National Junior Science & Humanities Symposium
Statement of Outside Assistance

(Student finalists presenting their research paper at the National symposium must complete this form and submit with the final research Paper.)

Name: Steven Qu

Regional Symposium: Tennessee

Title of Paper: Deep Learning to Detect Multiple Cancers From a Blood Test

1) Please explain your role in the development of the project idea.

Both my partner and I were interested in the potential applications of computer science in improving healthcare. We narrowed down this broad idea by reading relevant articles on the Science Magazine. Over this process, we discovered a recently published paper by Johns Hopkins on detecting multiple cancers simultaneously through a simple, economical blood test. We decided we would try to improve upon their results.

2) What steps led you to formulate your research question? --or—What steps led you to develop the design for your engineering project?

After determining our project topic, we analyzed the type of model used (logistic) and realized it was a rudimentary machine learning technique. During our research, we came across deep learning neural networks that could find nonlinear relationships that the logistic model couldn't. After deciding to use neural networks, we researched about neural networks before attempting to make our own.

3) Where did you conduct the major part of your work? (i.e. home, school, or other institutional setting – university lab, medical center, etc.)

While some of the work was done at home and school, the majority was done during the summer at Oak Ridge National Laboratory.

4) Describe the assistance that you received throughout the project.

I worked on this project with my partner Bill Andress. He helped prepare the data and analyze the results. Together, we worked under our mentor Dr. Christopher Symons, a former Oak Ridge National Laboratory employee of the Computer Science and Mathematics Division. He introduced us to machine learning theories helped us find our project topic, and guided us with potential ideas to improve our neural network model. Our math teachers, Dr. Deanna Pickel and Mrs. Jessica Williams, also supported us by assisting us in writing our research paper and submitting our research for review.

5) If you worked in an institutional setting, describe your role on the team.

I was in charge of neural network construction and coding. Specifically, I coded using Python 3 and built the neural network through the machine learning library Keras, which implemented the TensorFlow mathematics library. I compiled the results to send for evaluation before adjusting the model for improved results.

6) What role did each person play in the research investigation?

My partner prepared the dataset to be analyzed by replacing missing data with averages and sorting by cancer type. He also created spreadsheets of our neural network results and, together, we analyzed the best course of action to improve our model. Our mentor guided us by introducing machine learning techniques and brainstorming ideas to improve the neural network with us. When met with an issue, my partner and I would consult our mentor on the best course of action to move forward.

7) Describe what parts of the research you did on your own and what parts where you received help. (i.e. literature search, hypothesis, experimental design, use of special equipment, gathering data, evaluation of data, statistical analysis, conclusions, and preparation of written report (abstract and/or paper).

On our own: hypothesis, evaluation of data, statistical analysis, conclusions
Done with the help of mentor: literature review and experimental design
Done with the help of teachers: preparation of written report
We used data from the Johns Hopkins research group since we wanted a fair comparison of models.

8) If this research is a continuation of an investigation that was previously submitted to a regional JSHS, describe how you have expanded your investigation.

N/A

Comments by teacher and/or supervising mentor on the students' individual contributions to the research investigation or engineering/computer science project

I was Steven Qu's mentor at the Oak Ridge National Laboratory for his Oak Ridge High School Math Thesis project. I helped Steven choose a general project area, but Steven was responsible for choosing the final project goals, and he performed all of his own research, coding, analysis, and writing. The assistance I provided was advisory in nature, mostly based on suggested reading and discussions of the merits of various next steps.

Statement by the teacher or supervising mentor acknowledging that the student conducted the research in accordance with proper procedures and protocols for the conduct of animal research or human research. Projects which were conducted without proper supervision will be disqualified from both regional and National competition. Further guidelines may be found at http://www.jshs.org

Steven Qu's project was conducted in accordance with proper procedures and research protocols as required by any project performed at the Oak Ridge National Laboratory or any other Department of Energy facility.

Please have the supervising teacher and/or supervising scientist sign below. If you did the work without a teacher or supervising scientist, you will need a signature from your parent and a brief description of their role in the research.

1/22/19	Steven Qu	Oak Ridge High School
Date	Signature of Student (Required)	High School
1/23/19	Joanna Pickel	Oak Ridge High School
Date	Signature of Teacher	High School
	Christopher T. Symons	Senior Research Scientist
1/21/19		
Date	Name of Supervising Scientist	Title of Supervising Scientist

Oak Ridge National Laboratory

Institution of Supervising Scientist

Christopher T. Symons

Signature of Supervising Scientist