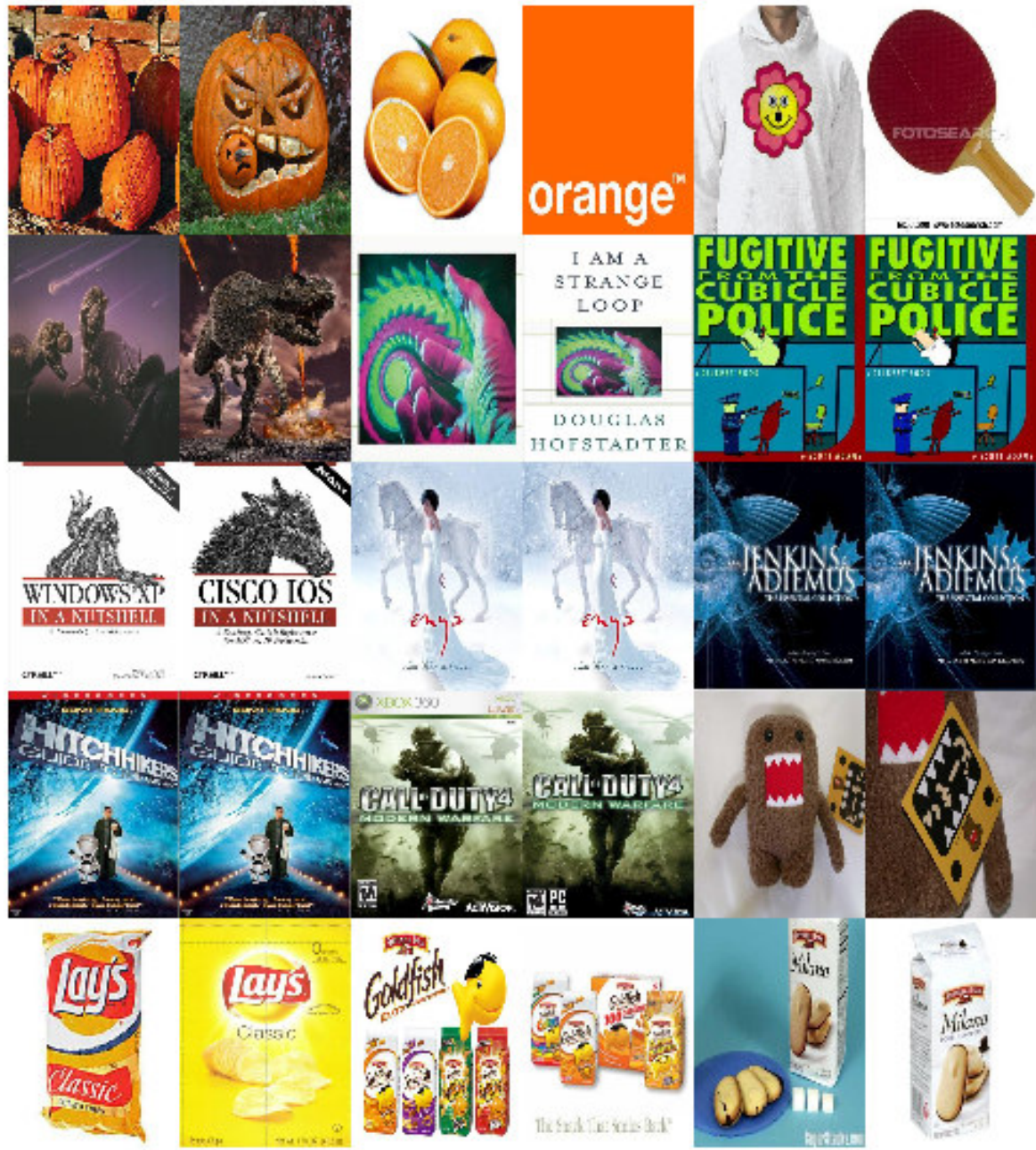


# Filtering Results: Filtered Data

- Number Of Outliers Removed - 30
- Number Of Outliers Not Removed – 3
- Returned 2 Images / Object
  - ▣ Filtered Out at Least 1 Good Image / Object
  - ▣ Filtered 2 Good Images for Each Object but 3



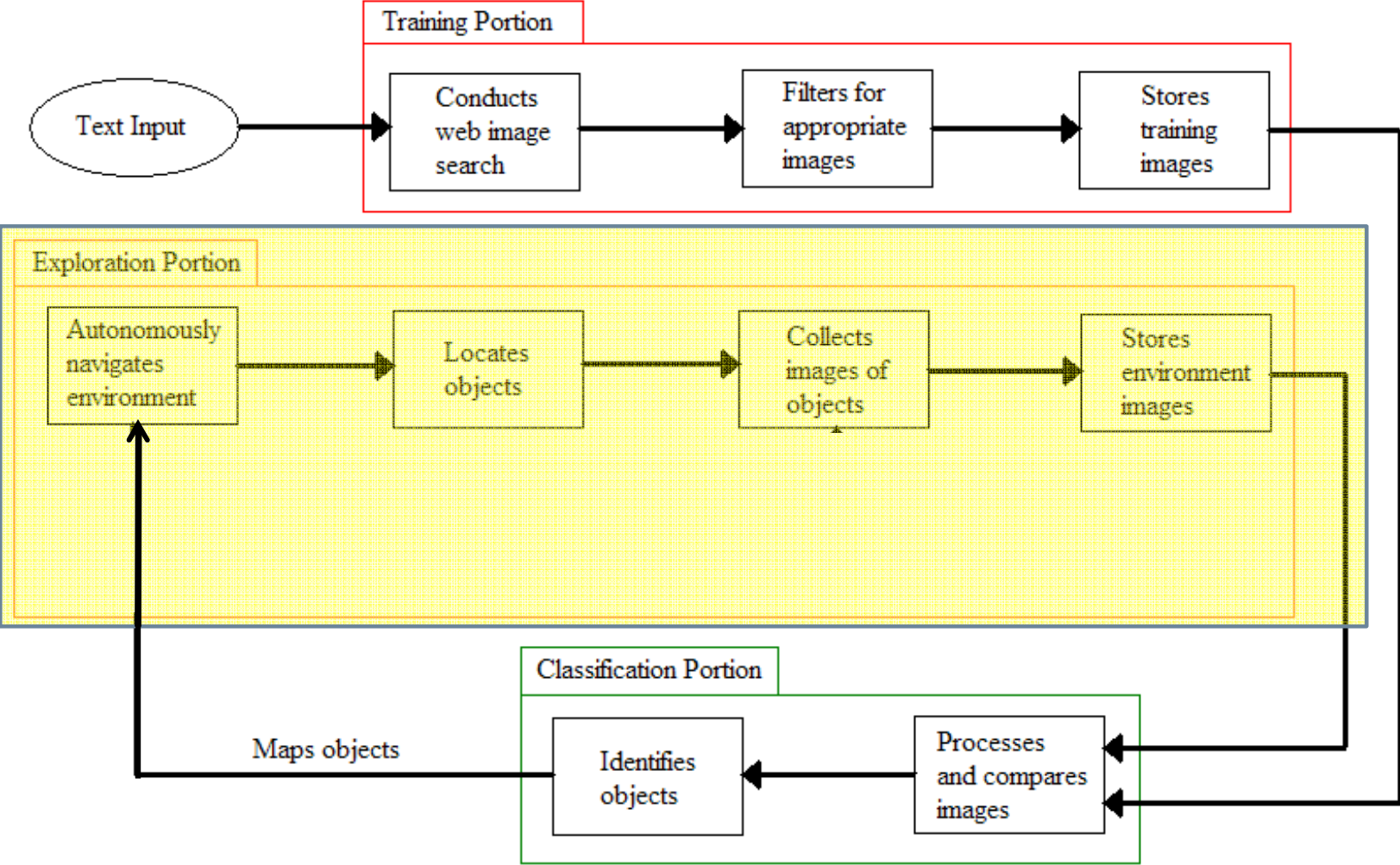
Red Ping Pong Paddle?



# Equipment Choices

- Platform:
  - iRobot Create: Small, robust, code available
- Sensors:
  - Hokuyo URG Laser Range Finder
  - USB CCD Color Camera (640 x 480 pixel)
  - Futaba S3004 Servo motor
- Computers:
  - NCS laptop with Windows XP Pro
  - Acer Aspire 1 Netbook with Windows XP Pro
- Environment:
  - MATLAB 2008
- Total Cost: less than \$4500.

# Functional Block Diagram

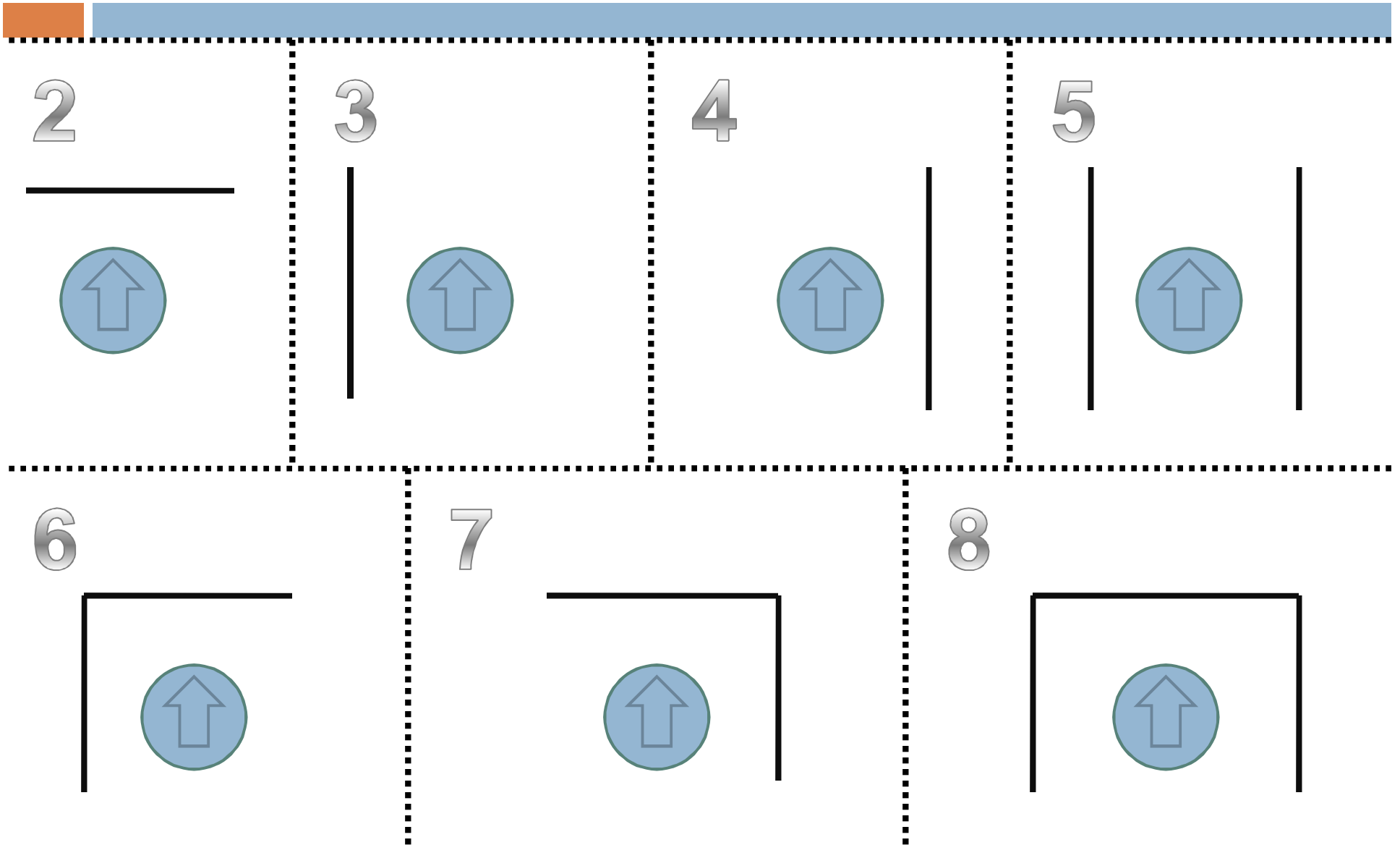


# Navigation and Control

- Finite state machine using nine possible states.
- Reactive navigation architecture.
- Randomization = a little bit of luck



# Finite State Machine



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