A Plug-and-Play Software Platform of Robotics-Inspired Algorithms for Modeling Biomolecular Structures and Motions

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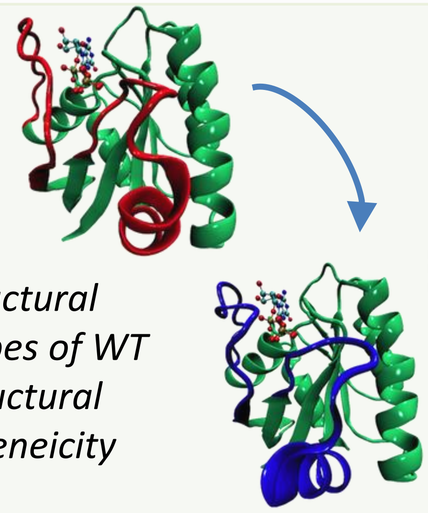
- ❑ *Objective:* Advance algorithmic research in molecular biology through a plug-and-play platform of open-source software elements.
- ❑ *Motivation:* Address algorithmic impasse faced by computational chemists and biophysicists in structure-function related problems involving dynamic biomolecules.
- ❑ Premise: Impasse can be addressed by integrating efforts of AI researchers on search and optimization algorithms for complex modular systems, bringing two communities together to advance biomolecular modeling and simulation.

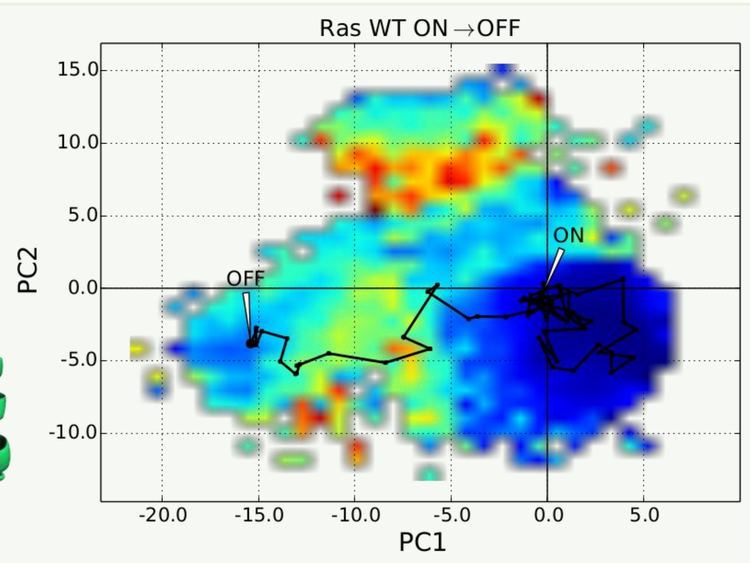
Application Setting:

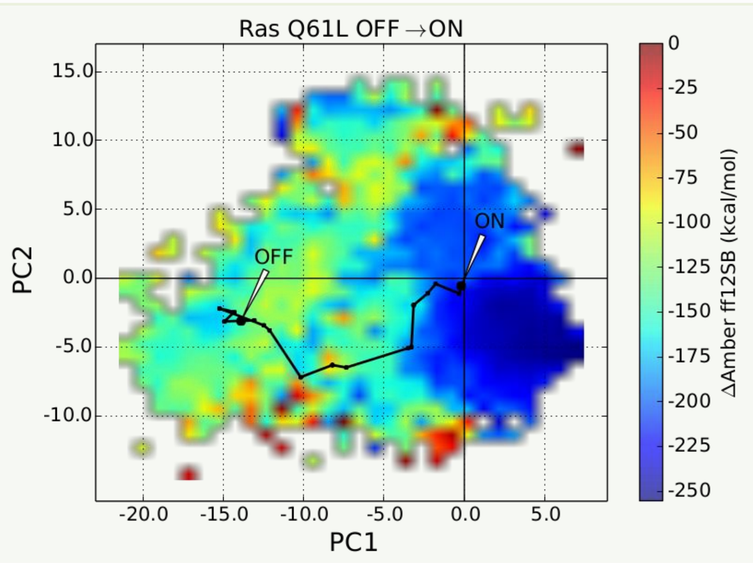
Protein and peptide structure and dynamics

Preliminary work:

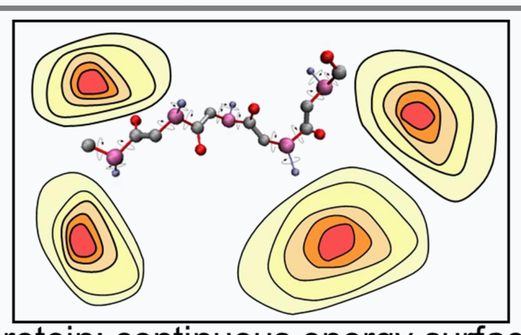
Determination of on and off structural states of H-Ras, energy landscapes of WT and oncogenic variants, and structural transitions for explaining oncogeneicity



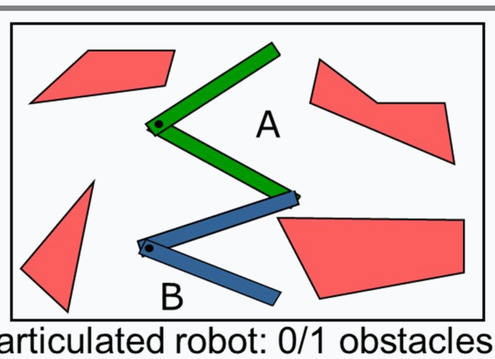




Software elements will integrate powerful search and optimization algorithms inspired from robot motion planning with sophisticated energetic models and molecular representations grounded in the latest understanding of protein biophysics.



protein: continuous energy surface



articulated robot: 0/1 obstacles

- ❑ *State in AI:* Powerful search and optimization algorithms beyond MD/MC but limited in applicability.
- ❑ *State in Computational Chemistry and Biophysics:* Saturation point due to inability to go beyond MD setting with state-of-the-art force fields.
- ❑ Challenges: integrate through object-oriented interface.

Contributions:

- ❑ Open-source software elements to conduct diverse structure-function studies in wildtype and variant protein sequences.
- ❑ Support of well-established software, such as AMBER and Rosetta.
- ❑ Intuitive python interface to facilitate usage by dry- and wet-lab biologists, chemists, and biophysicists.
- ❑ Plug-and-play feature to put together novel algorithms and so further drive algorithmic research in both AI and computational biophysics.
- ❑ Active education of involved communities through workshops, tutorials, and software demos at widely-attended conferences and society meetings.

Preliminary work in Publications:

Molloy K, Shehu A. Robotica 2015
Clausen R., Ma B, Nussinov R, Shehu A. PLoS Comp Biol 2015
Le D, Plaku E. IROS 2014; McMahon J, Plaku E. IROS 2014.

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