Perception Model for people with Visual Impairments

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RAINBOW RESEARCH GROUP

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- Modelling perception
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- Discussion

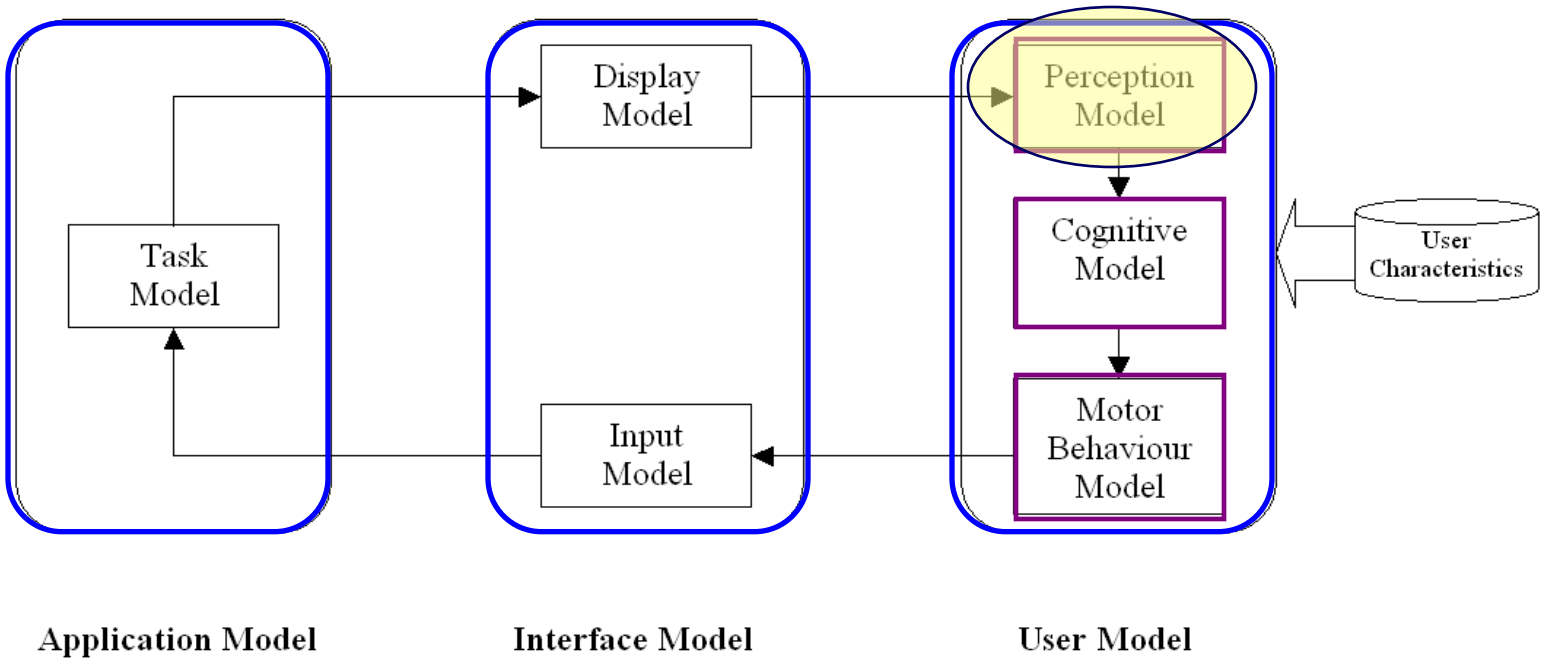
The Main Project

1. Simulate HCI of both able-bodied users and those with disabilities.

2. Work for users with different levels of skill.

3. Be easy to use and comprehend for an interface designer.

Architecture of the Simulator

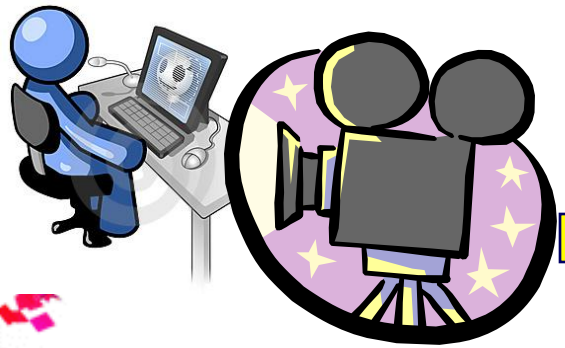


Introduction

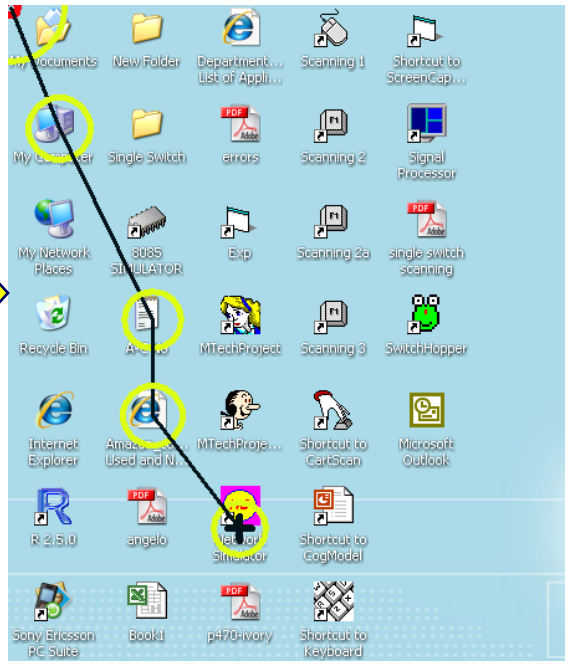
Two main modules

- Modelling basic mechanisms of perception
- Modelling visual impairments

The Perception Model



The Model



Recording of user interaction

Eye movement pattern

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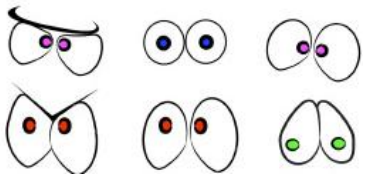
Problems in Modelling Perception

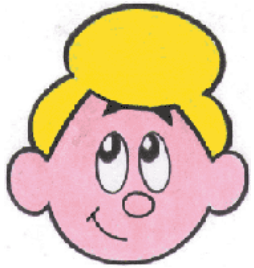
1. Modelling for complex scenes

$$(m_V \cdot l_V + m_G \cdot e) \cdot \ddot{V} + (m_V \cdot l_V \cdot h_V + I_{Vz} \cdot \sin(\sigma) + m_G \cdot$$
$$(m_V \cdot l_V \cdot (a_H - a_V) + I_{Vz} \cdot \cos(\sigma) + m_G \cdot e \cdot (a_N - N) + I_{Gz}$$
$$(I_{Vz} + m_V \cdot l_V^2 + I_{Gz} + m_G \cdot e^2 + \theta_{ML}) \cdot \ddot{\lambda} - I_{Vy} / R_V \cdot \cos(c$$
$$(m_V \cdot l_V + m_G \cdot e + I_{Vy} / R_V \cdot \sin(\sigma)) \cdot U \cdot \dot{\gamma} + (r_L + r_{ML}) \cdot \dot{\lambda}$$

2. Developing eye-movement strategy



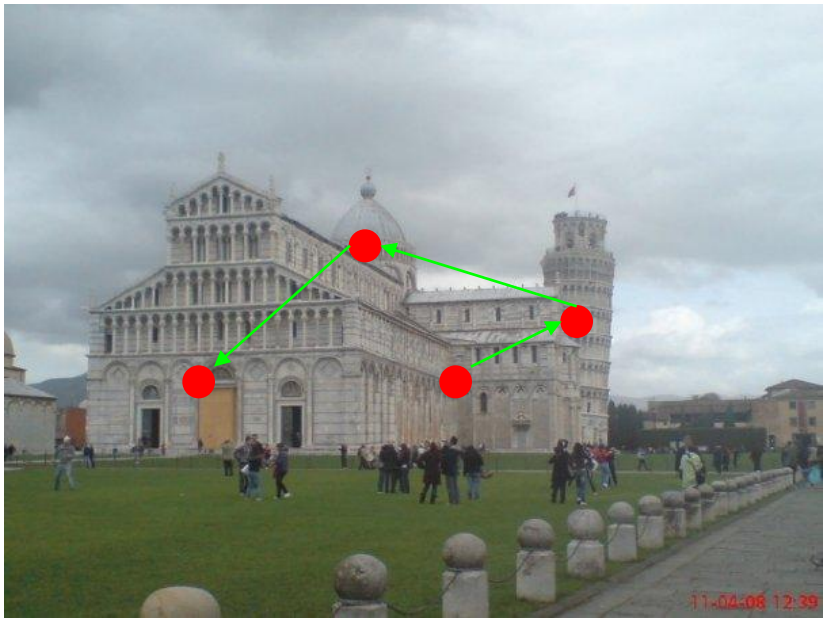
3. Modelling prior knowledge



Basic Strategy

Deducing

- Points of fixation
- Trajectory of eye movement



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Points of Fixation

- Feature extraction
  - Colour
  - Edge
  - Shape
- Segmentation
- Comparison with the target

Eye Movement Strategies

- Nearest
- Random
- Cluster

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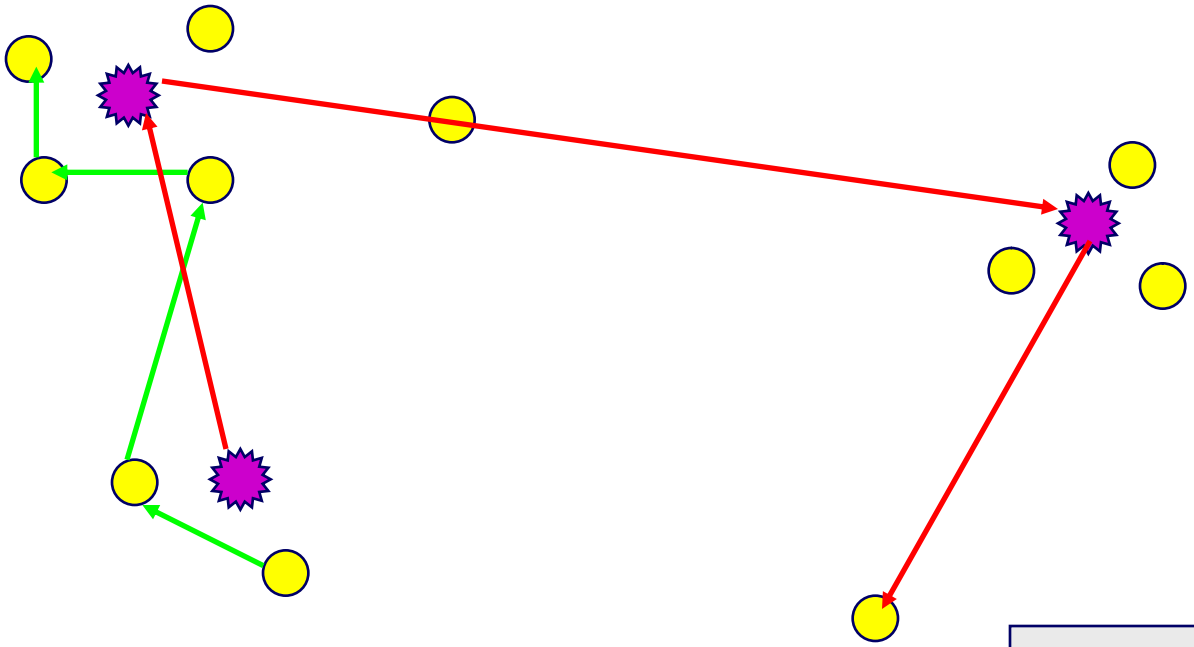
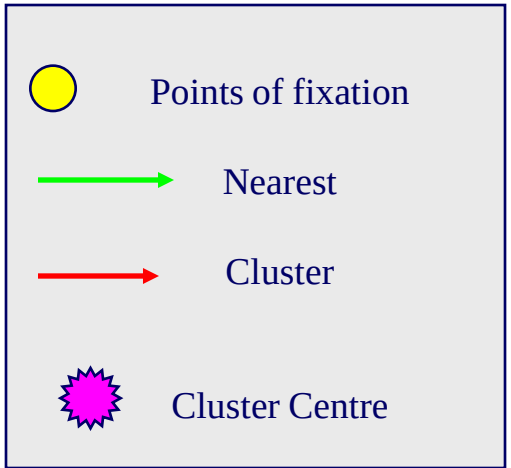
Eye Movement Strategies





Flexibility

Our system allows manual control of

- points of fixation
- probabilities of eye movement strategies

Problems in Modelling Visual Impairment

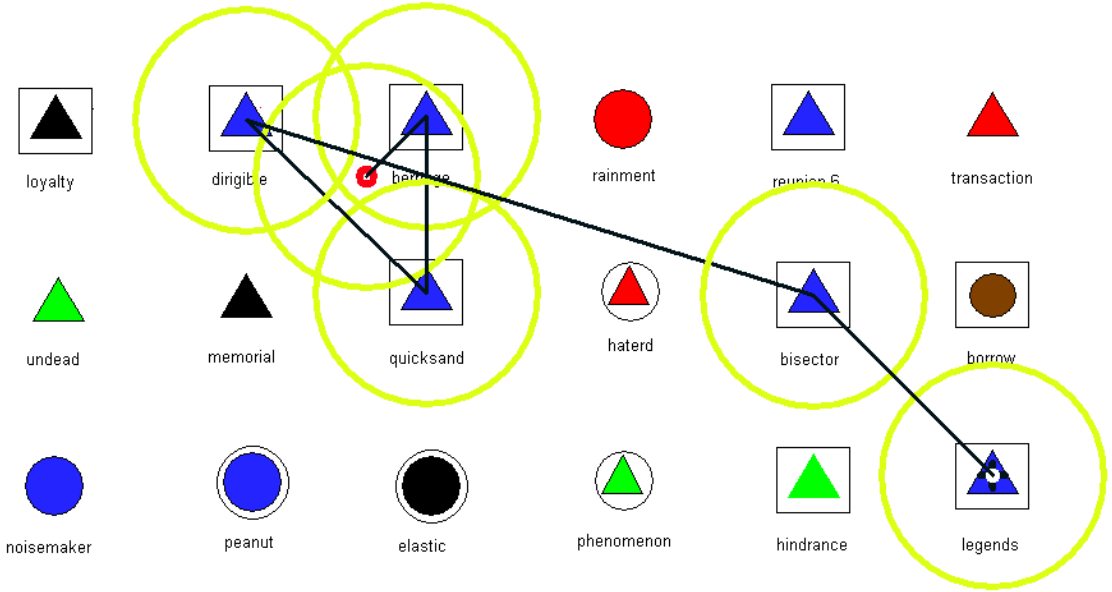
1. Modelling progress of a disease

2. Developing a generic model

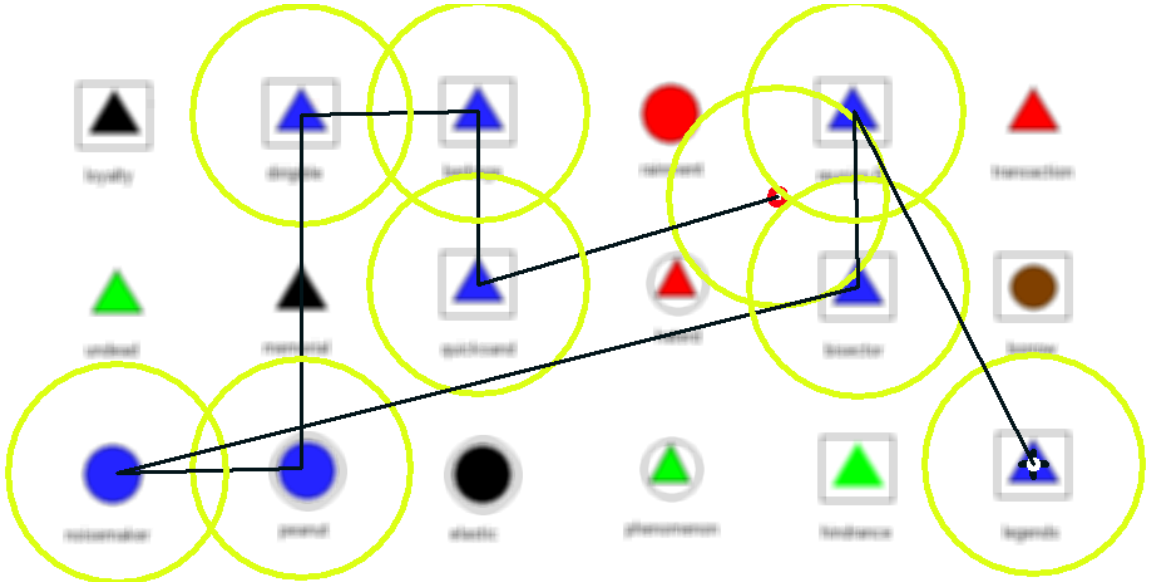
Modelling Visual Impairment

In three levels

- Diseases
- Visual functions
- Image processing algorithms



Normal Vision



Visual Acuity Loss

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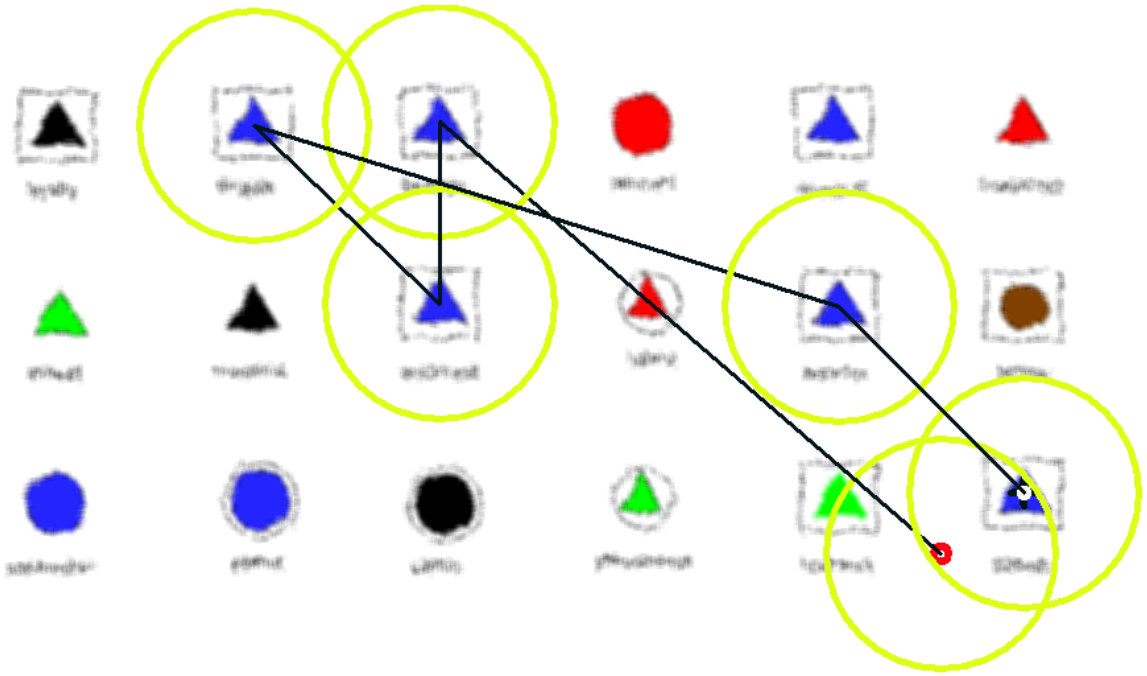
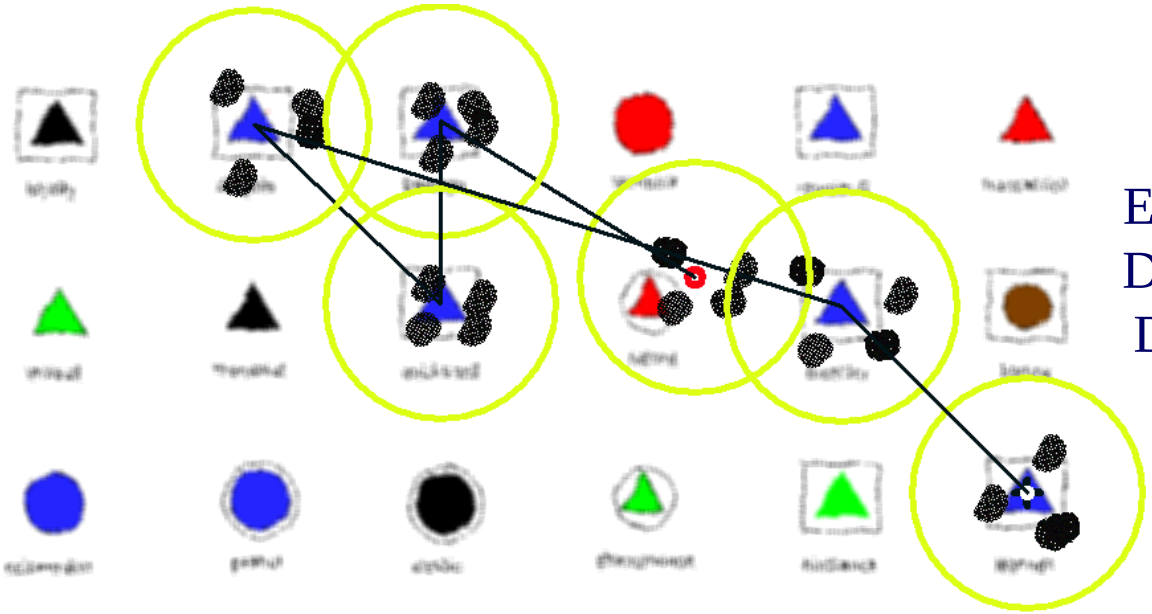


Early stage of Wet Maccular Degeneration



Early stage of Dry Maccular Degeneration

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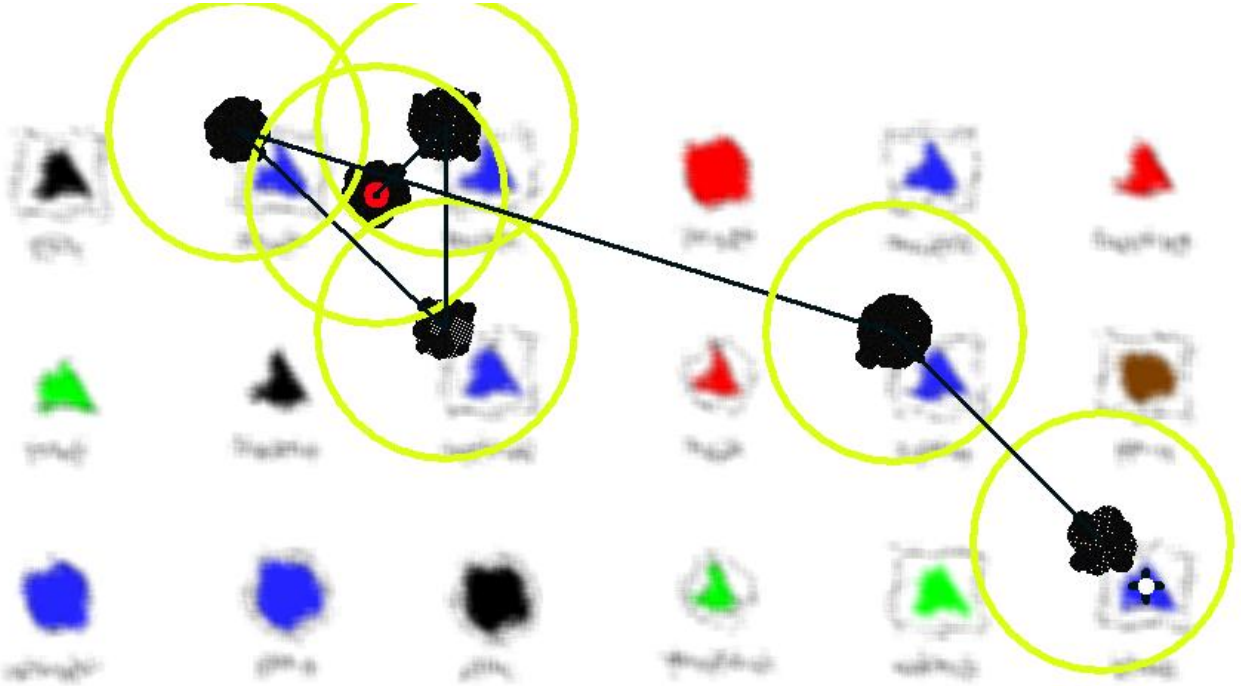
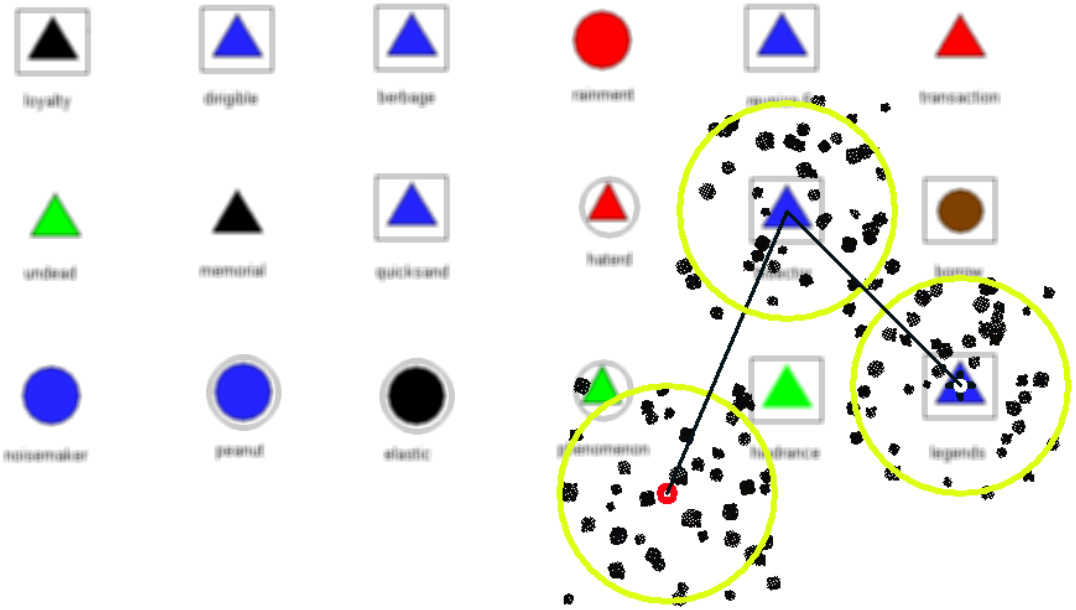
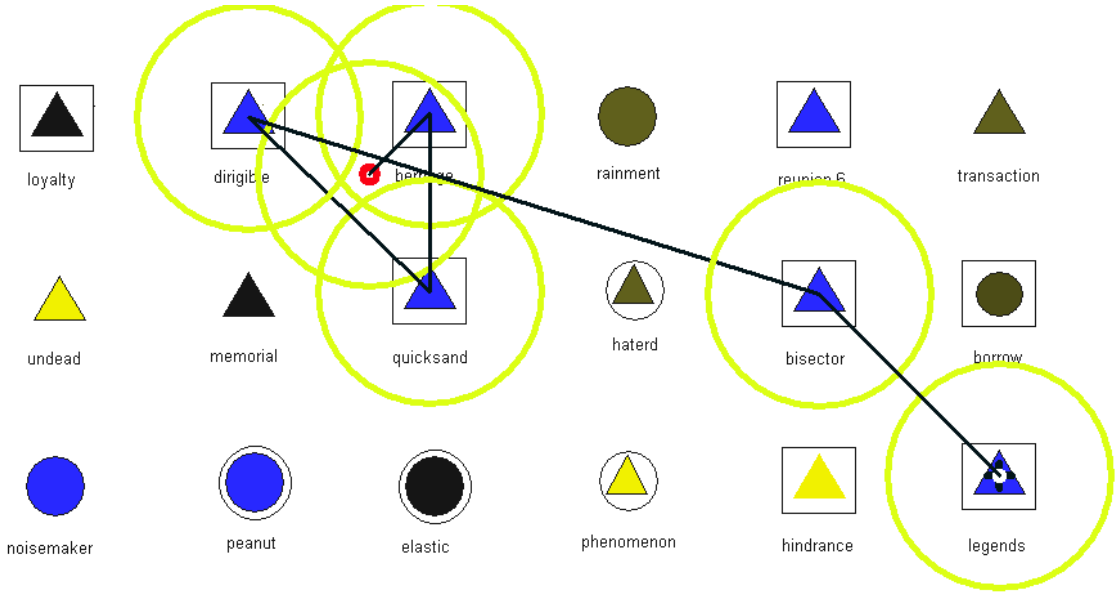


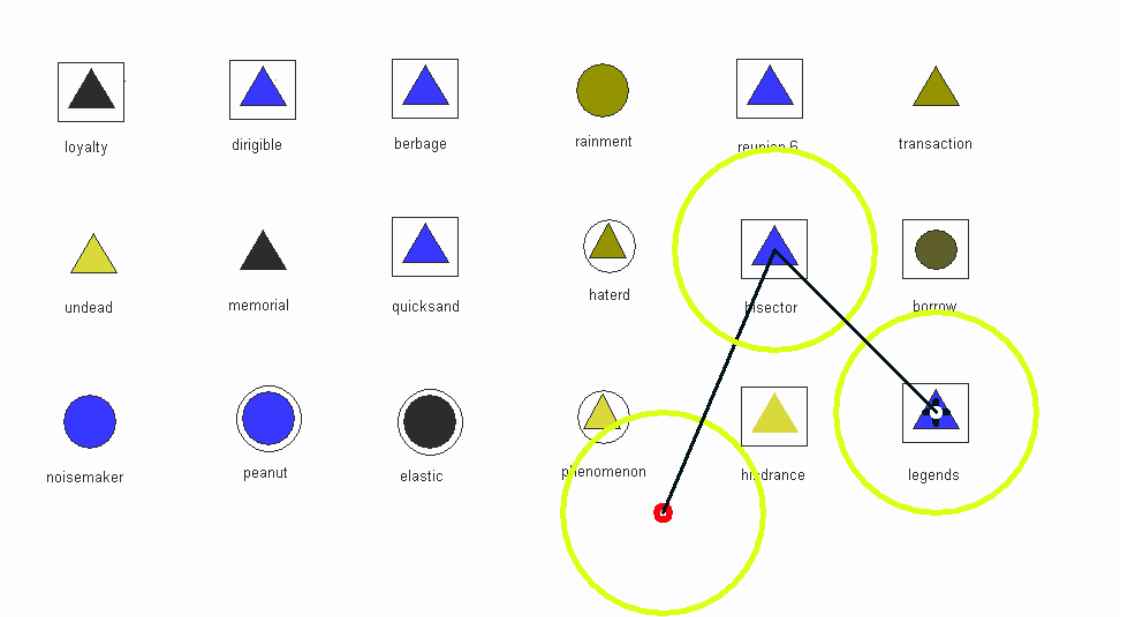
Late stage of Maccular Degeneration



Diabetic Retinopathy



Protanopia



Deuteranopia

Simulation

- Separate models for early and late stages
- Hierarchical modelling
- Colour blindness simulation in LMS colour space[1]

[1] Viénot F., Brettel H. and Mollon J. D. 1999. Digital video colour maps for checking the legibility of displays by dichromats. Color Research and Application 24, 243-252

Advantages

- Simulates more accurately
- Makes it easier to model progress of a disease and any individual case.
- Predicts eye movement w.r.t. a task

Discussion

- Scalability
- Usability
- Calibration
- Validation