MANA: Molecular Analysis of Non-Adiabatic Activity

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Photodynamic Therapy (PDT) is a non-invasive treatment for esophageal, skin, and non-small-cell lung cancers that relies on light-activated drugs called photosensitizers to generate cytotoxic singlet oxygen. Despite its clinical success, PDT is severely limited by a shortage of optimized photosensitizers. Current discovery techniques, such as Density Functional Theory and wet-lab synthesis, take anywhere from hours to weeks, making screening large libraries difficult. AI has been used to help speed up this task, yet most AI models analyze molecules as 2D fingerprints, ignoring important 3D structures, or they analyze molecules in a vacuum, ignoring the 3D interactions between the solute and solvent, leading to poor clinical predictions. To accelerate the discovery of effective cancer treatments, there is a major need for a high-throughput system capable of modeling these 3D environmental interactions to screen millions of candidates in seconds rather than days. MANA achieves this by using a novel dual-graph architecture with a pre-existing E(3)-equivariant backbone called PaiNN to model molecules as 3D geometric graphs, taking in information about not only the photosensitizer, but also its environment. MANA was able to pass all three of its engineering goals, accurately predicting absorption wavelength and singlet oxygen quantum yield (a measure of efficiency), ranking photosensitizers correctly, and generalizing to unseen families. MANA was then further used to screen a library of nearly 400,000 potential candidates, identifying 40 candidates outperforming current candidates used in PDT today. If these candidates were synthesized and tested-in lab, they could help treat cancer better than ever before.

Awards Won:

Association for the Advancement of Artificial Intelligence: AAAI Student Memberships for each finalist that is part of the 1st, 2nd, and 3rd Prize Winning projects and 5 Honorable Mention winning projects (up to 3 students per project) (in-kind award / part of the 1st-3rd prize)