

Reinforcement learning for adaptive brain-machine interfaces

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Consider the application of reinforcement learning (RL) to brain-machine interfaces (BMI) introduced by DiGiovanna et al. (2009). Write a brief paper about this topic, integrating answers to the following questions in the logical flow of your paper.

- Describe RL in general terms. Why is RL appropriate for the BMI application considered in this paper? For this particular application, how does RL compare with supervised learning?
- Two learning entities (one flesh-and-blood being, one artificial agent) are coupled together in this approach. While that increases the adaptability of the overall system, could it also potentially have a detrimental, destabilizing effect?
- Explain the meaning of the term *shaping* in the RL literature. How is shaping used in the BMI approach of DiGiovanna et al. (2009)? In your opinion, is the rats' pre-training phase (Section II-B) a part of the shaping process, or not? Why?
- The computational agent only receives as input the neural firing patterns of the rat. Do you think that additionally including the state of the robot arm in the computational agent's input would have been useful in achieving more effective brain control? Motivate your answer.
- Explain the meaning of the concept of *experience replay* in the RL literature. Where is experience replay used in the BMI approach of DiGiovanna et al. (2009)? How does it help?

Do not restrict your reading to this single article (DiGiovanna et al., 2009). Instead, search for related articles as needed; a sufficient understanding of the subject will most likely require further reading. For instance, some of the questions above cannot be answered without investigating the literature.

References

- DiGiovanna, J., Mahmoudi, B., Fortes, J., Principe, J. C., and Sanchez, J. C. (2009). Coadaptive brain-machine interface via reinforcement learning. *IEEE Transactions on Biomedical Engineering*, 56(1):54–64.