Training Restricted Boltzmann Machines to Generate Human-Like Eye Movements

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Background and ambition

The current research focuses on the creation of a neural network using Restricted Boltzmann Machines (RBM) with a 'Leaky Integrate & Fire' component based on the classical Itti and Koch saliency model. The aim is to teach it to generate human-like eye movements, but in a biologically more accurate way as compared to the saliency model, thus aiming at modelling the human superior colliculus (SC). The study suggests that each layer of the RBM would make different contributions to the entire model: for instance, one of the layers could represent the frontal eye fields in the human brain.

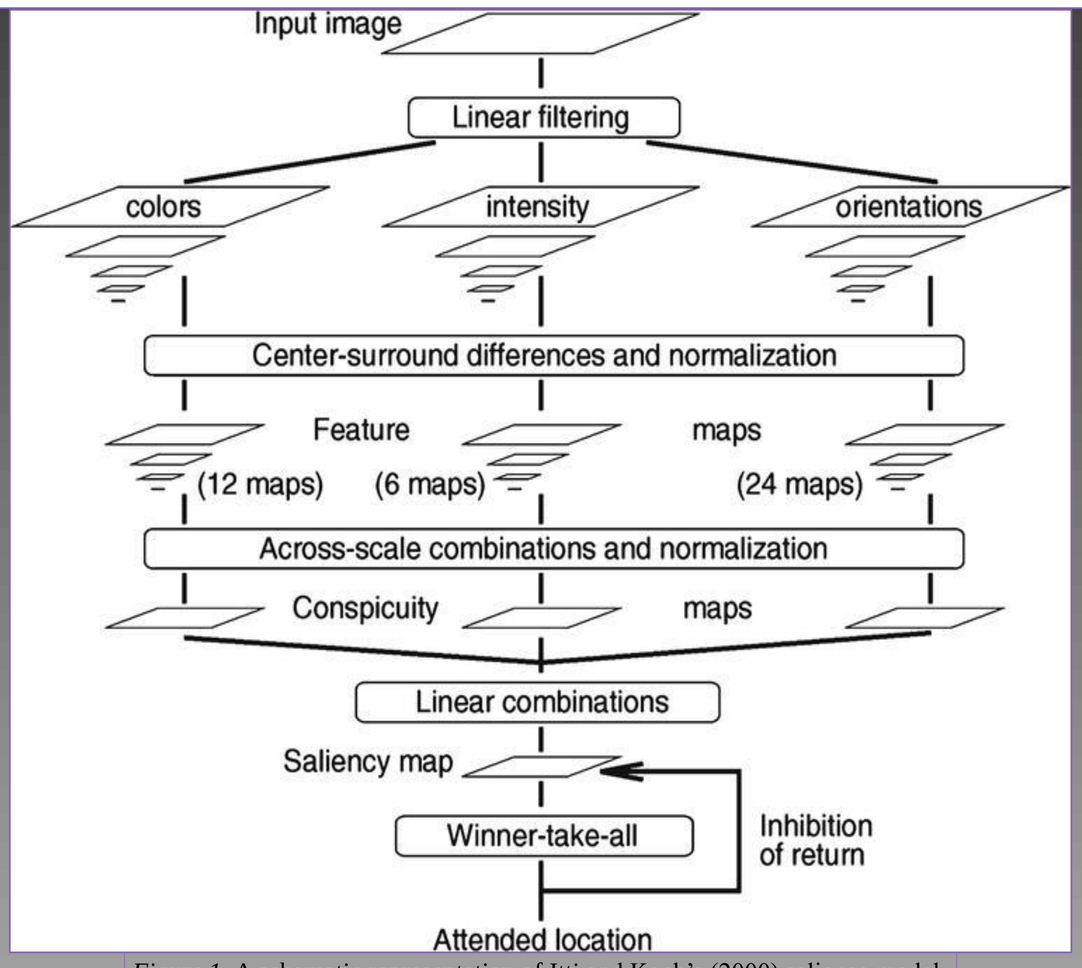


Figure 1. A schematic representation of Itti and Koch's (2000) salience model.

Why go Deep?

- Useful tool for modelling high levels of abstraction (vision, speech);
- Powerful algorithms for prediction and accuracy;
- Have a generative component;
- Classic salience models lack biological temporal distributions;
- Flexible (RBM's may be 'stacked' onto each other, with the previous RBM acting as hidden input to the following layer);
- Layers of the network may be visualised as layers of the visual cortex (the first layer corresponding to V1, etc.)

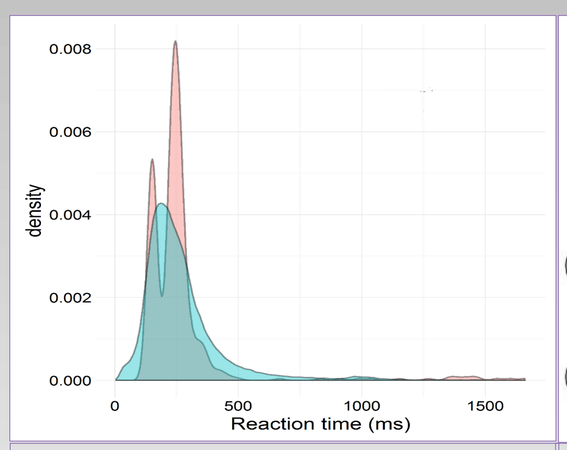


Figure 2. A demonstration of the bad matching of the Itti and Koch salience model with a leaky integrate and fire layer to human saccade latency data (MacInnes, 2017).

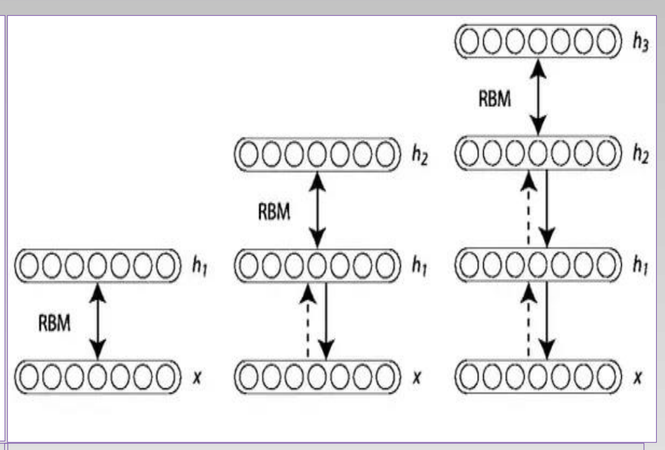


Figure 3. A visualisation of a 'stacked' RBM structure of a deep belief network.

Methods

- Two sets of images to train and test the RBM;
- Teach the RBM to reconstruct input data into saliency maps;
- Generate a distribution of saccadic reaction times and accuracy by passing the saliency maps to the 'Leaky integrate-and-fire' layer;

Proposed model

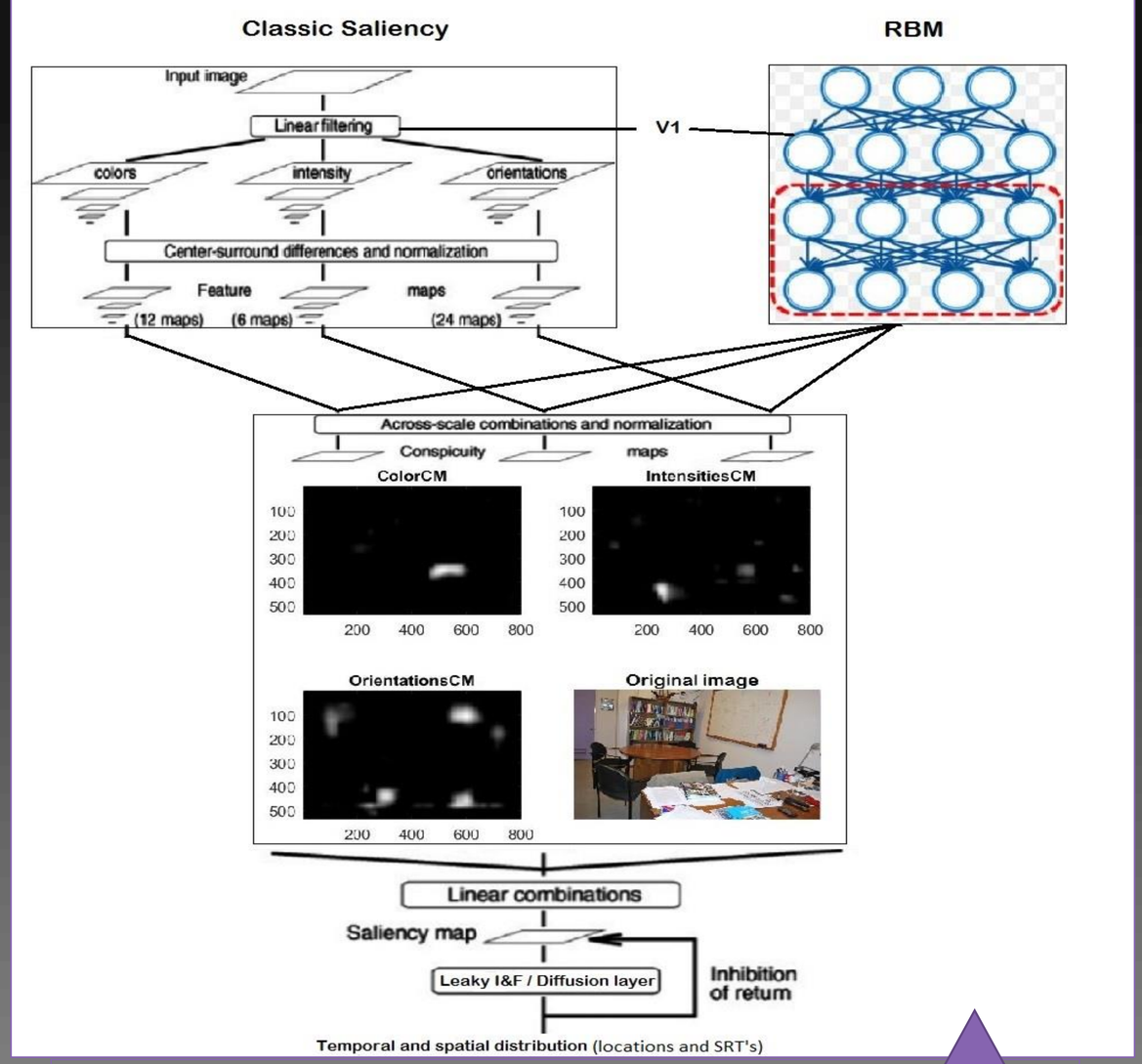


Figure 4. A schematic representation of the proposed model

General input/output

Input:

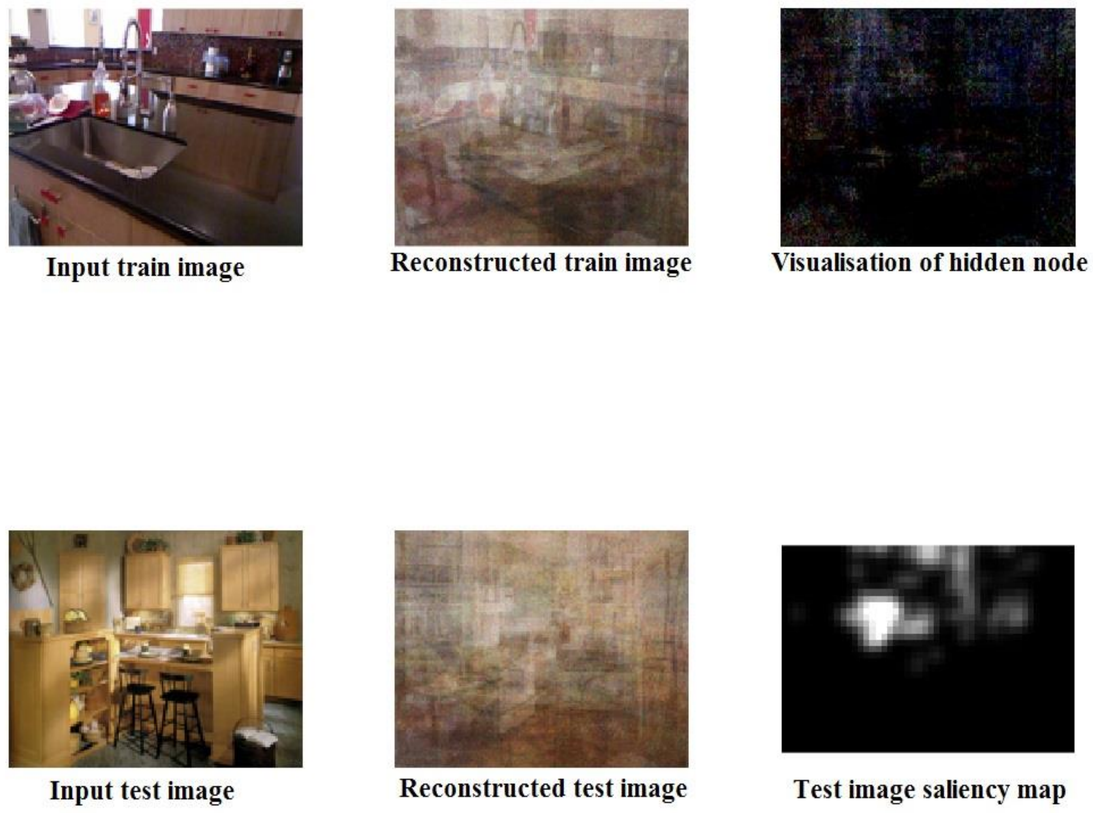
- Entire image fed to RBM;
- Saliency map fed to Leaky I&F

Output:

- Saliency map as output for RBM;
- Saccadic location and SRT distribution as output for the Leaky I&F

Goal: matching the spatial distribution using RBM instead of classic salience and adding a temporal component.

Initial results



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