Computational Account of Emotion - An Oxymoron?

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Criticism of Naturalism

- Sensory input and emotions often considered subjective and qualitative
    - "Qualia"
- Emotion defies computational explanation because:
    - Computation is taken as symbol manipulation
    - Emotion cannot be objectively expressed with symbols
- Emotion therefore sometimes excluded from cognition

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Our Stance

- Emotions and feelings naturally belong to cognition and can be explained computationally
- Emotion is more fundamental than symbol manipulation
- Cognition should be understood as computation in a wider sense than symbol manipulation
    - Symbolic *and* subsymbolic computation

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The Mind-Body Problem

- Mind = body?
- Mind is a process, not an object
    - "Minds are what brains do" (Minsky, 1988)
    - The embodied brain is necessary and sufficient for, but not equal to, the mind

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- Is naturalism incapable of explaining qualia?
  - A simple feature of a natural organism
  - No two individuals are identical
  - May be unique to each individual, but so is e.g. handwriting
  - *Can* be communicated and interpreted, even if the difference is big
- *Cognition is not the brain*

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Generative Reduction

- Goal: understanding cognition, including emotion and feeling, from the molecular level up
- Reduce complex processes to interactions between simpler processes
    - Molecules and chemical processes in networks of molecules
    - Cells and aggregates of cells
    - Organisms and social networks
        - Yes, including Facebook
- Model cognitive processes emerging on different scale levels in living organisms based on understanding of the underlying levels

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- This goal is still far off, but starting from the simplest form of cognition in the single cell, we can use that knowledge to understand the next level of organisation, and so on

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- The chemicals that mediate emotion are used to coordinate behaviour of single cells in bacterial colonies
  - Neurotransmitters: short range
  - Hormones: long range
- Emotion is used to orchestrate and direct cognitive subprocesses
  - Performance of the organism thus increases
  - Meta-computing, optimisation
- Guides behaviour without the need to resort to slow symbolic reasoning

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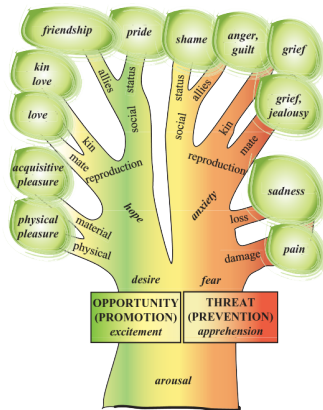
The Evolution of Emotion

Image from Nesse, R.M. 2004. Natural selection and the elusiveness of happiness.

Philosophical transactions of the Royal Society of London. Series B, Biological sciences. 359, 1449 (2004), pp. 1333–1347.

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The Need to Modulate Learning

- Environment dynamics may change rapidly for complex organisms
    - Failure to adapt could mean death
- Long-term or short-term optimisation?
- Exploration or exploitation?
- Quick or slow learning?
- Depends on the situation!

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The neuromodulators responsible for human emotion have also been shown to modulate (reinforcement-)learning metaparameters (Doya, 2002):

- Acetylcholine: learning rate
- Noradrenalin: exploration/exploitation tradeoff
- Serotonin: discounting factor
- Dopamine: discrepancy between expected and actual reward

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- Appraisal of the situation along a number of objective dimensions gives rise to (some) emotions
  - E.g. conduciveness, unpredictability, control, discrepancy from expectation...
  - A point in multidimensional space
- Emotion is connected to the value function, and thereby to learning and optimisation

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- Emotion as a cognitive process can be connected to its biochemical generative basis
  - This does not reduce emotion to a chemical any more than naturalism reduces mind to the brain
- Emotion can – and perhaps *must* – be studied as a computational process on all levels of abstraction
  - There is no need for mystification

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