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Bringing Mobility Back With Artificial Neural Connections

The Problem & Why it is difficult
Restoring mobility to individuals who are paralyzed is in ongoing research. AI in this field would not be possible without the use of biosensors and brain-sensors. These sensors create a direct connection from the brain to the agent. In this idea, the agent is embedded in an artificial spinal cord, or a section thereof, that has been used to replace a damaged spinal cord. The agent is designed to read the sensor data points of all possible brain activity and other biosensor readings from devices implanted on the body in the form of wearable technology, such as sunglasses that monitor the position of the eyes, size of the pupils to name a few, etc.

Besides the usual impediments such as materials, funding, health, safety, etc. the problem with designing an AI agent is that the many data points received by the agent must be interpreted and understood so that mistakes are not made in sending the proper nerve impulses throughout the body. To this end, we can use constraints and learning by correcting mistakes in our attempt to design an agent that would bring needed and correct mobility back into a person's life.

A Design Using Constraints and Learning By Correcting Mistakes

Constraint Propagation is a method of inference that assigns values to variables characterizing a problem in such a way that some conditions are satisfied. This involves repeated task decomposition. In my example, there are many tasks involved in even what seems like a simple motor operation, such as lifting a cup. In order to lift a cup, the agent must expect certain constraints to be present, such as outlined below:

> Variables
> vision: eyes looking right
> facing direction: right
> neck angle: 45°
> saliva: increase
> object recognition: yes
> object identifier: cup
> inference: human desires to pick up cup

Similarly, you could apply different constraints for picking up a piece of paper and holding in front of the eyes:

> Variables
> vision: eyes looking straight
> facing direction: forward
> neck angle: 35°
> saliva: normal
> object recognition: yes

object identifier: paper
inference: human wants to read

Variables
vision: eyes looking right
facing direction: right
neck angle: 45°
saliva: normal
object recognition: yes
object identifier: tv remote
inference: human wants to watch tv

Variables
vision: eyes down, forward
facing direction: straight
neck angle: 10°
neck position: down
object recognition: yes
object identified: dog
inference: human wants to approach dog

Configuration is a problem solving activity that assigns values to variables to satisfy constraints. So, if the inference is that the human wants to pick up a cup, the agent could expect impulses to be received from the brain which the agent would pick up and relay to the nerve centers of the right shoulder, elbow and hand. I don't know much about biology or the nervous system, but the configuration could consist of defined pathways to the nerve center needed for the intended movement. The configuration would contain several sub tasks, such as

A. using visual data from the sunglasses, measure the distance of the object from the hand
B. impulses to rotate or raise the right shoulder up and away from the body
C. impulses to extend the elbow either inwardly or outwardly depending on data point A
D. impulses to the the hand to grasp the cup and maintain its hold on the cup
E. impulses to the elbow and shoulder, once again to lift the cup to the mouth
F. finally, repeat the configuration for returning the cup to the table

Learning from Mistakes

Finally, how can the agent adjust for, or compensate for its mistakes? It would first need to know and understand that a mistake has been made. This could perhaps be monitored by the humans frustration level using data points collected from the sensors located in and around the brain's emotional center - the Limbic System. Incidentally, the Limbic System is where memories are formed and housed in the brain, and ethical arguments aside, perhaps this could be "mined" somehow as well.

So, the agent receives impulses from the brain and with it's data points received and mapped the agent mistakenly overreaches the cup. How can the agent isolate this error in it's former model? The agent could relook at the constraints and verify it's mapping:

<u>Variables</u>
vision: eyes looking right
facing direction: right
neck angle: 45°
saliva: increase
object recognition: yes
object identifier: cup
inference: human desires to pick up cup

How can the agent explain the problem that led to the error? The agent could reason that the cup was only 7 cm away from the hand. The agent could reason that the angle of the cup is directly associated with the angle of the facing direction combined with the angle of the eyes and chin. The agent would realize that there are more measurements to be considered, or perhaps the agent considered them the first time around, but the human sneezed and/or moved, altering the data. This learning is incremental and explanation based. Before a movement is attempted, the agent can revisit past failures to ensure they do not happen again, if avoidable.

So, now armed with the reason for overreaching the cup, the agent can repair the model to prevent the error from reoccurring. The agent could re-baseline it's position in space (much like a positioning system, now that I think about it). The agent could take in more knowledge of the world and try to understand what led to the initial failure and reattempt the configuration.

The errors may not only lie in the knowledge or the reasoning but could also originate in the architecture of the agent. Over time, sensors are likely to become faulty, or the implant can become misplaced. Maybe there are false-suspicious features at play here. Perhaps the human has arthritis or an injury that prevents full extension of the arm. The agent must be able to classify its knowledge of failures to broaden its accuracy and usefulness.

Conclusion
Of all the uses for artificial intelligence, I believe the most rewarding and noble of them to be in the use of artificial motor capabilities and transplant technologies. To give this to a person in need, who has known immobility and has suffered greatly because of it is a true accomplishment. It is an accomplishment beyond measure of the intellect, perseverance, ingenuity, compassion, creativity and selflessness of the human spirit. These and more are what has made us beautifully human. These and more are why we strive to build the same into artificial agents. Just as the poet seeks to write of human compassion, of experience, just as the poet seeks to draw out the full emotions of the reader, the computer scientist too, is also wrought with passion in it's quest to express humanity and intelligence in all it's beautiful forms.