

Brief note on the ISEF 21winning projects:

SHIVAM RAWAT

GRAND AWARD: SECOND AWARD OF \$2,000

GENOME-WIDE IDENTIFICATION, PHYLOGENY, AND CHARACTERIZATION OF THE NAC GENE FAMILY IN BRASSICA JUNCEA FOR PREDICTION OF STRESS-ASSOCIATED NAC GENES - *PLANT SCIENCES*



Abiotic stress on account of drought, heat, and salinity negatively affects growth and productivity in Brassica species. Efforts have been made in the past to identify genes that provide resistance against such stresses. NAC transcription factors form a large plant-specific gene family that is involved in the regulation of tissue development and abiotic stress. However, this gene family is not studied in *B. juncea*, an important oilseed, and multipurpose plant worldwide.

The purpose of this study is to use a comparative genome-wide method to identify, characterize and predict gene function of the NAC gene family in *B. juncea*. A total of 136 NAC genes were identified by performing computational analysis on the pre-existing proteome of *B. juncea* using Blastp and their respective NAC/NAM domain are verified using InterProScan. The NAC genes were named from BjuNAC1 to BjuNAC136 based on chromosomal distribution.



ARIA VIKRAM

GRAND AWARD: THIRD AWARD OF \$1,000

Special Award: U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT: THIRD AWARD GLOBAL HEALTH OF \$2,000

STETHODOC: SCREENING FOR LUNG DISORDERS WITH AN AUGMENTED REALITY GUIDED SMART STETHOSCOPE - *BIOMEDICAL*

ENGINEERING

More than 1 billion people worldwide suffer from lung diseases. The magnitude of this public health burden has been further escalated by the COVID-19 pandemic. Conventionally, lung disorders can be detected with the help of a stethoscope operated by trained medical professionals. However, reliable pulmonary screening is inaccessible to many demographics. Her patent-pending invention - StethoDoc - is an augmented reality guided smart stethoscope system. It allows non-medical laypersons to perform accurate pulmonary screening at a fraction of the traditional cost, thus reducing the pressure on the overburdened healthcare system.

CHINMAYI RAMASUBRAMANIAN

GRAND AWARD: THIRD AWARD OF \$1,000

Special Award: ACOUSTICAL SOCIETY OF AMERICA: HONORABLE MENTION

DIAGNOSING THE STAGE OF COVID-19 USING MACHINE LEARNING ON BREATH SOUNDS-
TRANSLATIONAL MEDICAL SCIENCES



With rapidly increasing COVID-19 cases, patients with mild and moderate symptoms are being asked to home-isolate themselves to save hospital resources for more severe patients. Such patients have been asked to self-monitor themselves and seek medical attention if their condition worsens. COVID-19 affects the respiratory system and home-isolated patients must

monitor their lung condition continuously before it quickly deteriorates. But this is difficult to monitor by oneself, and the patient may not notice his worsening lung condition before it is too late. A machine-learning based approach is proposed to monitor lung condition by analyzing the breath sounds of a patient for respiratory sounds like wheezes, crackles and tachypnea, which in turn can identify the stage of COVID-19. This model can be integrated with a mobile application to record and analyze breath-sounds.



JUI ABHIJIT KESKAR

GRAND AWARD: THIRD AWARD OF \$1,000

Special Award: SHANGHAI YOUTH SCIENCE EDUCATION SOCIETY: SCIENCE SEED AWARD

JTREMOR3D: A WEARABLE TREMOR PROFILING DEVICE FOR PATIENTS

WITH PARKINSON’S DISEASE - *BIOMEDICAL AND HEALTH SCIENCES*

JTremor3D, the wearable tremor profiler for patients with Parkinson’s Disease, can assist neurologists during dosage planning by providing tremor profile analysis of the patient. It can also provide recommendations to caregivers of patients who have undergone Deep Brain Stimulation surgery about re-tuning of brain pacemakers.

ADDEA GUPTA

GRAND AWARD: THIRD AWARD OF \$1,000

DIOPHANTUS EQUATIONS AND PARTIALLY ORDERED SETS- *MATHEMATICS*



finite equations

In Alzer, Horst and Luca’s paper it is shown that the Diophantine equation $(k!)^n + k^n = (n!)^k + n^k$ only has the trivial solution $n=k$, and $(k!)^n - k^n = (n!)^k - n^k$ only has the solutions $n=k$, $(n, k) = (1, 2)$, and $(2, 1)$. In this article we find all solutions of the Diophantine Equations $a_1! a_2! \dots a_n! \pm a_1 a_2 \dots a_n = b_1! b_2! \dots b_k! \pm b_1 b_2 \dots b_k$, where a_i majorizes b_i . Furthermore we find a sufficient condition on a function $f: \mathbb{N} \rightarrow \mathbb{R}^+$ to guarantee that f gives a monotone function on the POSET of all sequences of natural numbers. We then use that to solve other Diophantine involving factorials and generalize the results of Sándor’s paper.

VISHNU SAMPATHKUMAR

GRAND AWARD: FOURTH AWARD OF \$500

ADIAG: GRAPH NEURAL NETWORK BASED DIAGNOSIS OF ALZHEIMER’S DISEASE- *TRANSLATIONAL MEDICAL SCIENCES*



Alzheimer’s Disease (AD) is the most widespread neurodegenerative disease, affecting over 50 million people across the world. While its progression cannot be stopped, early and accurate diagnostic testing can drastically improve quality of life in patients. Currently, only qualitative means of testing are employed in the form of scoring performance on a battery of cognitive tests. The inherent disadvantage of this method is that the burden of an accurate diagnosis falls on the clinician’s competence. ADiag, is a novel quantitative method to diagnose AD through graph theory and deep learning based analysis of large graphs based on thickness differences between different structural regions of the cortex. ADiag is adept not only at differentiating between controls and AD patients, but also at predicting progression of Mild Cognitive Impairment (MCI) to clinical AD.

UTKARSH BAJAJ

GRAND AWARD: FOURTH AWARD OF \$500

VISUAL APPEARANCE OF EXTENDED OBJECTS IN SPECIAL RELATIVITY - *PHYSICS AND ASTRONOMY*

The Lorentz transformation is a spontaneous measurement. Utkarsh highlights the difference between “measuring” and “seeing”, where the latter considers the time light rays (emitted by each point on the object) take to reach the observer. He computed the apparent position of a point given its velocity, initial position, and observation time. The apparent speed of a point is calculated, and obtains that it exceeds the speed of light when approaching the observer, similar to superluminal motion. For parameterizable surfaces, he analyzed properties (such as curvature and torsion) of apparent shapes. The observation that a sphere retains its circular silhouette when transformed to its apparent shape, independent of the initial conditions, is proved mathematically.

ARANYO RAY & ANWESHA DAS

GRAND AWARD: FOURTH AWARD OF \$500

Special Award: AMERICAN

PSYCHOLOGICAL ASSOCIATION: FIRST AWARD OF \$1,500



AUTEST: CULTURALLY ADAPTED RISK-ASSESSMENT GAME FOR AUTISM SPECTRUM DISORDER - *BEHAVIORAL AND SOCIAL SCIENCES*

Diagnosing Autism Spectrum Disorder (ASD) using Western tools is challenging in the Indian setting due to huge diversity in sociocultural and economic backgrounds. Culturally adapted tools are available in several Indian languages, yet they do not accommodate all verbal abilities and educational backgrounds. We propose a home-based audio visual game app (Autest) suitable for ASD risk-assessment in Indian children under 10 years of age. The game, based on the Panchatantra, a popular story series, has 5 modules for each age group with specific peer interaction and play skills

SIDHARTH JAIN & AASIMM KHAN

GRAND AWARD: FOURTH AWARD OF \$500

CREATING A HAPTIC 4D MODEL ALONG WITH MACHINE LEARNING ANALYSIS BY DEVELOPING A NON-INVASIVE PRESSURE MAPPING METHOD TO SCREEN GENITAL SKIN CANCER - *BIOMEDICAL ENGINEERING*



Cancer is curable, but only when it is detected in its early stages. When focusing on genital skin cancer matters become worse since factors like privacy, comforts, social hurdles and restrictions play a key role in postponing cancer detection in genital regions. Biopsy is an invasive method to accurately screen cancer, but when conducted in genital region causes pain, infection, numbness etc. Hence, our engineering goal is to screen suspicious skin lesions non invasively providing detailed analysis doctors virtually, reducing the number of times patients experience an invasion of their privacy, giving them control of the screening process, respecting their privacy and promoting early detection

RUSHANK GOYAL

Special Award: EMBARK CHINA: FIRST AWARD OF \$3000



Special Award: AMERICAN STATISTICAL ASSOCIATION: CERTIFICATE OF HONORABLE MENTION

RESPRED: BIOMARKER DISCOVERY AND ANTIBIOTIC RESISTANCE PREDICTION THROUGH MACHINE LEARNING-BASED GENOMIC ANALYSIS OF NEISSERIA GONORRHOEAE - *COMPUTATIONAL BIOLOGY AND BIOINFORMATICS*

Antibiotic resistance is a global problem projected to kill 10 million each year by 2050. The CDC lists Neisseria gonorrhoeae among the most urgent threats in this area due to its widespread resistant mutations.



In this study, eight models were trained on three datasets of azithromycin, ciprofloxacin and cefixime, drugs used against N. gonorrhoeae. Each dataset had 3000+ samples and their corresponding resistance values, and each sample consisted of a unique pattern of certain consensus regions of the genome. Overall, this study led to the creation of a highly accurate machine learning model and identified resistance biomarkers for three drugs in N. gonorrhoeae. The model can be used for genotype-based resistance diagnosis and biomarkers can be further researched for point-of-care test development.

NIRANJANA BASKARAN

MU ALPHA THETA, NATIONAL HIGH SCHOOL AND TWO-YEAR COLLEGE MATHEMATICS HONOR SOCIETY: SECOND AWARD OF \$1,000

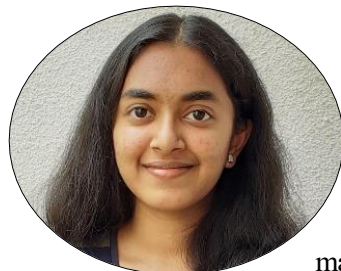
CRACKING THE INFINITE SHUFFLE: SOLVING THE KIMBERLING SEQUENCE PROBLEM - *MATHEMATICS*

The Kimberling shuffle is an integer sequence generated by the shuffling and expulsion of numbers. From the sequence of natural numbers, 1 is expelled and the first integer in front (2) is placed first and the first behind (nothing so it is skipped) is placed second, this gives the sequence 2,3,4,5... which will be the base for the next stage. Here the second element is expelled, and the numbers behind and in front will be shuffled so the third stage would be 4,2,5,6,7... and so on. The expelled elements (1,3,5...) form the Kimberling sequence. An open problem is whether every positive integer will eventually appear in this sequence, one that has remained unsolved for nearly 30 years. In this project, the nature of the sequence and problem is investigated using computational methods (measuring times and patterns required to reach certain values) and varied analysis, and from different angles: through that of limiting inequalities, number-theoretic properties, and algebraic manipulation.



TANVI PALSAMUDRAM

Special Award: AMERICAN PSYCHOLOGICAL ASSOCIATION: THIRD AWARD OF \$500
USING RESPONSE TIMES TO INVESTIGATE THE FACE RECOGNITION MECHANISM IN DEVELOPMENTAL PROSOPAGNOSIA - *BEHAVIORAL AND SOCIAL SCIENCES*



The nature of face recognition memory deficits in developmental prosopagnosia (DP) remains to be fully characterized. Previously, a dual process analysis of confidence ratings during face recognition showed that, compared to controls, DPs have deficient recollection (all-or-none recognition with context) but intact familiarity (feeling of knowing) (Stumps et al., 2020). Since confidence ratings are subjective, response times (RTs) may provide a complementary, objective measure of DPs' memory deficits