

The Natural Language of Actions

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ICML 2019

Technion Institute of Technology

What is Language?

'Language is a purely human and non-instinctive method of communicating ideas, emotions, and desires by means of voluntarily produced symbols.'

Edward Sapir, 1921

What is Language?



Contextual Representation

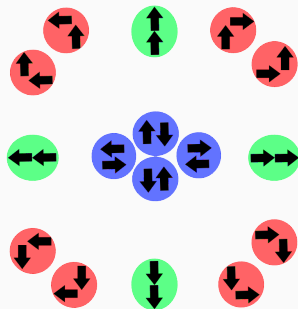
A word's contextual representation is an abstract cognitive structure that emulates from encounters with the word in various linguistic contexts.

We learn new words based on contextual cues

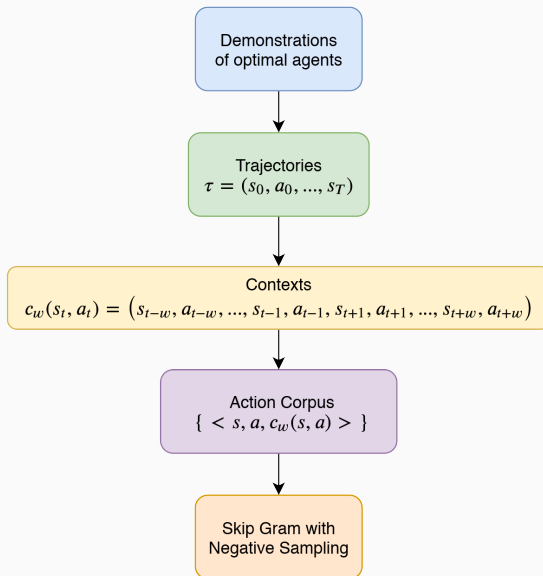
- I saw a little *yazuba* sleeping behind the tree.
- One glass of *feandra* is enough to get you drunk.

Characteristics

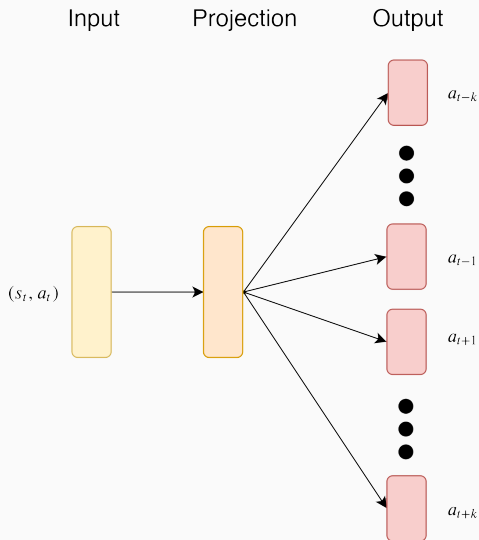
- Actions characterized by the company they keep
- Context is generated by an optimal agent
- Agent demonstrates acceptable behavior in the environment



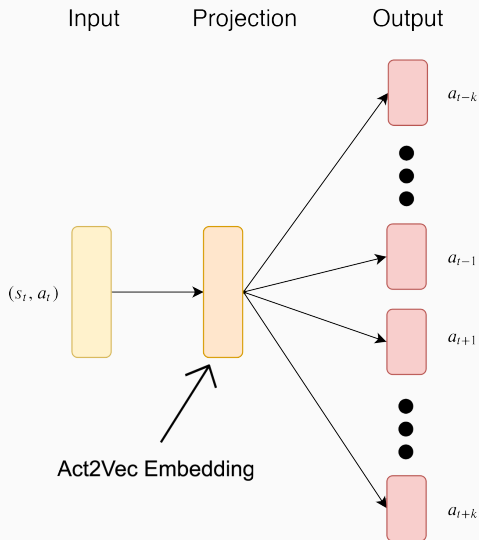
Act2Vec



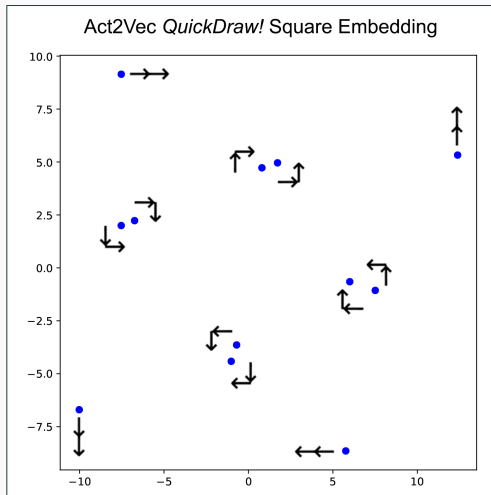
Skip Gram (used in Word2Vec)



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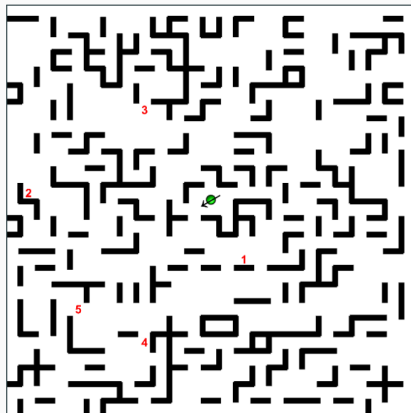


- 70,000 human drawn squares from the *QuickDraw!* dataset
- Strokes correspond to two operations

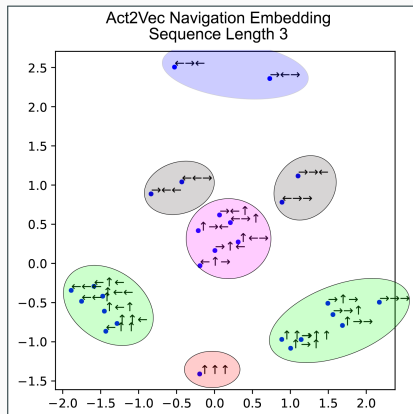
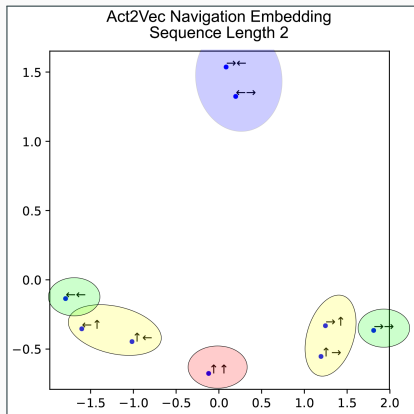


Act2Vec embedding trained in 2d environment on actions sequences of primitive actions:

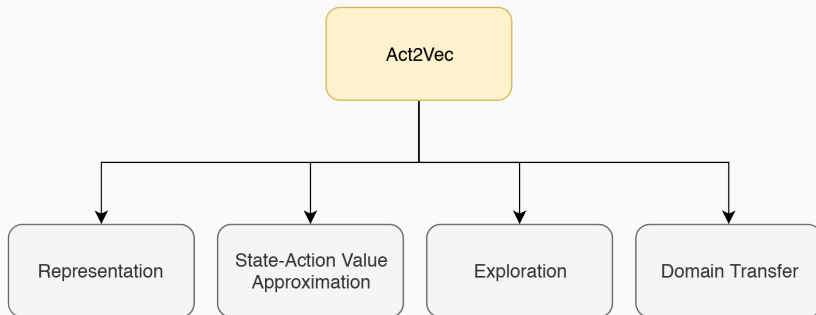
- Move Forward 1 unit
- Turn Left 15 degrees
- Turn Right 15 degrees

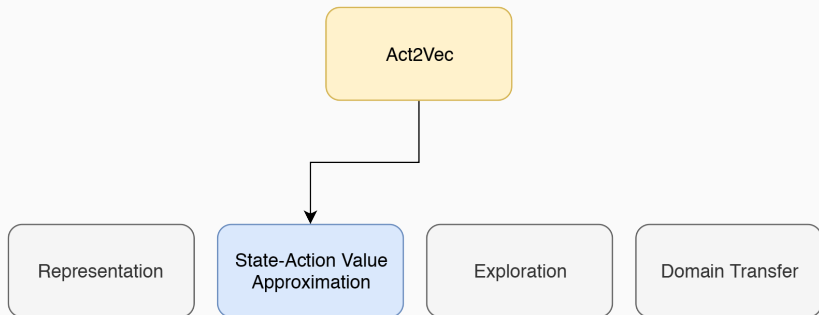


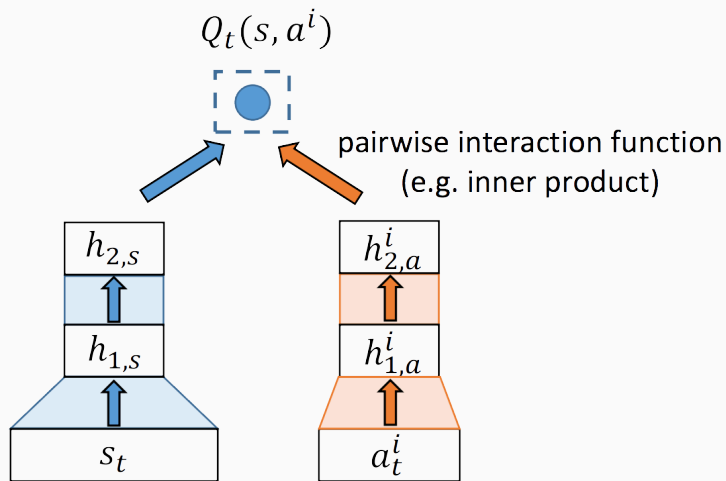
Act2Vec: Navigation



Act2Vec in Reinforcement Learning

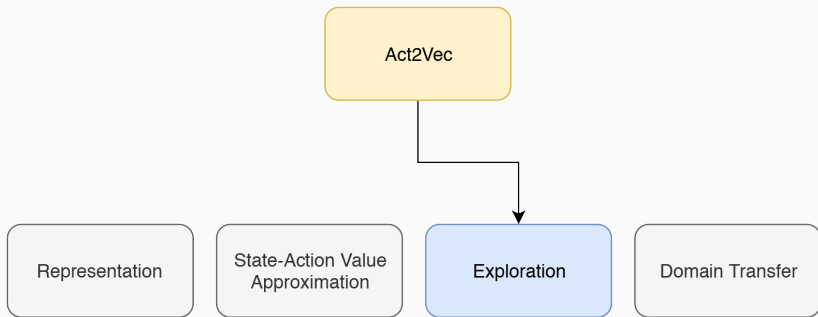






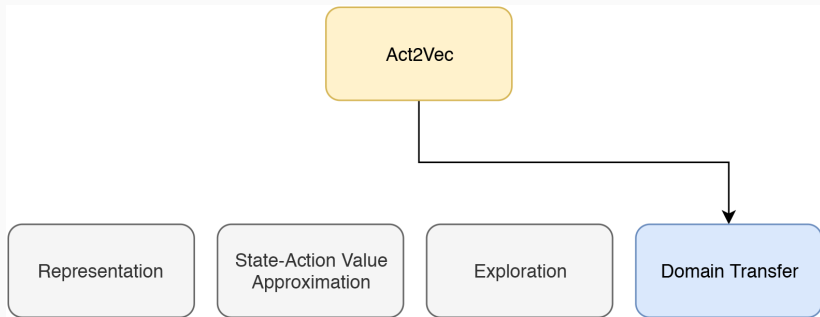
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¹He, Ji, et al. "Deep Reinforcement Learning with a Natural Language Action Space." Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics (2016).

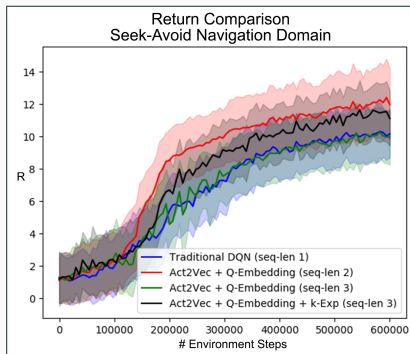
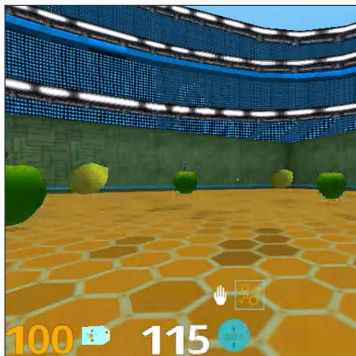


k-Exp

- Divide action embedding space into k clusters using a clustering algorithm (e.g., k -means)
- Sample a cluster uniformly
- Given a cluster, uniformly sample an action within it

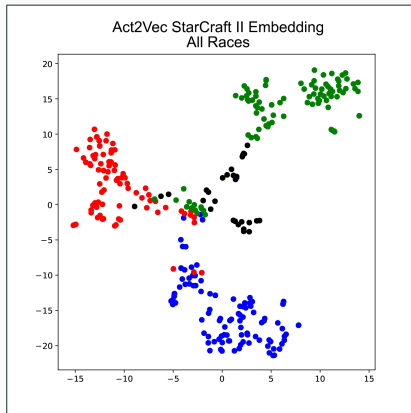


Transfer to 3d environment

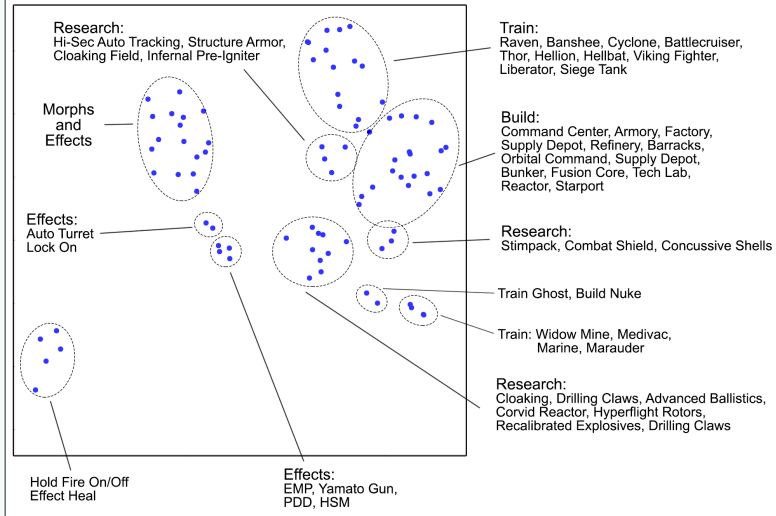


The Semantics of Actions in Starcraft II





Act2Vec StarCraft II Embedding Terran Race



Conclusion

- Actions are thought of as symbols of a natural, expressive language
- Actions represent thoughts, beliefs, and strategies
- Their meaning is captured through their context
- Similarity between actions helps reduce cardinality of action space
- Prior knowledge is incorporated through action representations