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Presentations Computer Vision Research Lab

- Relevant UMass Research Edward Riseman
- Image Warping for Image Registration Howard Schultz
- 3D Panoramic Imaging Howard Schultz
- 3D Terrain and Site Modeling Edward Riseman
- Aided Search and Target Cueing Gary Whitten
- Knowledge-Based and Adaptive Image Processing

  Allen Hanson

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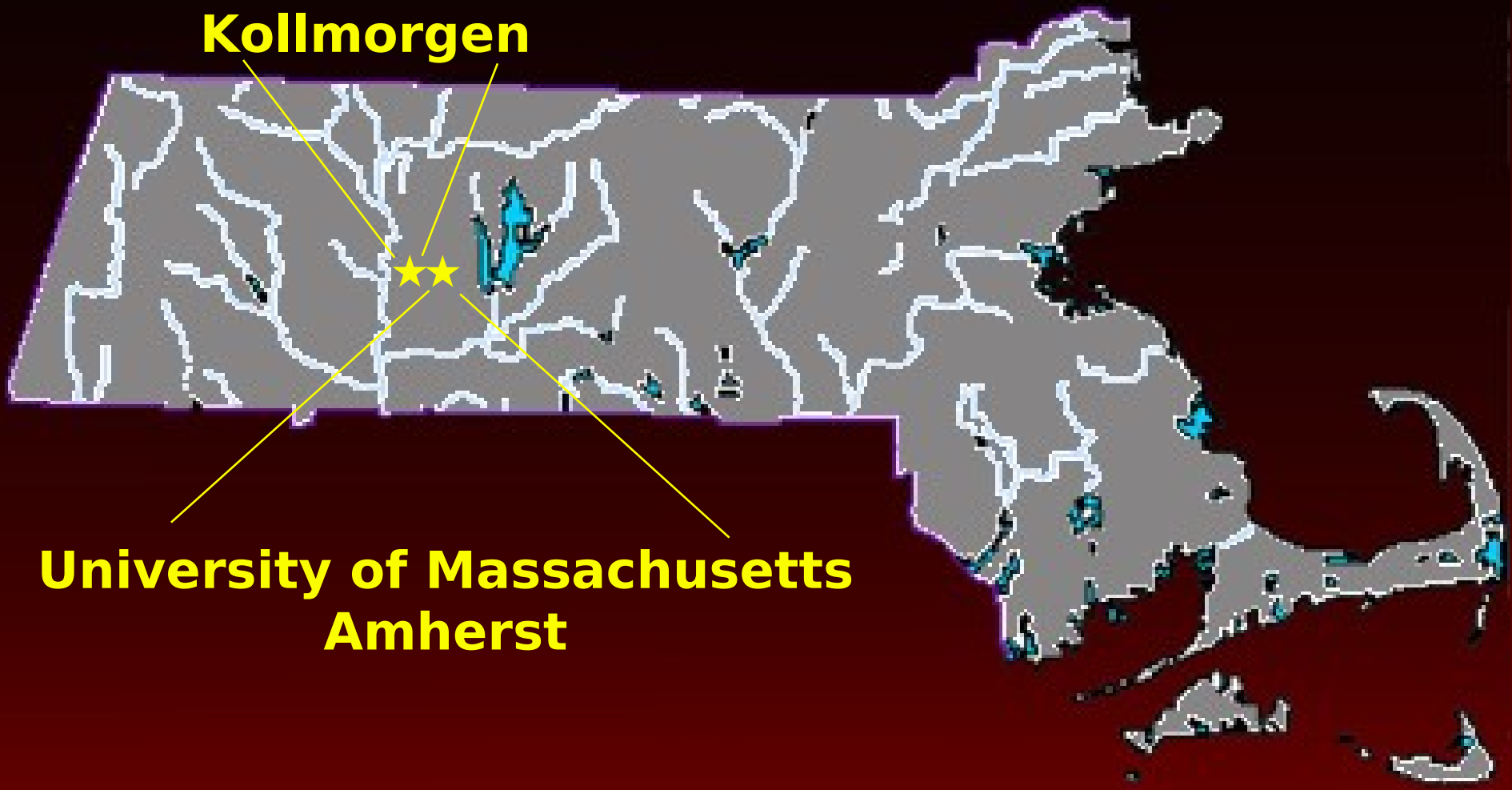
Knowledge-Based and Adaptive Image Processing



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What?

Two premises and a conjecture

- Vision works reasonably well.
- Vision doesn't work.
- Vision can be made to work better.

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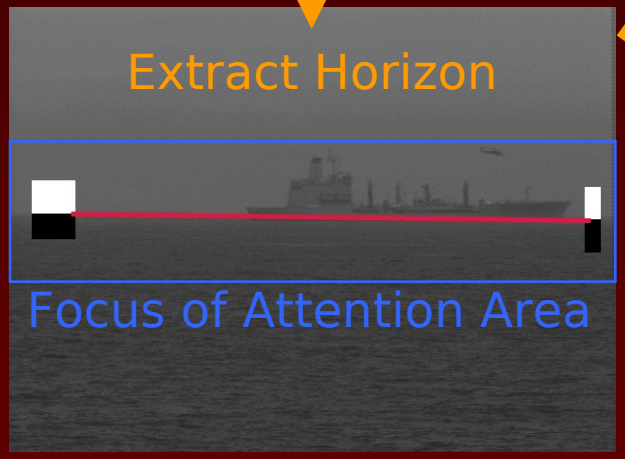
A Simplified Example

gorithm for target (and algorithm!) cueing:



Process Area

Visual Inspection ATR Algorithm

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Hidden Assumptions and Constraints

- Targets on or near horizon
- Good contrast separation between water and sky
- Targets large enough to detect as irregularities along horizon line
- More or less calm seas
- .....

LOTS OF VIOLATIONS!

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Violations

Not enough contrast between water and sky

Target below horizon

Target too small

Alternative Algorithm

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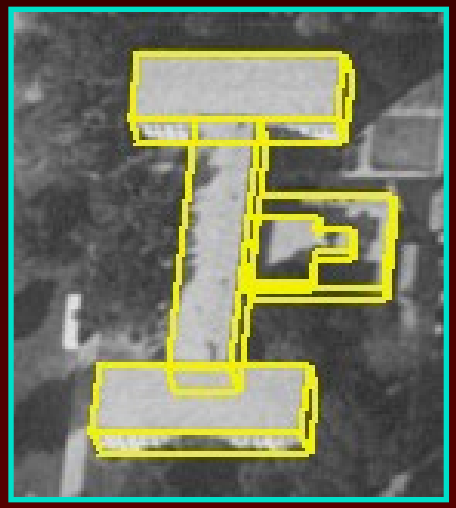
Ascender I

System for Automatic Site Modelling

Multiple Images → Geometric Models

- rooftop detection
  - line extraction
  - corner detection
  - perceptual grouping
- epipolar matching
- multi-image triangulation
  - geometric constraints
  - precise photogrammetry
- extrusion to ground plane
- texture mapping



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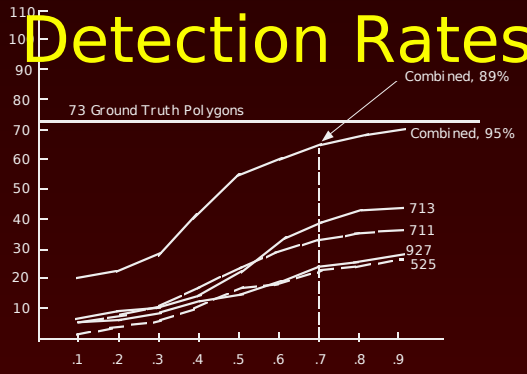
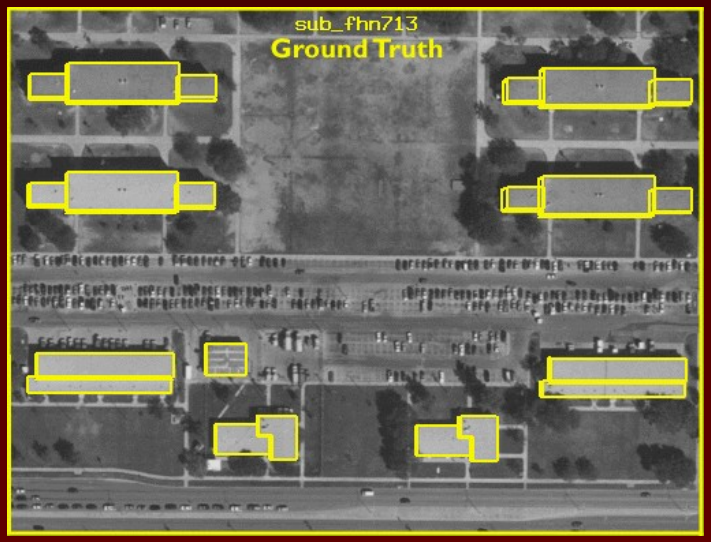
Ascender Works

- Extensive evaluation
  - Good detection but high false alarms
  - Good geometric accuracy

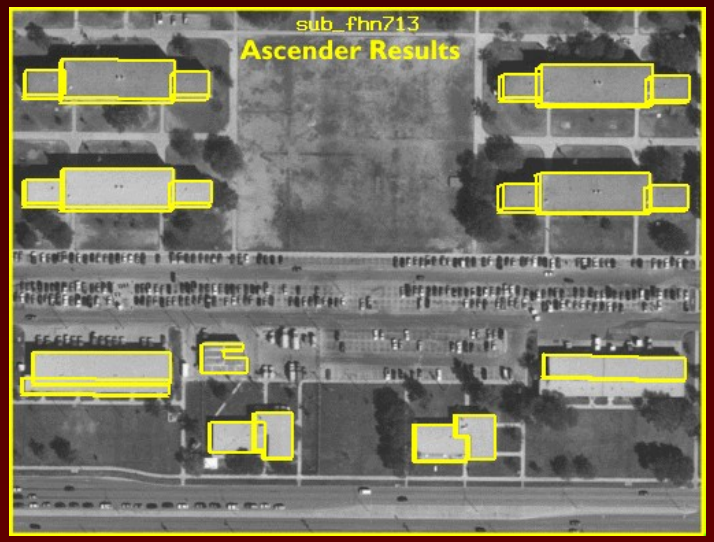
Detection Rates



Ground Truth



Ascender Results



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Ascender Doesn't Work

- Delivered to NEL (NIMA)
- Applied to classified imagery
- Performance not as expected
  - High failure rate (buildings not detected)
  - High false positive rate
- WHY? Imagery didn't conform to design constraints!

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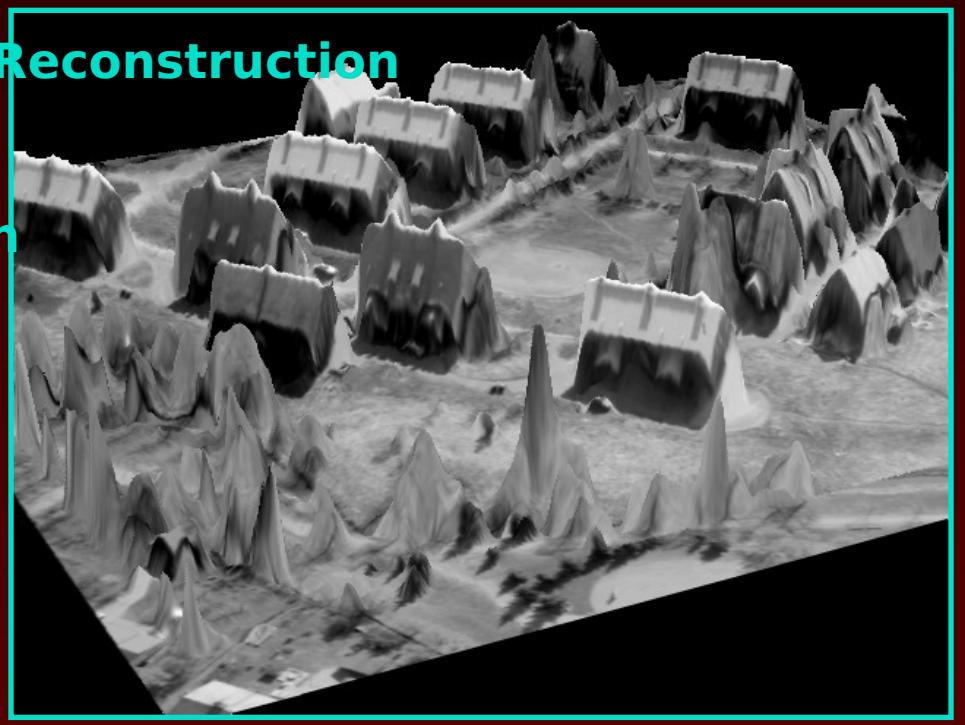
Stereo Terrain Reconstruction

ISPRS Data

Stereo Correlation



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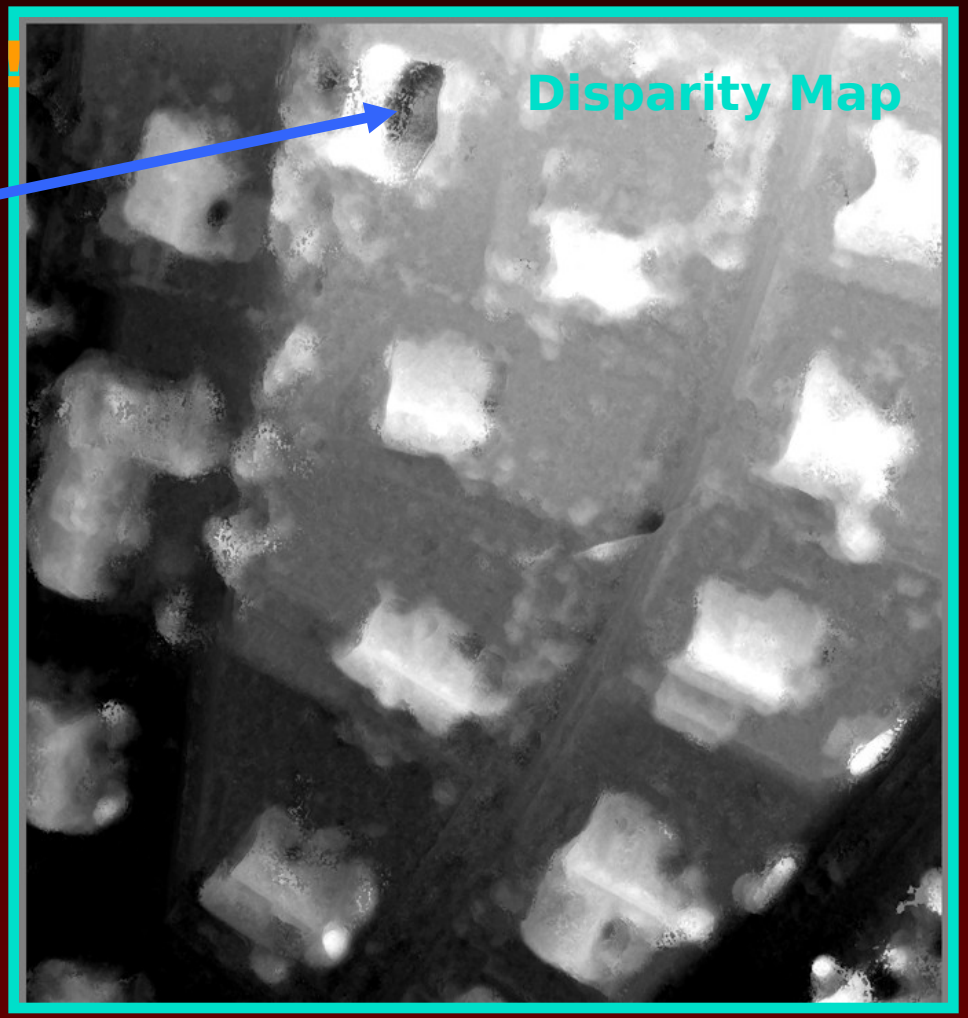
Stereo Reconstruction Doesn't Work

No Correlations!

Avenches Image - Right



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Making Vision Work

- Algorithm Selection - which of many is the right one?
  - Function of data and explicitly represented constraints
  - Apply *right* algorithm at *right* time to *right* data
- Parameter Selection
  - Automatically set critical parameters
  - Function of data and result of probes
- Data Selection / Context Sensitivity
  - Data appropriate for algorithm?
  - Characterize data requirements

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Dealing with Context: Ascender II

- Goals
  - 3D Geometric Site Model Reconstruction
  - Complex building structures
  - Context sensitive control strategies for applying algorithms
    - Multiple strategies
    - Multiple images
    - Multiple sensors

EO, Digital Elevation Maps

IFSAR,

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Basic Principles

- IU Algorithms work within correct context
  - constrained contexts
  - constrained object classes
- Constraints
  - from domain knowledge, partial results, strategies
- Of many strategies, only *correct* ones used
  - selective application
  - correct parameters
  - fuse results from individual strategies into complete reconstructions

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Ascender II Overview

CP: Control Policy

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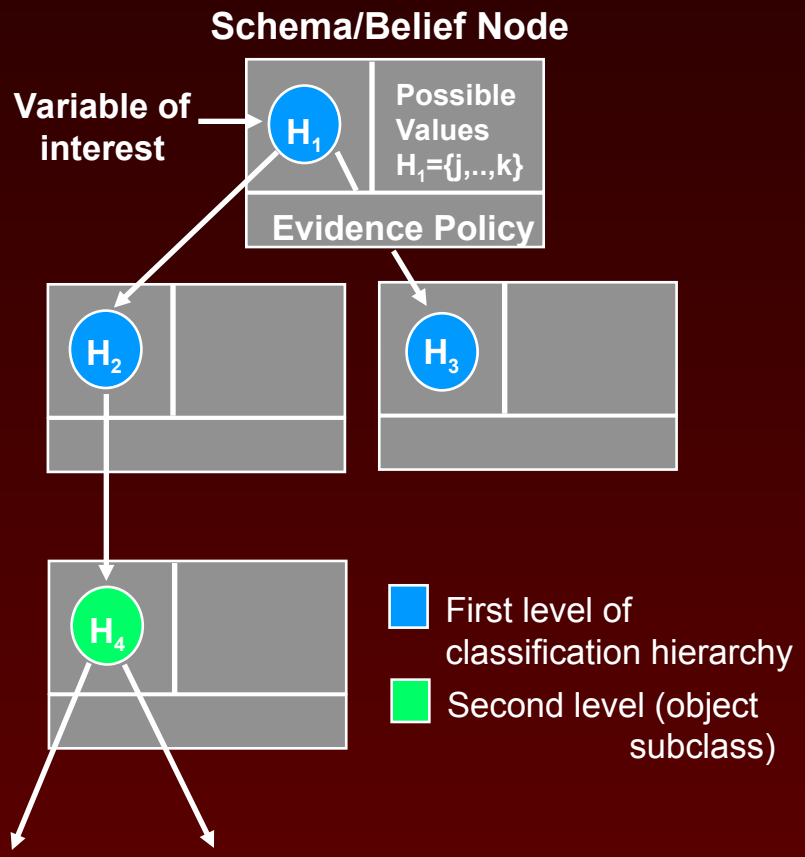
Knowledge Representation

- Combination of belief networks and visual schemas, implemented in Hugin.
- Encodes: Domain Knowledge
  Acquired Site Knowledge
  Control Mechanism
- Allows both diagnostic and causal inference.
- Evidence policy defines how IU strategies gather relevant evidence according to context.
- Hierarchical topology allows simpler networks which reduces propagation time and controls complexity.



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Preliminary Experiment

- Goals
  - Show knowledge can improve accuracy of site model
  - Address NP-hard propagation using hierarchical nets
- Approach
  - Site model from Ascender I with no filtering and loose polygon acceptance criteria =>
    high detection rate but lots of errors
  - Classify Ascender I regions into
    {building, parking lot, open field, unknown}
  - Classify buildings into
    {multi-level building, single-level building}
  - Site model from Ascender II after classification

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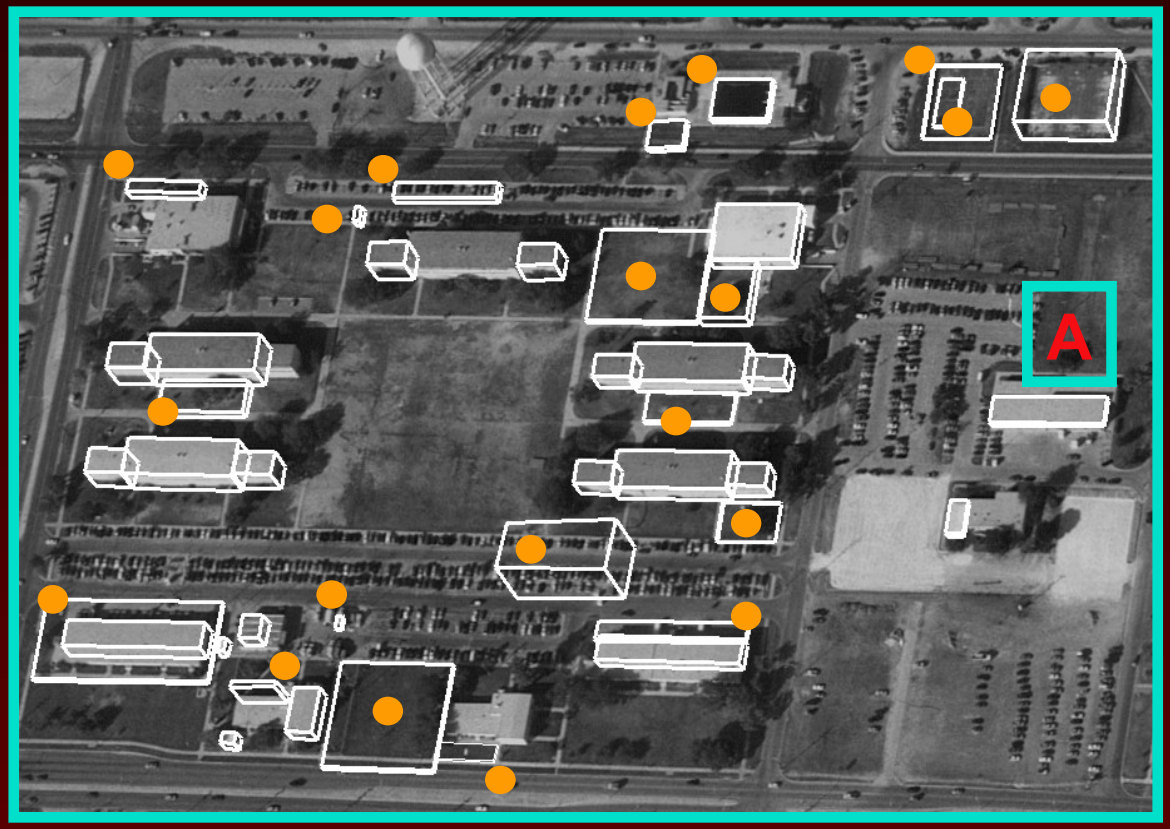
Degraded Ascender I Model

No Knowledge and Loose Polygon Acceptance Criteria



20 False Positive Buildings 22 True Positive Buildings

1 Incorrect Model (A) (multi-level reconstructed as single level)

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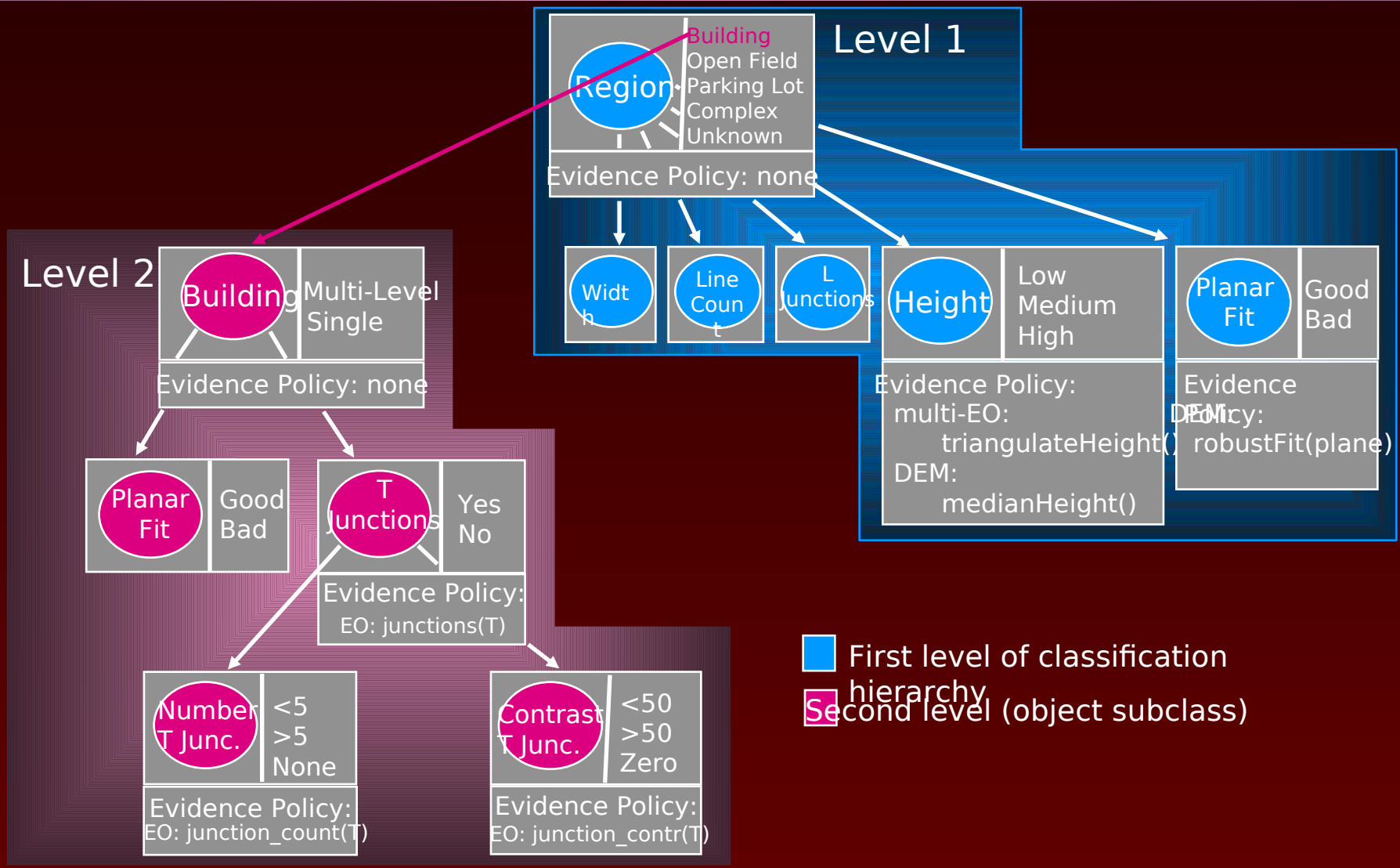
Bayes Net for Experiment



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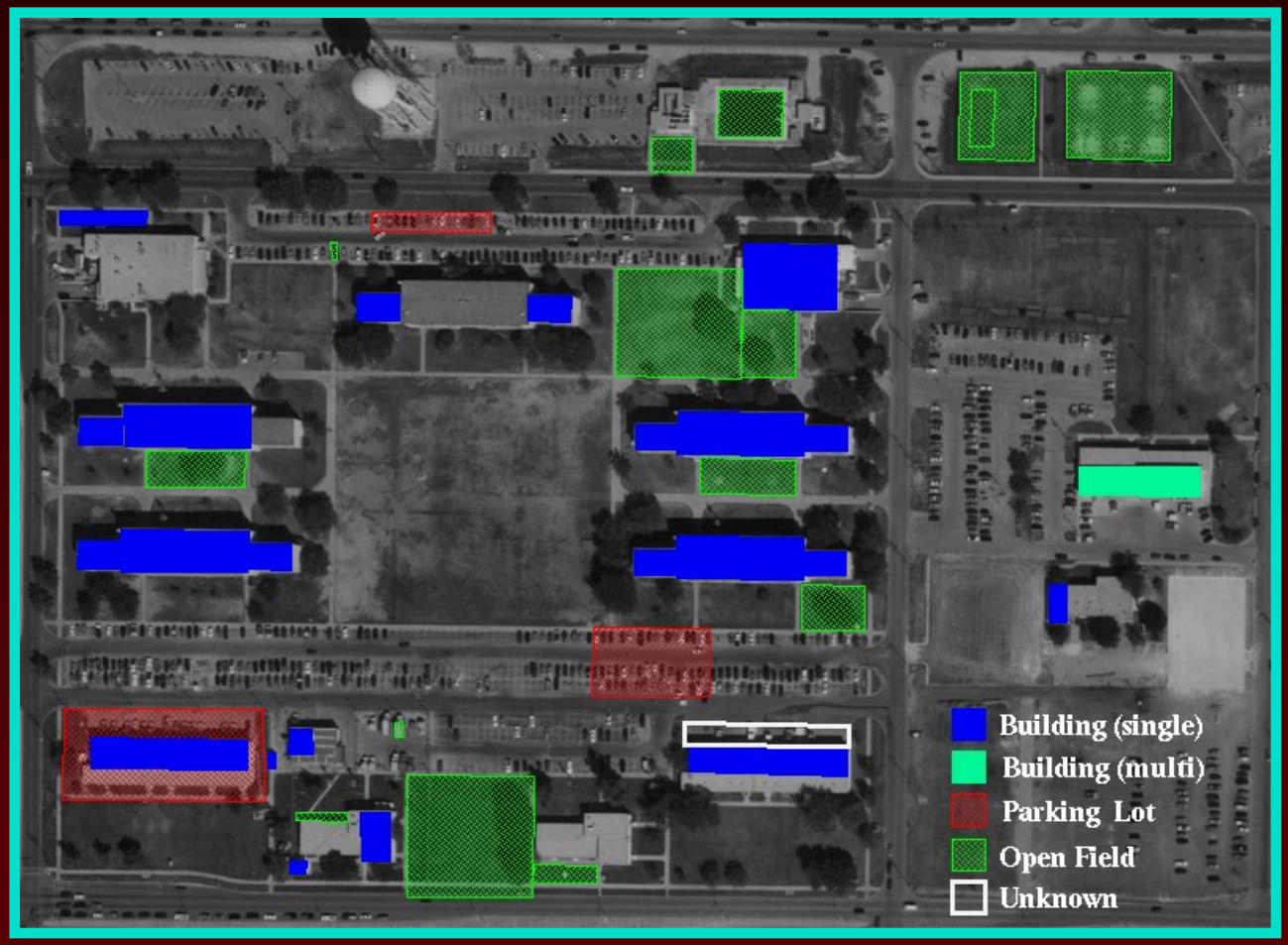
Using Context Sensitive Strategies



43 Regions, 4 Misclassified, 1 Unknown

88% Accuracy

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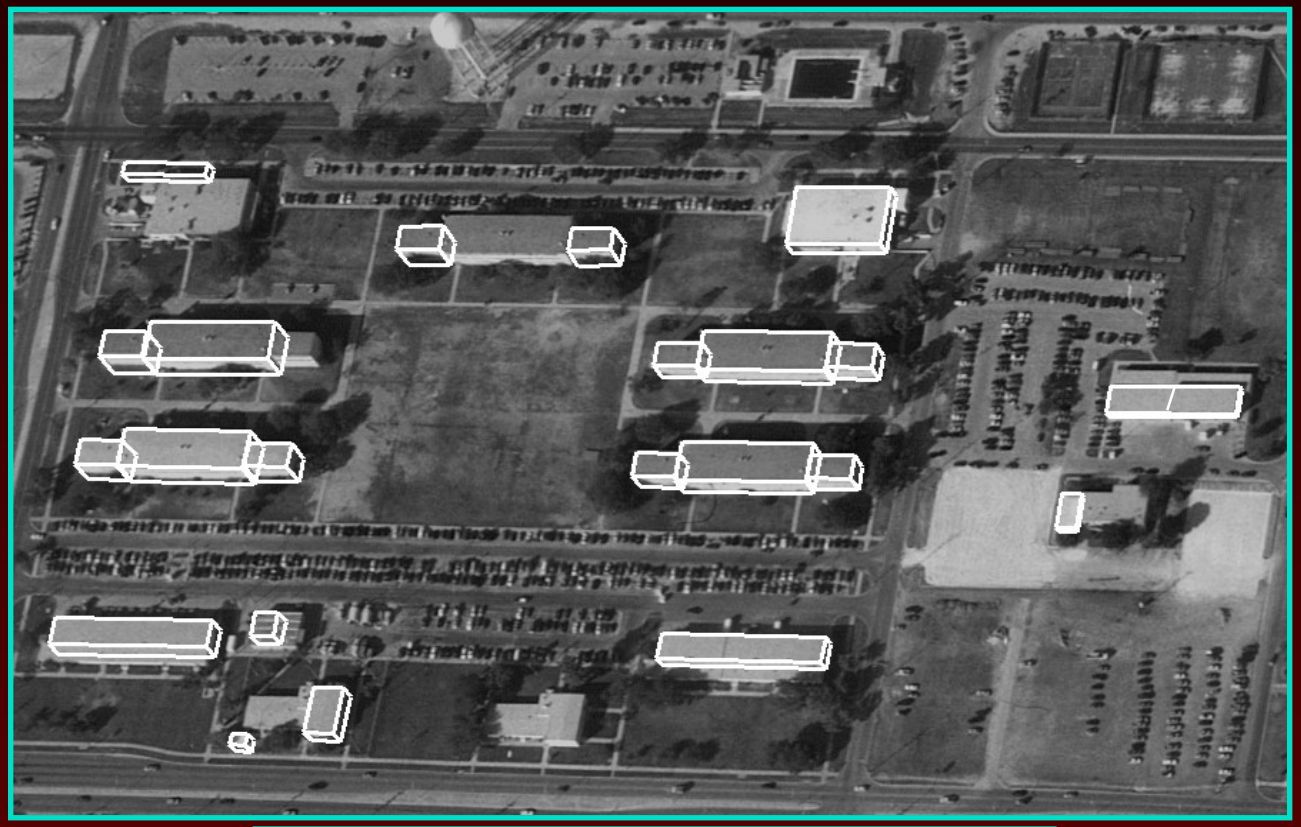
Ascender II Reconstruction



1 False Positive
23 True Positive Buildings
0 Incorrect Models (single, multi level)

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Conclusions

- Vision works when properly constrained and focussed
- Still a lot of work to do on:
  - Basic Algorithms
  - Knowledge Representations
  - Representing and Using Context and Constraints
  - Automatic Parameter Selection
  - Inferencing and Causal Reasoning
  - System Architectures