Syosset STEM Newsletter

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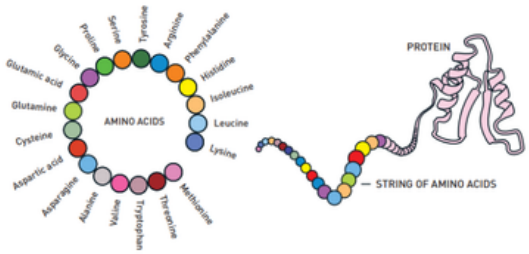
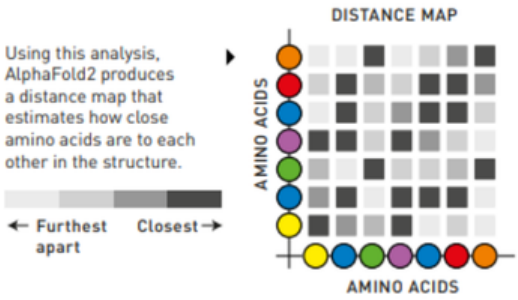
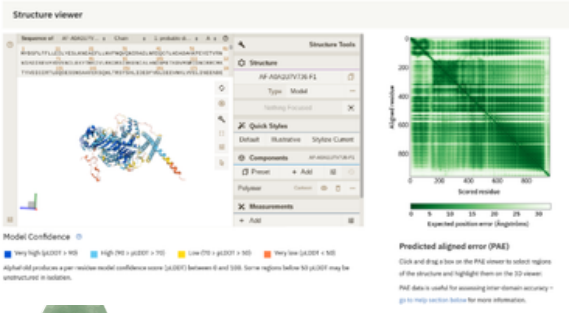
Predicting the Unpredictable: A New Way to Discover the Structure of Life's Building Blocks

by Ashvik Varma



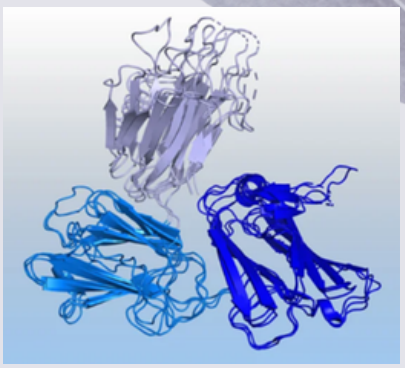




In Stockholm, Sweden, on October 9, 2024, David Baker, Demis Hassabis, and John Jumper all won the Nobel Prize in Chemistry, awarded by the Royal Swedish Academy of Sciences.

Half of the prize went to Hassabis and Jumper, who used artificial intelligence to determine, with a lot of accuracy, the chemical shape of all currently known proteins. The other half went to Baker, who was able to create completely new proteins.

All proteins are formed by amino acids, of which there are 20. Each protein is made up of its own distinct sequence of these amino acids, all lined up in a specific order. The protein then folds over itself and creates its own distinct shape, which is determined by its sequence. The shape is essential in determining the protein's function. Proteins are incredibly important to both the body, and in medicine. Enzymes, a type of protein, carry out most chemical processes in a cell. Antibodies are another type of protein, and they help in protecting the body from pathogens. Many vaccines are protein-based, such as a protein subunit vaccine that was used during the COVID-19 Pandemic.



In 2020, Hassabis and Jumper created AlphaFold2, a database that, when given a sequence of amino acids, uses artificial intelligence to determine the shape of the protein it'll create. First, AlphaFold2 searches other protein databases, if the structure is already well known. Then, if it's not well known, the AI model tries to determine where the sequence will fold over. It uses some tricks to determine where the protein will fold over. For example, a positively charged molecule will attract a negatively charged molecule, and vice versa. Also, if a molecule is polar or nonpolar, it will attract molecules with the same polarity. A distance map is then created, which estimates how close every amino acid is to every other amino acid. Next, the AI model uses neural networks to refine the distance map, using well known proteins to adjust the map. Finally, the amino acids are put together by AlphaFold2, with a protein structure being created. The structure is replaced into the AI model to adjust for errors, until a protein structure is accepted. Currently, its proteins have over a 90% accuracy. The database for the proteins is open source, and the paper for the database has been cited over 30,000 times.

AlphaFold is already helping in creating a large impact around the world. For example, using the database, researchers are closer than ever at creating a vaccine for malaria, with possible vaccines having a 30% and 77% efficacy rate. Additionally, even in non-medical fields of science, AlphaFold can be used. For example, proteins can also capture carbon in the atmosphere or deteriorate plastic, helping lessen the effects of climate change.

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Catching up with our Science Olympians

Sean Yang

The Syosset Varsity SciOly team recently won first place at the Science Olympiad at Cornell Invitational for the second year in a row! Though the Junior Varsity team was not so fortunate this time, they are maintaining a very healthy mindset moving forward. We checked in with four of our members after the competition.

Derek Huang, a junior, is competing in Astronomy and Forensics this year. He stated that he found his events to have more depth than topics traditionally covered in the classroom. “There’s more to learn than you might expect at first,” explains Derek.
About his experience at the Cornell Invitational, Derek remarked, “I definitely enjoyed it. It was an amazing experience overall, especially beyond just competing. Explor[ing] the campus… and hav[ing] fun with my teammates made this first invitational an incredible one.” Continuing about the team’s performance, “As the JV team, we did not place as well as we had hoped to, but it set a precedent that we needed to work harder and improve for our future invitationals… but of course, we were all proud of the Varsity team’s win.”

Roger Yi, a sophomore, is competing in three events this year: Dynamic Planet, Geologic Mapping, and Fossils. He believes that SciOly has something for everybody interested in STEM. “[SciOly] offers many events. I think anyone interested at all in STEM can find something at SciOly to compete in,” says Roger passionately.
Regarding Cornell, Roger felt that Varsity did a great job, with everyone playing their part to contribute to the first place win, and that, though Junior Varsity did not win overall, this first invitational built chemistry within the new team and posed a “positive learning experience” for all members.

Grace Lu is competing in four events this year — Experimental Design, Optics, Wind Power, and Robot Tour — the latter of which is a build event, requiring students to pre-build a programmable robot to control across a track on competition day. She expressed that she enjoys the aspect of teamwork and getting to work with friends on these events.
About Cornell, Grace said, “[Varsity] placed first, but a lot of people, individually, feel that we could’ve done better, and I think that’s true… we’re going to work harder for our next competition and hopefully beat ourselves.”

Shawn Lim is competing in four events as well: Codebusters, Disease Detectives, Ecology, and Helicopter. A few weeks ago, he was spotted practicing decoding ciphers using an online tool. He shared that he finds his events enriching and that they promote his critical thinking, especially Codebusters, where the solution to ciphers isn’t always immediately obvious despite the experience he has.
About Cornell, Shawn noted retrospectively, “I think it was a good practice experience for JV. We definitely could’ve done better, but since it’s our first comp[etition] of the year, I’m not that disappointed! There’s a lot of room for improvement… since JV doesn’t usually get the opportunity to go to some of the more challenging competitions with harder tests, we learned a lot.”

In their statements regarding competition, one may notice that all four of the interviewed team members used growth-oriented language — “improve”, “learning”, “beat ourselves” — a testament to the strong work ethic that our members have. They seem to never be complacent nor beaten down, standing vehemently for their motto, “success is not an option; it is an obligation.”

The Syosset SciOly team achieving 6th at the national competition, 2024

Additionally, all four had attested to the tight-knit community that SciOly has gathered for each generation of students. Derek stated that alumni often keep in touch and share wisdom with the current team and its incoming members through their club-wide Discord server. Grace discussed that she often hangs out and studies with her teammates during their competition season. Shawn recalled last year's year-end formal where they gave bittersweet send-offs to the graduating seniors, to which alumni were also invited.

The continued involvement of alumni highlights the everlasting nature of the roots that students find in the SciOly community, both academic and social.

The Syosset SciOly team achieving 6th at the national competition, 2024

Syosset High School has participated in regional competitions beginning in 1986. Since 2012, led by Mrs. Mildred Castaneda, we have kept a streak of being first place at regionals. In 2023 and 2024, our team won first place at the state competition for the first two times in school history, and went on to achieve 12th and 6th at the national level, respectively.

With such a promising streak and a phenomenal start to the year, we are hoping to hear the best from our SciOly team during this current invitational season as well as their competition season in a few months! Several members of the team have expressed aspirations to win gold at nationals this year. Will the third time be the charm?

The 10th Anniversary of Christopher Nolan's 'Interstellar' and Its Cultural Endurance

By Kingsley Cheng

A decade has passed since the premiere of Christopher Nolan's Interstellar, yet it still remains commended for advancing the science fiction genre. What about the picture resonates with audiences, exactly? Simply put, the answer lies within both Nolan's (who collaborated closely with theoretical physicist Kip Thorne) devotion to scientific accuracy, as well as the film's examination of humanity's existential struggles. With Interstellar's rerelease in theatres becoming the highest-grossing IMAX re-release of all time, it is once again with the captivating return of Interstellar where Nolan's ambition synthesizes the film's starring physicists, astronauts, wormholes, and plot to save humanity with a poignant exploration of the human condition.

A widowed former NASA test pilot, Joseph Cooper (Matthew McConaughey) works as a farmer in a mid-21st century society plagued by crop blights - a society where NASA is prohibited by the government, students are taught that the Apollo missions were fabricated, and that there is nothing to be found among the stars. However, Cooper is led, in a miraculous fashion, by a gravitational anomaly within his house that creates dust patterns translating into the coordinates of a secret NASA facility. Enlisted on an expedition through a wormhole near Saturn leading to a system in another galaxy potentially housing habitable planets, Cooper accepts the journey in the chance that he may never see his daughter again, yet in the hopes of saving humanity. Filled with grief and regret, Cooper's journey is motivated by the promise of Professor John Brand (Michael Caine) to have solved the problem of gravity in transporting humanity across the universe upon his return, and in the hopes of returning to reconcile his relationship with 10-year old daughter Murphy Cooper (Mackenzie Foy) before she is lost to him by time, leaving her only with his wristwatch. The final but arguably most potent of the multiple climaxes in the nearly 3 hour-long film, with insufficient fuel Cooper sacrifices himself and robot TARS (Bill Irwin) in a last-ditch effort to reach the final planet, costing them 51 years and already having lost multiple decades due to time dilation on the others. Saving only remaining crew member, Dr. Amelia Brand (Anne Hathaway), Cooper and TARS eject their landers to lighten the load of the Endurance, falling into the event horizon of fictional black hole Gargantua. Not only did Thorne and a team of over 30 people collaborate to create the visual effects of a rotating, supermassive black hole, with some individual frames taking up to 100 hours to render on the CGI software based on deeply sourced theoretical equations, but the work on the visual effects provided Thorne with enough new insight on the gravitational lensing and accretion disks of black holes to result in the publication of three scientific papers.

The creative liberties, albeit ones that are rooted in scientific theory, taken by Nolan are on display as Cooper and TARS find themselves in a tesseract within the black hole representing infinite copies of Murphy's bedroom across moments in time, allowing Cooper to manipulate the second hand of the wristwatch he had left Murph to communicate the data collected by TARS within the black hole through Morse code, allowing adult, NASA scientist Murph (Jessica Chastain) to complete Brand's gravity solution. Nolan uses time as a non-linear construct to underscore the entire narrative, where Cooper's actions within the tesseract allow him to communicate with a past Murph. This is also exemplified in Cooper's realization that he was also responsible for the "gravitational anomaly" that initially gave NASA's coordinates to Cooper and Murph at the opening act of the film.

One of the many reasons Interstellar remains in discussion as a classic of science fiction is its flawless attention to scientific detail, accompanied by Christopher Nolan's masterful exploration of scientific theory. Yet beyond its elaborate, oftentimes baffling narrative, it still leaves audiences with an inspiring message as a celebration of humanity's ability to overcome any limitations, within a universe of infinite possibilities. Its message of self-determinism, hope, and love will forever hold cultural endurance, because to quote Anne Hathaway's Dr. Amelia Brand, "Love is the one thing we're capable of perceiving that transcends dimensions of time and space".

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