A cognitive perspective on aerial image interpretation

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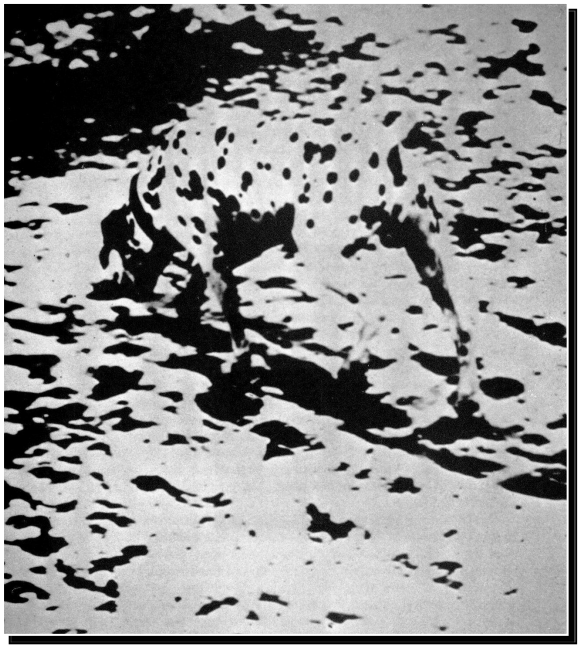
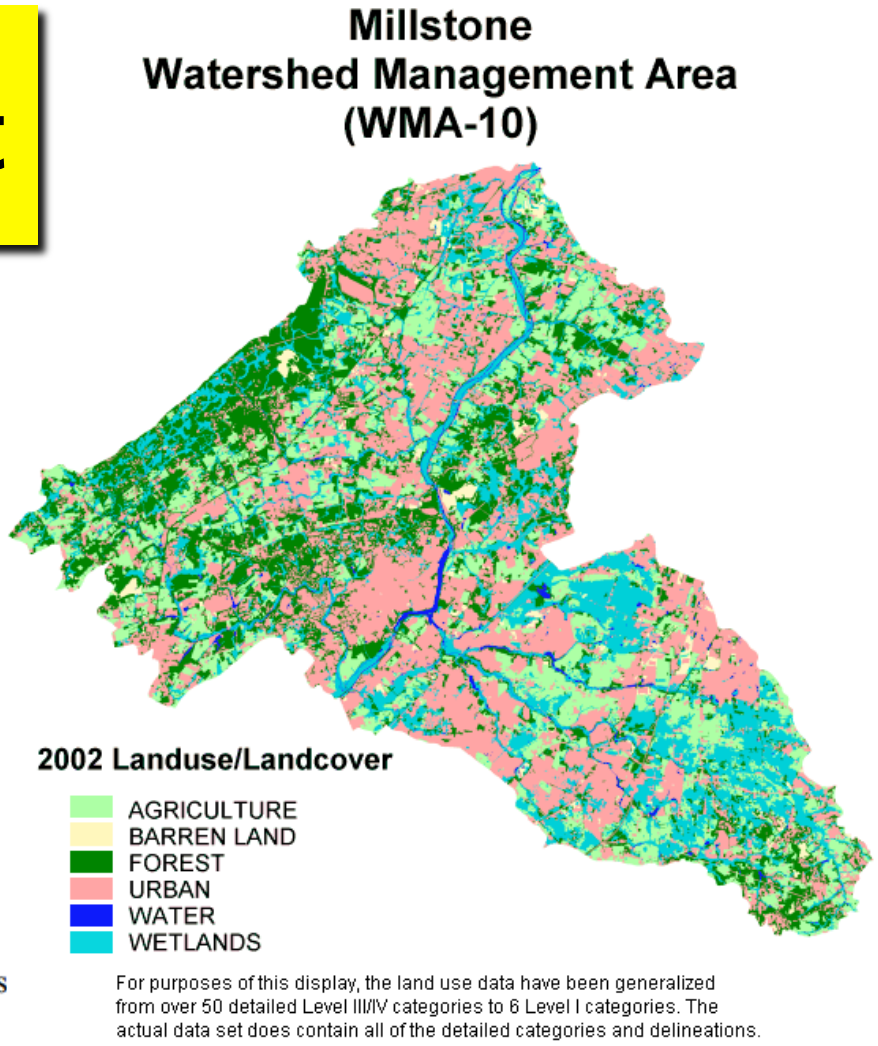


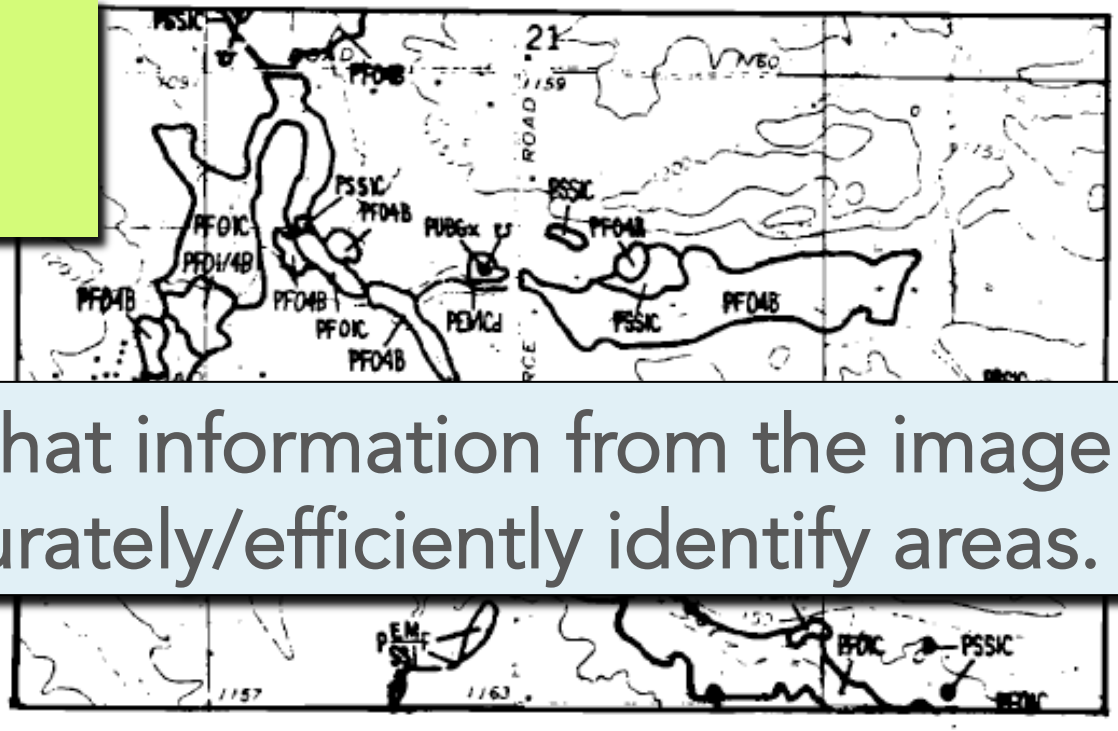
Motivations /context

USGS Land Use/Cover Classification System



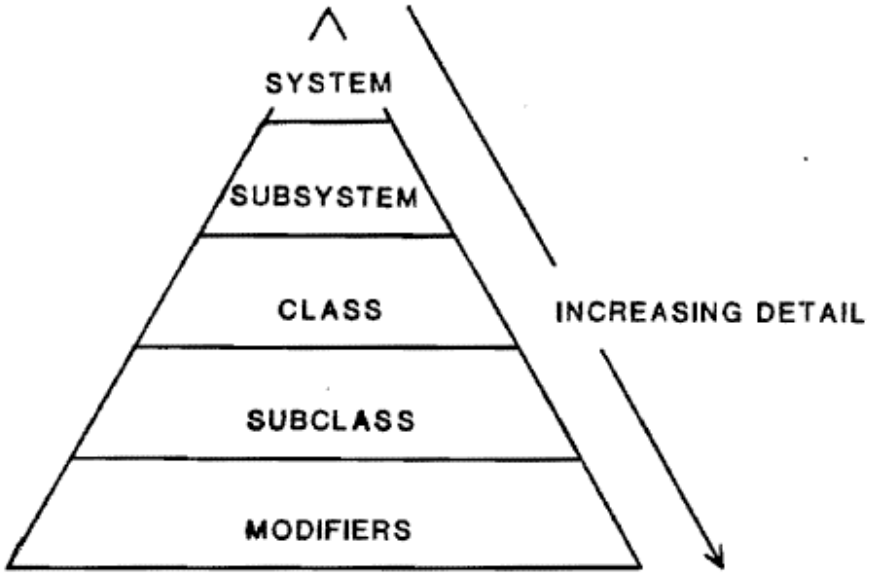
Level I	Level II
1 Urban or Built-up Land	11 Residential
	12 Commercial and Services
	13 Industrial
	14 Transportation, Communications, and Utilities
	15 Industrial and Commercial Complexes
	16 Mixed Urban or Built-up Land
	17 Other Urban or Built-up Land
2 Agricultural Land	21 Cropland and Pasture
	22 Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas

National Wetlands Inventory (NWI)



We want to know what information from the image is necessary to accurately/efficiently identify areas.

NWI MAP CODES
AND
THE WETLAND CLASSIFICATION SYSTEM*



Sample Research Questions

Cognitive Process

Classical Remote Sensing Interpretation Key

A manufacturing facility may contain raw materials, storage of finished products, shipping lines, etc.

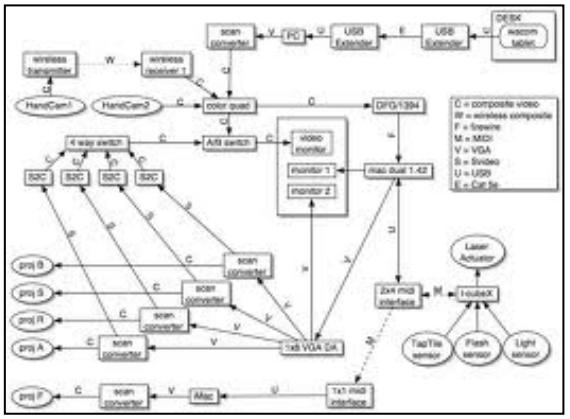
A high school will contain a football stadium, parking lot for student cars, etc.

- Is the analyst working from general to specific? (or vice-versa)
- What sub-objects are identified first, second, etc?

Research Goals

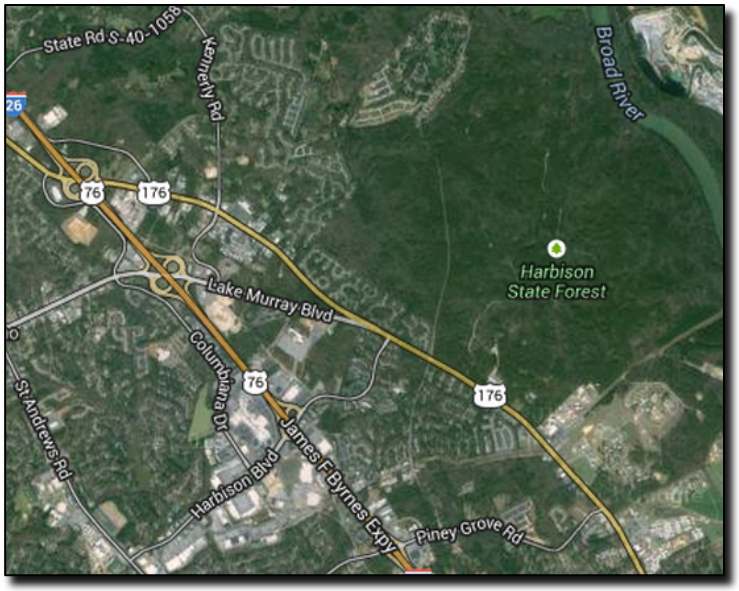
Cognitive Process

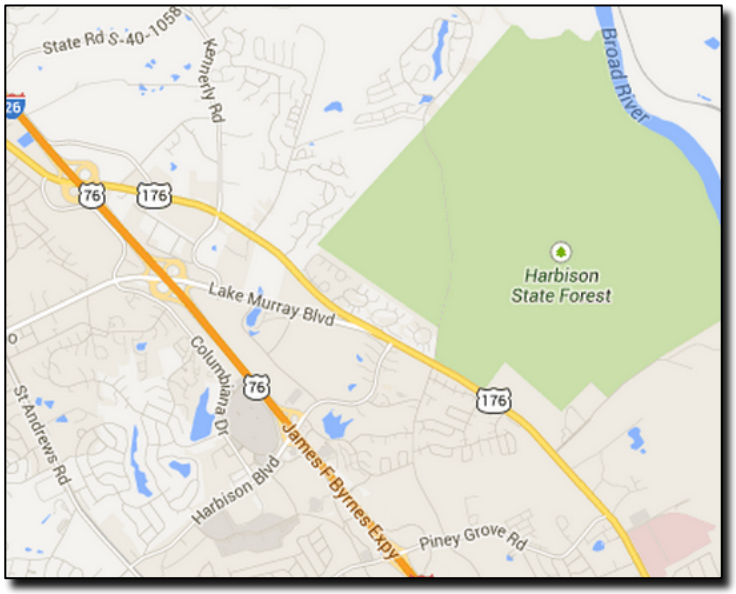
Automated Algorithm



- Pragmatic Goal: Design algorithms that …
  - Producing the same results as humans
  - Producing the same results by the same process

- Science Goal: Understanding the cognitive process
  - ultimately for a pragmatic goal (designing algorithms)
  - pedagogical (e.g. training students, analysts)

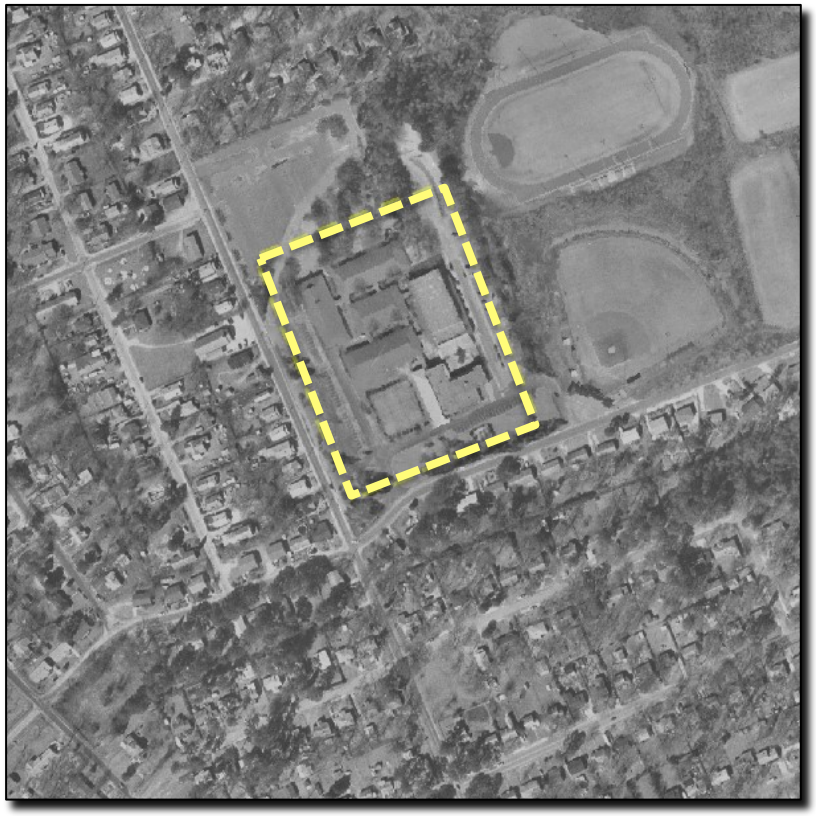




– Our 'imagery' is of a <u>natural scene</u> rather than a <u>generalization</u> in graphic form.

(1) Our scene is similar to what humans process continually, except our scene is ***viewed from above*** *and at* ***distant*** *objects.*

(2) The details of the image (generalized out in a map) may contain important information.



Task-oriented versus free viewing

We have a specific task & we want to understand task-oriented or task-directed cognitive processes.

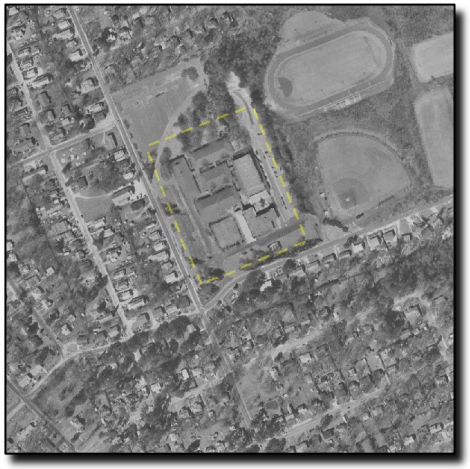
Why eye-tracking?

- Helps to understand ***why*** a performance is good or poor:
  - Did the viewer use contextual information (that information surrounding the target)?
  - Do viewers need to find one piece of information before another can be useful?
  - To what extent do different image characteristics alter/influence visual search (bottom-up vision)?

Visual interpretation of aerial imagery *is not simple*

Do visual search and cognitive processes vary with …

.. experience?
.. gender?
.. age?
.. spatial resolution?
.. spectral band/composition (e.g. panchromatic, natural color, CIR)?
.. geography?
.. classification system (USGS, NWI, etc.)?
.. classification level (i.e., specificity)?

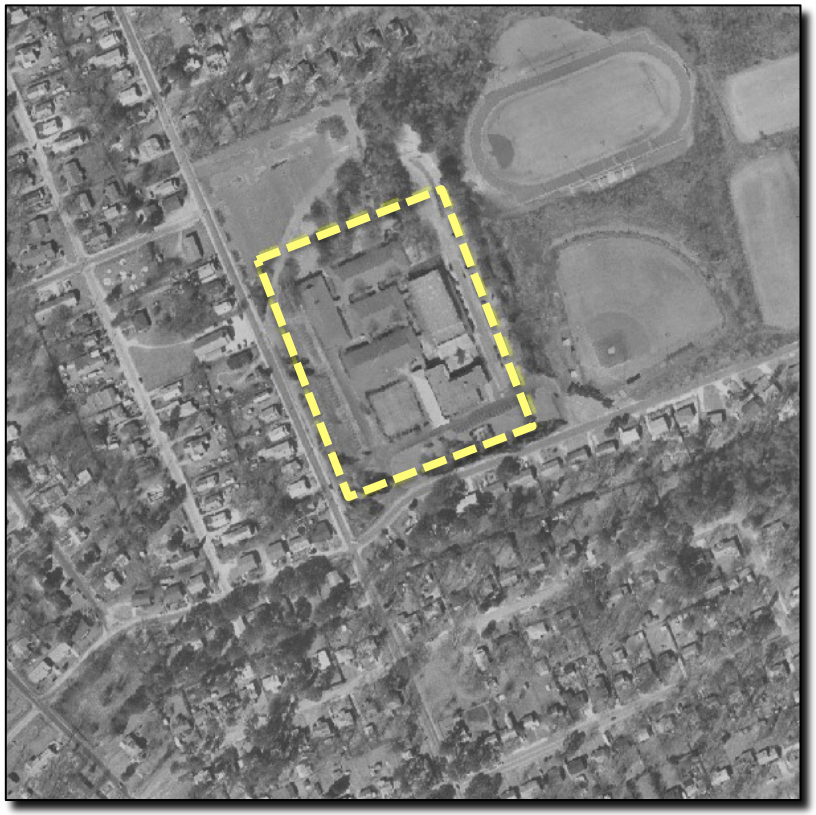


.. … all of these are factors that could be examined.

Small Exploratory Study

12 remote sensing experts @ AAG meeting in 2013
(university faculty/PhD students teaching remote sensing)

24 panchromatic photos in piedmont South Carolina
(all same spatial resolution and size of geographic area)



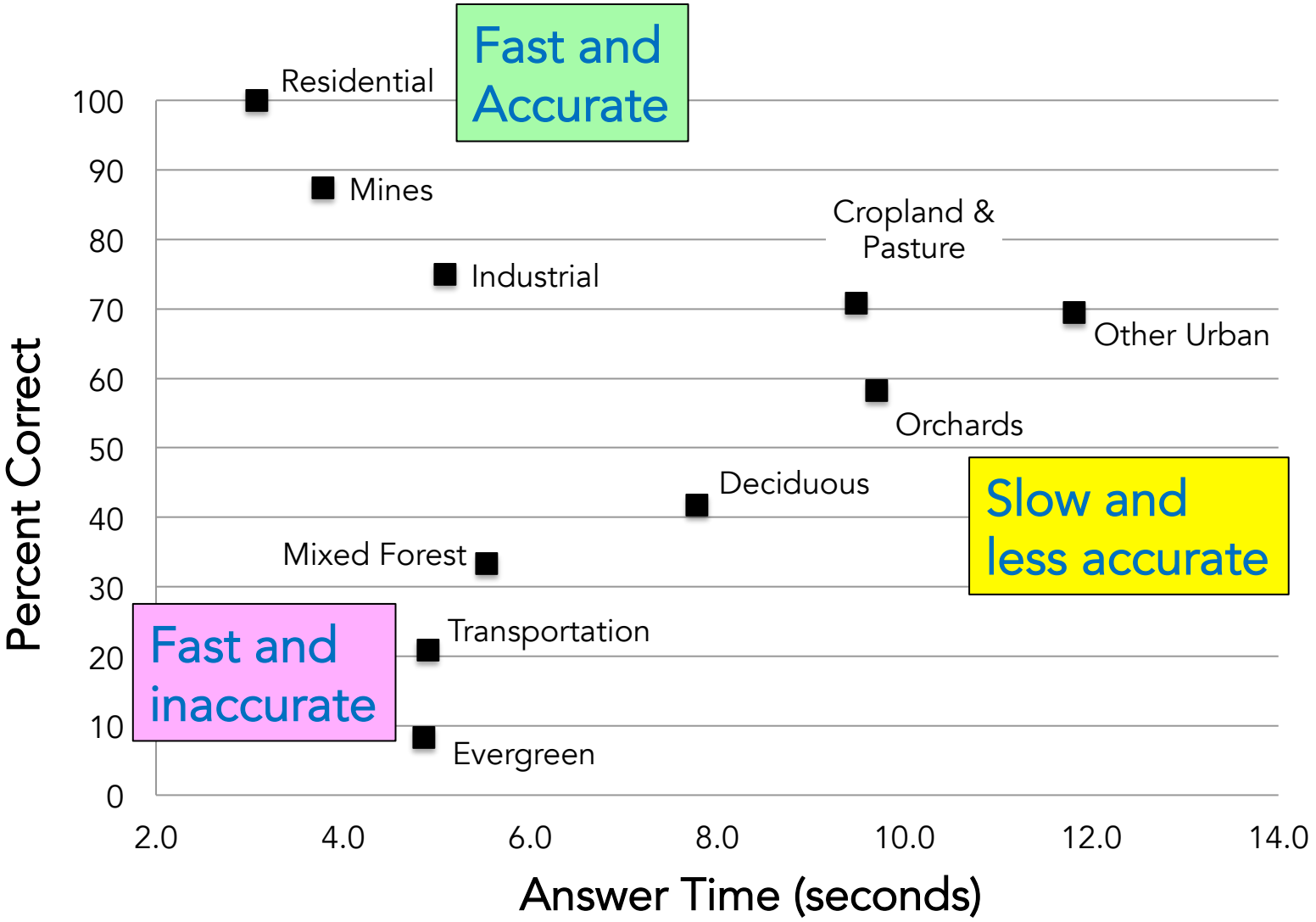
General instruction:
You should try to identify the land use/land cover target as quickly but as accurately as you can.

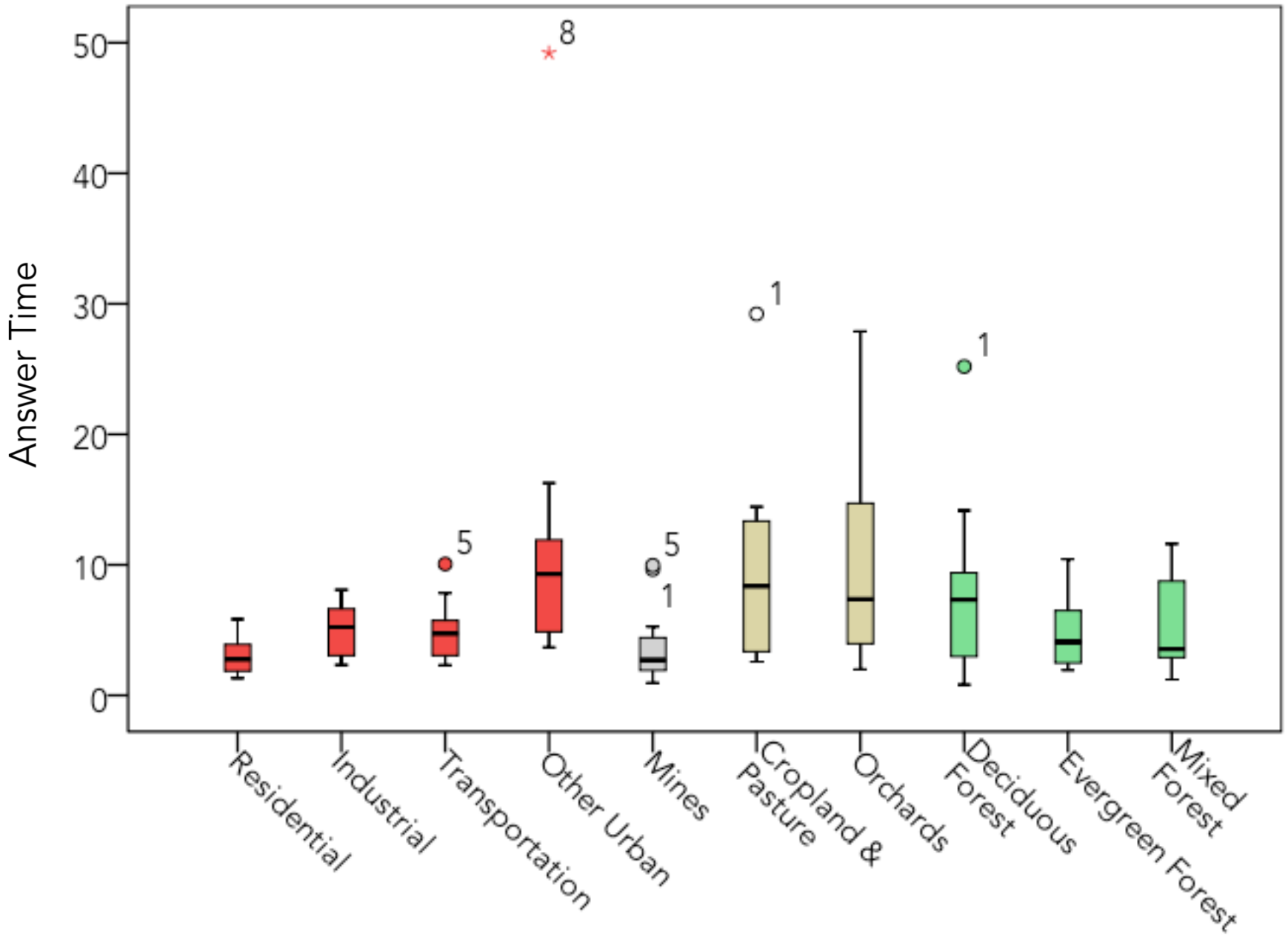
Task:
What Anderson level II class does the target location have?

Experimental setup and details

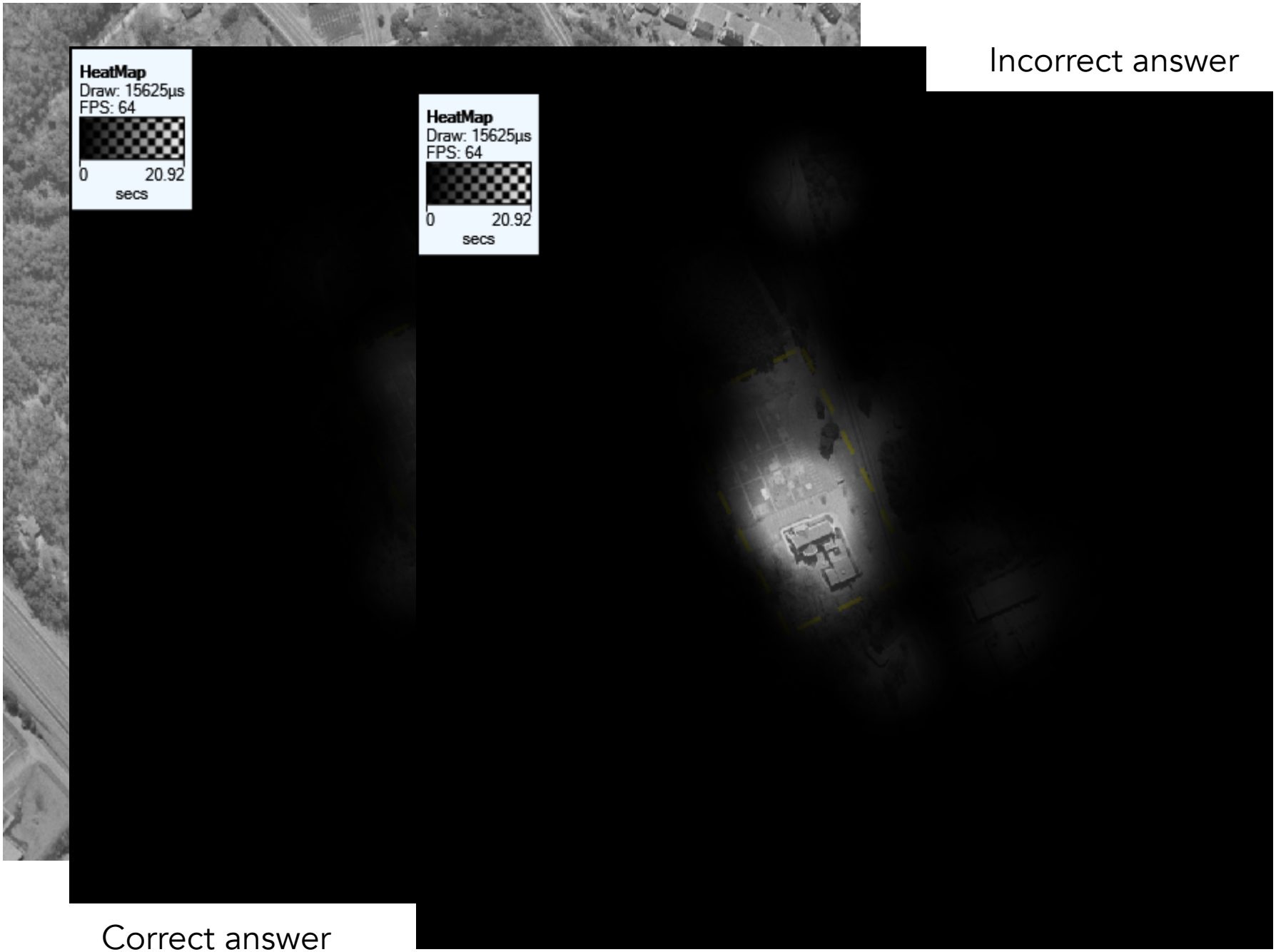
- Tobii x120 eye-tracker recording at 120 Hz
- Conducted in a hotel meeting room (not ideal!)
- Within-subjects design; stimuli Latin squares presentation of stimuli
- Independent variables:
  - Land use/land cover classes
  - Experience teaching air photo interpretation
- Dependent variables:
  - Answers (verbalized)
  - Answer time (seconds)
  - Eye tracking metrics
- Also asked what strategies they used to identify targets (at end of the experiment).

Some Preliminary Results




Answer Time
50
40
30
20
10
0
8
1
5
5
1
1
1
Residential
Industrial
Transportation
Other Urban
Mines
Cropland & Pasture
Orchards
Deciduous Forest
Evergreen Forest
Mixed Forest


5
7
1
4
3
6


HeatMap
Draw: 15625µs
FPS: 64
0
20.92
secs
HeatMap
Draw: 15625µs
FPS: 64
0
20.92
secs
Incorrect answer
Correct answer

Next steps with our data

- We are still trying to figure out the most appropriate parameterization for the Tobii fixation filter (velocity based).
  - Does generally a better job of identifying fixations than other options.
- To what extent is the context surrounding the target important for correct identification of the LULC class?
  - Is context more important for 'difficult-to-identify' classes?
- What distinguishes/differentiates good from poor performance, especially for 'difficult-to-identify' classes?
  - Viewing strategy?
  - Do 'correct' performances replicate what used to be taught in classification keys?
  - What critical image details do inaccurate performances miss?
- Is the order of fixations (i.e. what image sub-objects are viewed and when) related to effective and efficient performances?