

UREAP APPLICATION FORM



THOMPSON RIVERS
UNIVERSITY

Office of Research and
Graduate Studies

First Name: **Kieren**

Last Name: **O'Neil**

Student ID: **T00238338**

Start Date of Project: **01/May/2022** (DD/MMM/YYYY)

Please complete all sections of this application form.

1. FACULTY MENTORS INFORMATION

1.1 Who is your Primary Faculty Mentor? **Dr. Mohamed Tawhid**

1.2 Who is your Secondary Faculty Mentor? **Dr. Mark Paetkau**

NOTE: Your Primary and Secondary Faculty Mentors must each complete a Faculty Mentor Support Form. Forms can be found under the attachments tab within your TRU Romeo UREAP application and on the TRU UREAP webpage under information and Forms for Faculty Mentors..

2. PROJECT DESCRIPTION

2.1 Provide an abstract of your proposed research: (maximum 1500 characters)

Parkinson's Disease (PD) is a central nervous system disorder caused due to the loss of brain cells. The early symptoms of the disease are trembling, tremors, stiffness, problem in walking and control of hands. As with many diseases, early diagnosis is important, and this project will look at the efficiency of an optimized Hunger Games Search Algorithm (HGSA) for feature selection based on the traditional HGSA. Parkinson is a central nervous system disorder, caused due to the loss of brain cells. Parkinson's disease is incurable and could eventually lead to death but medications can help to control symptoms, improve quality of life, and extend the patient's life to some extent. The proposed model uses the standard hunger games search algorithm as a search strategy to ascertain the optimal subset of features. The decision tree and k-nearest neighbor classifier as a judgment on the selected features. The Parkinson speech (with multiple types of sound recordings) and Parkinson Handwriting sample's datasets are used to evaluate the proposed model. The proposed algorithm can be used in predicting the PD with an accuracy that helps individual to have proper treatment at early stage. The experimental result reveals that the proposed bio-inspired algorithm finds an optimal subset of features, maximizing the accuracy, minimizing number of features selected and is more stable. Moreover, a comparison between the proposed algorithm and other state-of-art algorithms will be given.

2.2 Provide a brief literature review for your proposed research: (maximum 3500 characters)

Artificial Intelligence depends on many different types of algorithms, these are applied to problems they are suited to solve. Evolutionary algorithms mainly focus on simulating biological evolution; this consists of four main processes: reproduction, mutation recombination and selection. Unlike traditional optimization techniques, evolutionary algorithms depend on random sampling. These processes are repeatedly applied on the solutions formally stated as population and the fitness function is used to determine the quality of the solution. These solutions change according to the evolutionary process

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which eventually helps us to find the global solution to the problem. Evolutionary algorithms perform well under different circumstances as they do not assume the underlying fitness landscape. Even simple evolutionary algorithms can solve complex problems easily; the only drawback of their use is the computational cost which can be reduced using fitness function approximation. There are many types of evolutionary algorithms, including genetic algorithms, evolutionary programming, evolutionary strategies. The work in the field of evolutionary algorithms and Metaheuristic algorithms has been increasing in the recent past. These algorithms are mostly genetic based algorithms and nature inspired using the concepts of mutation and survival of the fittest based on the calculation of a fitness function which discards the unimportant solutions and further carries down good solutions down the genetic line optimizing them further. One of the algorithms- Firefly Algorithm proposed by Xin-She Yang uses flashing characteristics of fireflies (Xin-She, 2009). The same author has also proposed a bat algorithm based on bat echoing characteristics (Xin-She, 2010). Many other algorithms include ant colony optimization algorithm (A. Gonzalez- Pardo, et al. 2017), gravitational search algorithm based on the relationship between mass and gravity have been inspired from laws of nature, bees algorithm by Pham et al. given in Esmat (2009) and CAB algorithm by Erik Cuevas et al. given in C. Erik et al. 2012. Using the above ideas, we have introduced a novel improved and optimized version of traditional hunger games search algorithm (HGSA) inspired by the behavior of animals in nature when they are hungry (Yang et al. 2021), and combined it with feature extraction. We have been able to optimize the proposed algorithm using the different fitness functions as compared to the original algorithm. The HGSA has been applied on Parkinson's speech and HandPD datasets for identification of Parkinson's disease (PD) at early stage which helps individual to receive proper treatment early. The algorithm efficiently will extract the perpetual attributes and give a good accuracy. Online smart healthcare technologies using Internet of Things (IoT) is a large field of research today. Some of the methods have been devised in Elhoseny et al. (2018). One such example is given in M. Vardhana at al., (2018) where convolutional neural networks were used for bio-medical image segmentation with hardware acceleration. Use of IoT based technologies can also be used in this smart healthcare system (J. Rodrigues et al., 2018). HGSA can be implemented online so that it can give a reasonable prediction to the input drawings in real time. Further studies can be conducted on creation of virtual environments using augmented reality and similar concepts to treat the PD given in D. Gupta et al. 2018.

2.3 What is the hypothesis or research question for your proposed research? Include any specific objectives: (maximum 500 characters)

The research question of this project is: how optimized can the Hunger Games Search Algorithm (HSGA) be to select optimal features for the detection of Parkinson's disease. Additionally, how will the optimized HGSA compare with other algorithms on a variety of tasks including that of feature selection as well as standard benchmark functions.

2.4 Provide a description of the research methodology/methodologies and analysis that you intend to employ in completing this research: (maximum 1500 characters)

The project highlights the following:

- An optimized feature extraction based on traditional hunger games search algorithm algorithm has been discussed.
- Hunger games search algorithm (HGSA) is used as a search strategy to find optimal subset of features.

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- Decision tree and K-nearest neighbor are used to evaluate the quality of the selected features.
- HGSA is evaluated on speech with multiple types of sound recordings and Parkinson's HandPD datasets for the identification of Parkinson's disease with a good accuracy
- We would also like to highlight that the main goal of proposing and implementing the HGSA is to keep it as easy, simple and understandable as possible.
- To evaluate the quality of selected features, we have used two different classifiers: (i) k-nearest neighbors

2.5 Provide a description of how your research will significantly impact your field of study:

(maximum 1500 characters)

The Hunger Games Search Algorithm is a new novel search algorithm for optimization (published 2021); this project will further improve the abilities of this algorithm for feature selection specifically, as well as other tasks. The goal of this work is the development of a refined Hunger Games Search Algorithm for feature selection to help identify individuals with Parkinson's. The subset of features selected by the algorithm will be optimized for the detection of Parkinson's, being small in number and large in their relevancy to the detection of the disease. The optimal set of features can then be used in the future to allow for the detection of the disease at its early onset more easily. This will contribute to the literature on the application of swarm intelligent algorithms for feature selection on medical datasets and present an algorithm that can be used on them. The resulting algorithm may also be utilized for other optimization problems in further research. To facilitate this, addition to the selection of features by the improved Hunger Games Search Algorithm will be compared with others based their abilities for feature selection as well as on a variety of IEEE CEC benchmark functions; the resultant comparison of these algorithms can be used by others for algorithm selection on related tasks. This work will contribute to the research on swarm intelligent algorithms and will further test many recent state of the art algorithms for comparison.

2.6 Describe your plans to disseminate your research findings: (maximum 500 characters)

The findings are planned to be disseminated through the Thompson Rivers University Undergraduate Research conference March 2023 and the Fall 2022 West Coast Optimization Meeting. In addition we plan to publish one paper in referred journal such as International Journal of Machine Learning and Cybernetics, Springer.

2.7 List the references that you have cited throughout your research proposal observing the appropriate citation style for your discipline: (maximum 3500 characters)



1. ElhoM., Ramí rez-Gonza lez, G., Abu-Elnasr, O. M., Shawkat, S. A., Arunkumar, N., & Farouk, A. (2018). Secure medical data transmission model for IoT-based healthcare systems. IEEE Access. <https://doi.org/10.1109/ACCESS.2018.281761>
2. Erik, C., Mauricio, G., Daniel, Z., Marco, P.-C., & Guillermo, G. (012). An algorithm for global optimization inspired by collective animal behavior. Hindawi Publishing Corporation Discrete Dynamics in Nature and Society
3. Esmat, R., Hossein, N.-P., & Saeid, S. (2009). GSA: A gravitational search algorithm. Elsevier (Information Sciences).
4. Gonzalez-Pardo, A., Jung, J. J., & Camacho, D. (2017). ACO-based clustering for Ego Network analysis. Future Generation Computer Systems, 66, 160–170.
5. Gupta, D., Sundaram, S., Khanna, A., Hassanién, A. E., & de Albuquerque, V. H. C. (2018). Improved diagnosis of Parkinson's disease based on Optimized Crow Search Algorithm. Computers and Electrical Engineering, 68(May), 412–424.
6. Lins, A. A., Oliveira, J. M., Rodrigues, J. J. P. C., & De Albuquerque, V. H. C. (2018). Robot-assisted therapy for rehabilitation of children with cerebral palsy – A complementary and alternative approach. Computers in Human Behavior.
7. Rebouças Filho, P. P., Cortez, P. C., Barros, A. C. S., De Albuquerque, V. H. C., & Tavares, J. M. R. S. (2017a). Novel and powerful 3d adaptive crisp active contour method applied in the segmentation of ct lung images. Medical Image Analysis (Print), 35, 503–516.
8. Rebouças Filho, P. P., De Albuquerque, V. H. C., & Tavares, J. M. R. S. (2017b). Analysis of human tissue densities: A new approach to extract features from medical images. Pattern Recognition Letters, 94, 211–218.
9. Rodrigues, J. J. P. C., De Rezende Segundo, D. B., Junqueira, H. A., Sabino, M. H., Prince, R. M., Al-Muhtadi, J., & De Albuquerque, V. H. C. (2018). Enabling technologies for the internet of health things. IEEE Access, 6, 13129–13141
10. Vardhana, M., Arunkumar, N., & Abdulhay, E. (2018). Convolutional neural network for bio-medical image segmentation with hardware acceleration. Cognitive Systems Research, 50, 10–14.
11. Xin-She, Y. (2009). Firefly algorithms for multimodal optimization. Stochastic algorithms: Foundations and applications, SAGA 2009, Lecture notes in computer sciences.
12. Xin-She, Y. (2010). A new metaheuristic bat-inspired algorithm. Springer
13. Y. Yang, H. Chen, A. A. Heidari, and A. H. Gandomi, "Hunger games search: Visions, conception, implementation, deep analysis, perspectives, and towards performance shifts," Expert Syst. Appl., vol. 177, Sep. 2021, Art. no. 114864.

3. PROJECT TIMELINE WITH BENCHMARKS

3.1 Provide a timeline for your project that includes key benchmarks: (maximum 1000 characters)

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May-June

- 1) Write codes of many binary swarm intelligent algorithms (using S-shape and V-shape) and validate and verify them on some datasets from UCI and apply Friedman's test to rank these algorithms
- 2) Apply Feature selection approach such as wrapper approach with classification Naive Bayes Classification, k-nearest neighbors, Support Vector Machine on Parkinson datasets

June-July

- 1) Combine swarm intelligent algorithm with wrapper approach on the Parkinson datasets and apply nonparametric statistical test, Friedman's test.
- 2) Start writing paper

July-Aug

Finish writing paper

NOTE: Please refer to the UREAP Help Guide for a project timeline example. Students must demonstrate a willingness to engage in 12 weeks or equivalent of sustained research per the Terms of Reference.

4. OPERATING GRANT BUDGET PROPOSAL

4.1 The UREAP award offers up to \$1000 toward direct research expenses. These expenses must be preapproved by the UREAP committee in the adjudication phase. Use the provided template under the Attachments tab in the TRU Romeo UREAP application to complete your budget proposal. Copy amount from the TOTAL AMOUNT line of the budget here. Total Amount: \$ 1,000.00

4.2 Additional budget information: (maximum 500 characters)

If the operating grant is not obtained we will apply to both the student union and the conference itself for the necessary funds. If those options do not pan out we will look into other grants or use personal savings.

5. CONTRIBUTION TO ACADEMIC/PROFESSIONAL GOALS

5.1 Describe how this project will contribute to your academic and/or professional goals:

(maximum 1000 characters)

This project will allow the continuation and expansion of the work that I have already done as a TRU Research Apprentice. I will gain further hands-on research experience which will improve my overall education and give me the experience to further pursue research in graduate school. Additionally, this project will enable me to learn about advanced topics in software engineering outside of the classroom, and apply these to solve real-world problems. Finally, at the completion of this project a paper of the results will be published in a scientific journal to share the findings of the project with others working in

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the field; expanding my personal research credibility and building up a reputation with the relevant research authorities so I can further pursue this and other research topics in the future.

NOTE: Include your role in conceiving of the project, your role in the implementation of the project, and your overall academic objectives – explaining how this project will help to advance those objectives.