Towards an affective computational model for machine consciousness

Dr. Rohitash Chandra

1. Centre for Translational Data Science
http://sydney.edu.au/data-science
2. Discipline of Business Analytics
School of Business

THE UNIVERSITY OF SYDNEY

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Overview

Background on Consciousness Studies

- What is consciousness?
- Do you experience consciousness?
- Why is there a need for consciousness?
- Do we need machines to be conscious?

Background on Consciousness Studies

- John Searle defines consciousness as all states of experience which includes the waking and sleeping states. Dreaming state hence is also part of conscious experience.
- In an attempt to empirically study consciousness, Tononi proposed the information integrated theory (IIT) of consciousness to quantify the amount of integrated information an entity possesses which determines its level of consciousness.
- IIT - Conscious experience or Qualia?
- David Chalmers - defined “hard problem of consciousness. He highlighted the explanatory gap in defining consciousness and indicated that the hard problem of consciousness emerge from attempts that try to explain it in purely physical terms.

Background on Consciousness Studies

- Chalmers argued that the science of consciousness must integrate third-person data about behavior and brain processes with first-person data about conscious experience. Some examples include comparing conscious and unconscious processes, investigating the contents of consciousness, finding neural correlates of consciousness, and connecting consciousness with physical processes.
- "Hard problem of consciousness refers to conscious experience - which cannot be replicated or defined according to Chalmers. The other problems are known as the easy problems, which are interesting and more achievable, such as natural language processing, speech recognition and motor control.

Background on Affective Computing

- The field of affective computing focuses on the development of systems that can simulate, recognize, and process human affects which essentially is the experience of feeling or emotion. Affective computing could provide better communication between humans and artificial systems that can lead to elements of trust and connectivity with artificial systems.

Overview

- An affective computational model for machine consciousnesses is presented that features an algorithm for management of the major aspects of consciousness that range from information processing to critical thinking.
- Real-world problem scenarios is presented to further illustrate the functionality of the model and a road-map for software-based implementation has been also discussed.

Elements of Consciousness

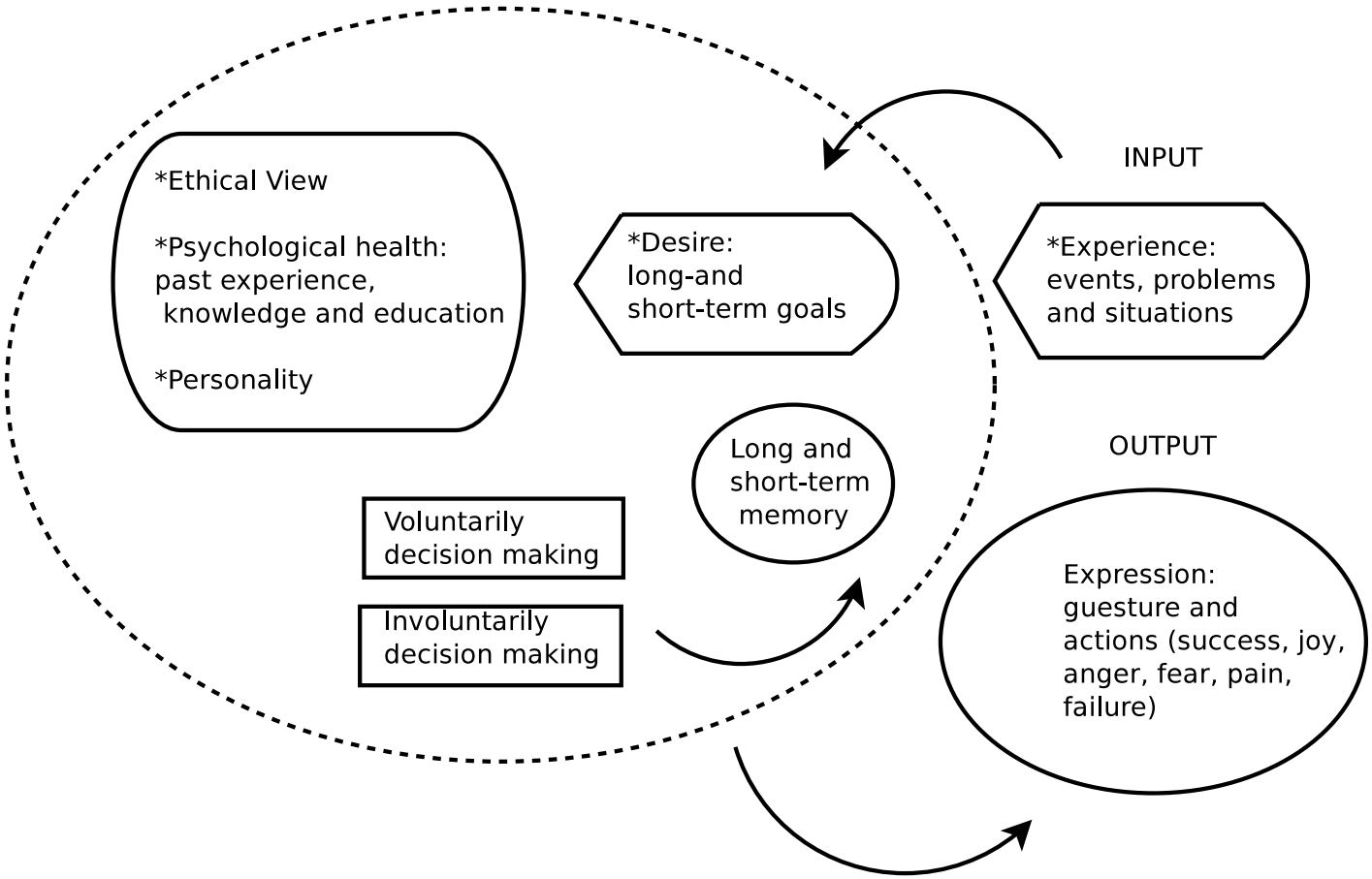


Figure: Response after processing the features that contribute to a system that replicates elements of consciousness

The Conscious Observer

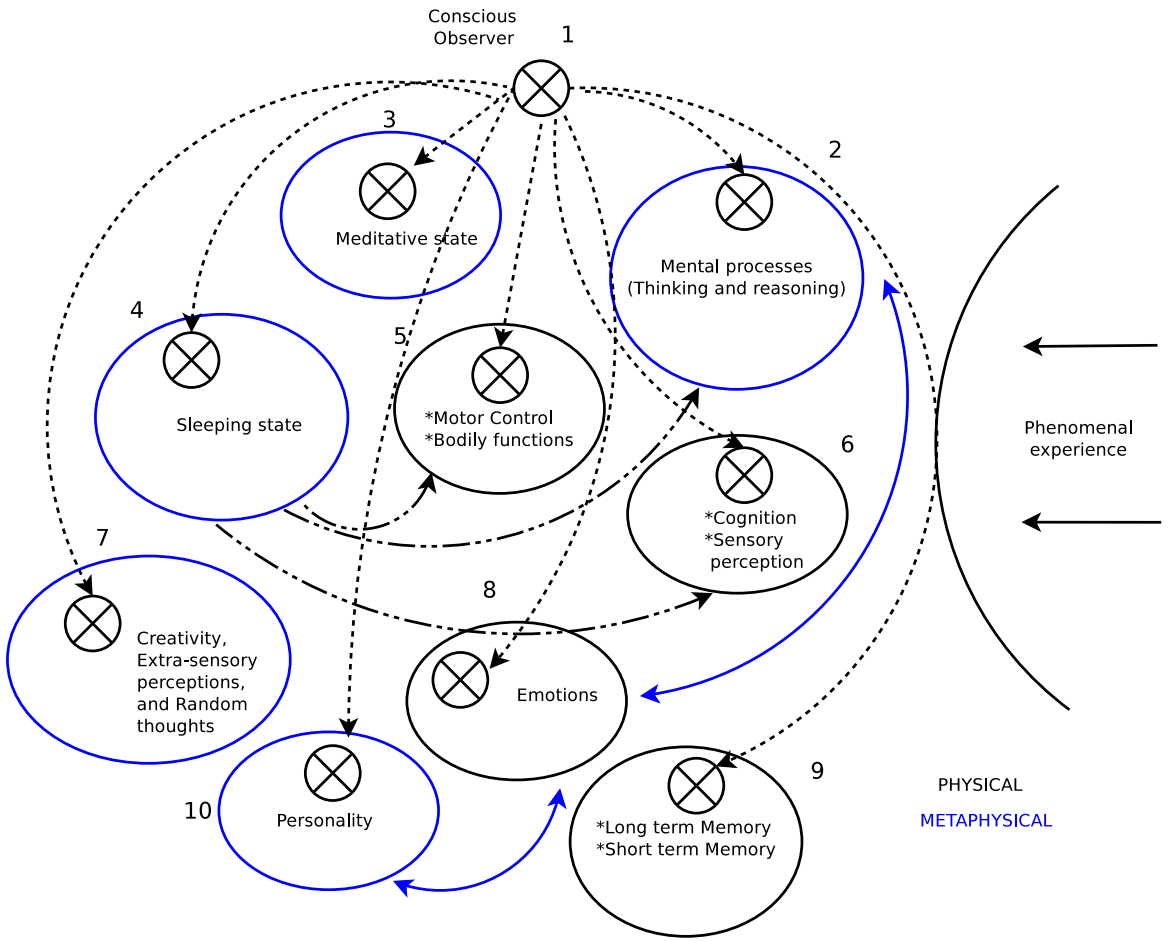


Figure: The conscious observer is defined as the root of consciousness which is also referred to as "qualia". It can enter different states while also having the property to exist within two states, i.e it can self-replicate as a process, gather knowledge and update long and short-term memories. The blue states are metaphysical and black states are physical.

Scenario 1

Ramon is traveling on a flight from India to Japan and has a connecting flight from Shanghai, China. His flight lands in Shanghai and he is required to make it to the connecting flight gate. Ramon's boarding pass has gate information missing and since his flight landed about and hour late, he needs to rush to the connecting gate. Ramon is not sure if he will pass through the immigration authority. His major goal is to reach a connecting flight gate. In doing so, he is required to gather information about his gate and whether he will go through the immigration processing counter. He encounters a series of emotions which includes fear of losing the connecting flight and hence exhibits a number of actions that show his emotive psycho-physical states which include sweating, exaggerating while speaking and even shivering due to fear.

Evaluation

1. Exit flight and find the way to transfer desk.
    1. Search for information regarding "transfers and arrivals" through vision recognition system (State 2 and then State 6).
    2. Process information and make decision to move to the area of "transfers" (State 2 and State 5).
2. Since information that no baggage needs to be collected was already given, check boarding pass for baggage tag sticker.
    1. Process visual information by checking boarding pass (State 2 and 6)
3. Confirm with the officer at transfer desk if there is a need to go through the Immigration Counter.
    1. Find and walk to transfer desk (State 2, 6, and 5)
    2. Communicate with the officer at transfer desk (State 2 and 6)
    3. Fear and emotions during communication (State 2, 5, 8, and 10)

Evaluation

1. Information was given by the officer that there is a need to go through immigration booth, hence, prepare boarding pass and passport.
    1. Rush to the immigration processing section (State 5 and 6).
    2. Wait in queue and go through a number of emotions such as fear of losing flight and also sweat (State 5, 6, 8, and 10).
2. After immigration processing, find gate information and move to gate and board connecting flight.
    1. Rush to the gate. In the process breath heavily and also sweat (State 2, 5, and 6).
    2. Wait at the gate with some random thoughts and then board when called (State 7, 8, 6, 2 and 5).

Artificial Qualia Manager - Algorithm

Alg. 1 Artificial Qualia Manager

Data: Data from sensory perception (video, audio, and sensor data)
Result: States for consciousness
Initialization (knowledge and personality)

Φ is the list of states
Σ is the final gaol to reach
Ω is the list of actions required to reach the goal

while *alive* **do**
  traverse-states(Σ, Φ])

  while *goal* Σ *not reached* **do**
    if *challenge* **then**
      1. Nominate a state
      2. Attend to challenge (injury, pain, emotion)
      3. Store short-term and long-term memory

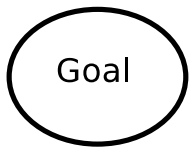
    end
    if *goal* Σ *reached (success)* **then**
      1. Output through expression (action, gesture, emotion)
      2. Store short-term and long-term memory

    end
    if *goal* Σ *not reached (failure)* **then**
      1. Output through expression (action, gesture, emotion)
      2. Store short-term and long-term memory

    end
  end
  1. Generate random thoughts based on problem and emotion
  2. Automated reasoning and planning for states needed for future goal(s)
  3. Address the requirements to revisit failed goals

end

Artificial Qualia Manager



Successful -> Action

Not Succesful -> Try Again or Quit

0. Control (Walk, Raise Hands, Run, Move around, Move Head)
1. Perception (Read, Listen, Focus, Scan, Recognize)
2. Emotion (Anger, Fear, Joy, Trust, Disgust, Sadness, Surprise)
3. Memory (Short term, Long term)
4. Reasoning (Generate series of options and weigh them)
5. Personality (Conscientiousness, Openness, Extraversion, Aggreableness, Neuroticism)
6. Meditative (Complete rest)

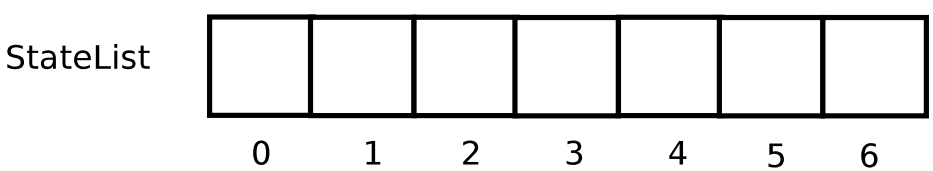


Figure: States in affective computational for the artificial qualia manager

Implementation Strategies

- The affective computational model can feature multi-task learning for replicating sensory perception through recognition task that includes vision, sensory input for touch and smell and auditory tasks such as speech verification, speech recognition, and speaker verification.
- Shared knowledge representation would further be used for recognition of objects, faces or facial expression where visual and auditory signals would be used in conjunction to make a decision.
- Furthermore, language models that feature neural networks could be used in conjunction with speech recognition methods.
- Deep learning methods could also be used to convert video-based input to natural language that could be used by the affective model.

Discussion

- It is important to highlight the potential of animal consciousness as it can motivate models for consciousness that fill the gaps in models for human consciousness.
- For instance, a robotic system that can replicate cognitive abilities and level of consciousness for rats can be used for some tasks such as burrowing holes, navigation in unconstrained areas for feedback of videos or information, in disasters such as earthquakes and exploration of remote places, and evacuation sites.
- Such an affective model, with future implementations could give rise to household robotic pets that would have or could develop emotional relationship with humans.
- Humans are well known to be poor decision makers when in emotional states which also resort to level of aggression and violence.

Conclusions and Future Work

- Affects in computational model for machine consciousness in order to give a human-like expression or behavior for artificial systems. The challenges lie in further refining specific features such as personality and creativity.
- The simulation for affective model of consciousness with the features of artificial qualia manager can also be implemented with the use of robotics hardware.
- The affective model is general and does not only apply to humanoid robots, but can be implemented in service application areas of software systems and technology.
- Future research could concentrate in simulation of the proposed model and development of areas such as artificial personality in machine consciousness.

Thank You

More information: https://rohitash-chandra.github.io