**Docket #:** S13-061

# Brain machine interfaces incorporating learned dynamical structure in the brain

Millions of people are unable to move due to neurological injury or disease. Brain-machine interfaces seek to restore lost motor function to patients suffering such neurological deficits. Stanford researchers have discovered a way to provide a new class of brain-machine interface (BMI) algorithms to significantly improve performance over existing algorithms. These novel algorithms utilize learned dynamical structure in the brain for BMIs. This dynamical structure assumes an underlying lower-dimensional and latent state in the brain ("neural state"), which is the state of a dynamical system. If the dynamical structure is present in the brain, then decoding algorithms can leverage said structure to improve the performance of a BMI.

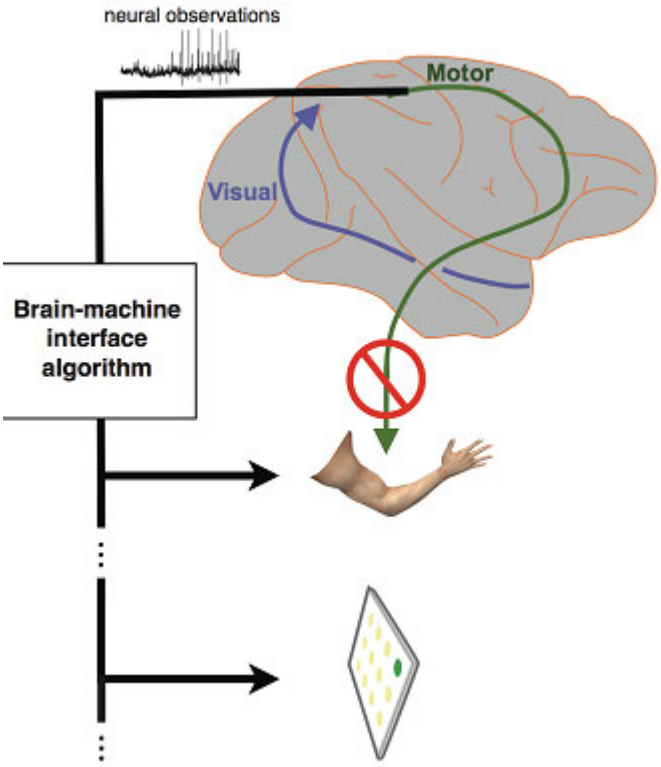



**Figure 1** - BMI seek to restore lost motor function

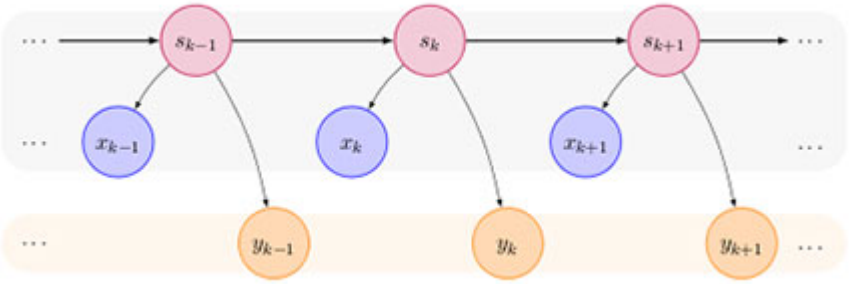



**Figure 2** - An example graph theoretic implementation of a dynamical BMI. The BMI incorporates an underlying neural state, $s_k$, which obeys dynamics and generates both the kinematics of the prosthetics device ($x_k$) and the neural data observed ($y_k$).

## Applications

- Wide applications to the design and optimization of BMI algorithms, which allow the incorporation of fundamental knowledge of the dynamics of the evolution of neural state.

## Advantages

- By incorporating information about the dynamics of an underlying brain state, the BMI's versatility, speed, and accuracy can be increased.

## Publications


- Churchland MM*, Cunningham JP*, Kaufman MT, Foster JD, Nuyujukian P, Ryu SI, Shenoy KV (2012) "Neural population dynamics during reaching". *Nature*. 487:51-56.
- "Stanford researchers reveal more about how our brains control our arms". *Stanford Report*, January 28, 2014.


## Patents

- Published Application: 20140257520
- Issued: 9,095,455 (USA)

## Innovators

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