

Using Artificial Intelligence in Academia to Help Students Choose Their Engineering Program

Dr. Shatha Jawad, National University

Dr. Shatha Jawad has more than 22 years of experience in teaching and more than three years as a software engineer. She had UNESCO Fellowship in the field of Information and Communication Technologies, in 2002. Her Ph.D. is in computer engineering. She is a member of the Institute for Learning-enabled Optimization at Scale (TILOS) which has an NSF grant that began on November 1, 2021, for five years. TILOS is a National Science Foundation funded Artificial Intelligence (AI) Research Institute led by the University of California-San Diego and includes faculty from the Massachusetts Institute of Technology, the University of Pennsylvania, the University of Texas at Austin, Yale University, and the National University.

Dr. Ronald P. Uhlig, National University

From 2010-2014, Dr. Ronald P. Uhlig was Dean, School of Business and Management, National University, La Jolla, CA. He returned to the engineering faculty in 2014 and is currently Chair, Department of Engineering, School of Technology and Engineering. During 2005-2010 he served in multiple positions including Chair of the Department of Computer Science and Information Systems, and Academic Program Director for the Master of Science in Wireless Communications; as well as Principal Investigator for two HP Technology for Teaching grants. From 2000-2005, he was President/CEO, SegWave, Inc., an educational technology systems company he founded.

Previous positions include Vice President for Russia and Eastern Europe, Qualcomm Inc., 1995-99, with offices in San Diego and Moscow, Russia and multiple positions with Northern Telecom and Bell-Northern Research in Ottawa, Canada and Richardson, TX during 1978-1995, including Director, Intelligent Network Solutions and Director, Asia/Pacific Strategic Marketing. He is one of several "Fathers of email", based on work he did with the US Army and DARPA in the 1970s and several international committees he chaired during 1979-91. Those committees took him to nearly 100 countries globally. He had nationwide responsibility for US Army Materiel Command Scientific and Engineering computing, 1969-78, pioneering many applications in what has become today's Internet, and he served as a US Army Officer in the Office of the Chief of Staff, in the Pentagon, 1966-1968.

He holds a B.Sc. in Physics from the Massachusetts Institute of Technology, and a Ph.D. in Physics from the University of Maryland. He is the recipient of a Gold Medal from the International Telecommunications Academy for sustained contributions to telecommunications; the Silver Core from the International Federation for Information Processing; and the Founders Award from the International Council for Computer Communications. He has served as a member of the Steering Committee for Project Inkwel.

Dr. Pradip Peter Dey

Dr. Pradip Peter Dey has more than 20 years of experience in Computer Science research and education. His university teaching and professional experience emphasizes mathematical modeling, information extraction, syntax and semantics of natural language, w

Dr. Mohammad N. Amin, National University

Mohammad Amin received his Ph.D. and M.S. degrees in Electrical Engineering & Computer Engineering, and M.S. degree in Solid State Physics from Marquette University, Milwaukee, Wisconsin. He also received M.Sc. and B.Sc. degrees in Physics from Dacca University. Currently, he is working as a Professor of Engineering at the National University, San Diego, California. He received the President Disguised Teaching Award in 2020 and two times President Professoriate Awards. He published and presented 100+ technical papers in the peer reviewed journal and conference proceedings. He edited nine conference proceedings, chaired nine conferences including 2009 ASEE/PSW and 2015 ASEE/PSW and three US Patents.

Dr. Bhaskar Sinha, National University

Dr. Bhaskar Sinha is a Professor in the School of Engineering and Computing at National University in San Diego, California.

Using Artificial Intelligence in Academia to Help Students Choose Their Engineering Program

Abstract

It is important to find an area of focus that is related to a career path that aligns with engineering students' abilities, technical background, and long-term goals. Due to the array of available specializations in industry categories, selecting the best fit for their interests is a big challenge for engineering students. For example, the computer science category includes information technology, programming languages, software engineering, networks, etc. Most departments focus on one industry category and under each category there are concentrations. When students start their journey through college, they focus on a specific concentration that they think they will succeed in. Some students, after starting some of the courses, find that their selected area of focus no longer fits with their abilities or their interests. Some of them try to change their concentration, program, or college, while some of them leave college because they think that their ability is not enough to continue studying. Today, Artificial Intelligence (AI) can be used to improve the education process by helping students learn better and faster when paired with high-quality learning materials and instruction. Also, AI systems can help students get back on track faster by alerting teachers to potential problems. This paper proposes a Deep Learning Neural Networks approach that helps students select their best-fit specialization in a specific category. Deep learning is a subset of machine learning, but it can determine whether a prediction is accurate through its own neural network- no human help is required [1]. The proposed system will use a dataset that contains student data that is related to the general education courses required for their program, such as grades, the number of hours spent on each course's materials, the opinion of the student about the content of each course, and the course(s) that the student enjoyed the most. Additional data will be included in the dataset such as the student's preferred specialization and the kinds of subjects the student enjoys studying. The proposed Deep Learning Neural Networks system will help students choose a path of study that best fits their abilities and their goals, and that prepares them for successful careers.

Introduction

AI is a field of computer science that focuses on the creation of intelligent machines that can perform tasks that would normally require human intelligence, such as learning, decision-making, and problem-solving [2]. It has been applied in a wide range of fields, including engineering, to automate tasks and improve efficiency.

One potential application of AI in engineering education is in the selection of engineering programs. AI algorithms could be used to analyze data on factors such as student interests, academic achievements, and career goals, and suggest programs that are most suitable for the individual student. This could be helpful for students who are unsure of what engineering program to pursue, or for those who are considering multiple options.

Many papers [3]- [9] were focused on how artificial intelligence aided engineering education. Alabdulhadi and Faisal [3] have explored the latest trends and identified limitations and opportunities in recent work on STEM (Science, Technology, Engineering, and Mathematics)

self-study simulator based ITSs, by conducting a systematic literature review investigating 47 papers from four different databases. They found that the traits of feedback in simulator-based systems that result in positive learning outcomes are ones that combined immediate and delayed feedback [3].

Azcona, Hsiao, and Smeaton in their paper [4] presented a new research methodology to automatically detect students “at risk” of failing an assignment in computer programming modules (courses) and to simultaneously support adaptive feedback. By leveraging historical student data, they built predictive models using students’ offline (static) information including student characteristics and demographics, and online (dynamic) resources using programming and behavior activity logs. The results showed that students who followed their personalized guidance and recommendations performed better in examinations [4].

Blikstein, et al in their article [5], presented studies focused on how students learn computer programming, based on data drawn from 154,000 code snapshots of computer programs under development by approximately 370 students enrolled in an introductory undergraduate programming course. They used methods from machine learning to discover patterns in the data and try to predict final exam grades. Their results showed that the process-based metric has better predictive power for final exams than the midterm grades.

Cantú-Ortiz, et al [6] presented a strategy for a state-of-the-art review of artificial intelligence (AI) in education and a case study about preparing students to have the competencies and skills necessary for the current and future digital transformation to Industry 4.0. Their goal was to support institutions of higher education to build curricula that help companies by providing them with qualified human capital to face the challenges of the twenty-first century.

Also, Deo, et al [7] in their study, implemented a robust AI methodology to uncover relationships among student learning variables, developing teaching and learning interventions, and course health checks, to address issues related to graduate outcomes and student learning attributes in the higher education sector.

García-Gorrostita, López-López, and González-López [8] presented a system for argument assessment embedded in an Internet-based Moodle course with Learning Tools Interoperability (LTI) standard, to help students improve argumentation in the problem statement, justification, and conclusion sections of their final project report. The results showed that using the argument assessment system increased the number of arguments in the experimental group [8].

Martin Nunez and Diaz Lantada, in their paper [9], concentrate on how AI techniques can support the teaching-learning process in engineering, and they describe how AI can be swiftly introduced into any engineering program. They also analyze the potential impact of AI on improving the overall operation of universities, as extremely complex systems manage myriads of data and countless processes and interactions. However, Xu and Ouyang [10] did a study that conducted a systematic review to examine 63 empirical AI-STEM research studies by the authors [10] from 2011 to 2021 to gain a comprehensive understanding of AI applications in STEM education. The results examined the major elements in the AI-STEM system as well as the effects of AI in STEM education. Six categories of AI applications were summarized in

Figure 1. The six categories of AI applications were identified, namely learning prediction (29% of 64 articles), intelligent tutoring system (25% of 64 articles), student behavior detection (21% of 64 articles), automation (13% of 64 articles), educational robots (9% of 64 articles), and others (3% of 64 articles).

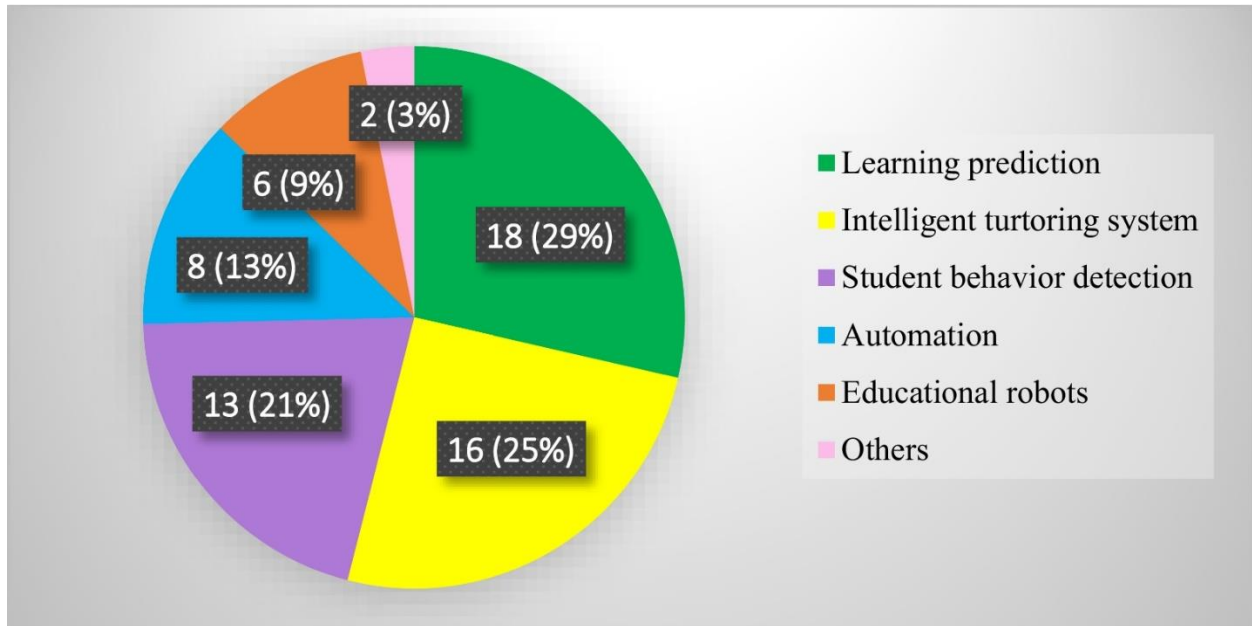


Figure 1: The application categories of AI techniques in STEM education (N = 63) [10]

According to the paper [10], 18 of 63 reviewed articles were focused on learning prediction in STEM education which is related to predicting student learning performance or status in advance through AI algorithms and modeling approaches. 16 of 63 reviewed articles were focused on the second category of AI applications in STEM education - the intelligent tutoring system, defined as an AI-enabled system that was designed to provide customized instruction or feedback to students and promote personalized, adaptive learning. The third category (student behavior detection) included 13 articles that referred to systems to exploit and track students' learning behaviors, patterns, and characteristics with AI-enabled data mining and learning analytics in the instructional and learning processes. The fourth category (automation) was comprised of 8 articles focused on utilizing AI technologies to automatically assess students' performances and generate questions or tasks for instructors. The fifth category (educational robots) included 6 articles focused on the adoption of robots in STEM education to facilitate students' learning experience as well as allow them to acquire knowledge in interactive ways. In the sixth category (other), 2 articles were concerned with the AI textbook and group formation [10].

Other researchers focused on helping people to find their careers by creating assessments and job personality tests to help them identify which occupational fields and career paths might help them live their best professional life [11]- [13].

Using AI to improve the education process is important to help students learn better and faster when paired with high-quality learning materials and instruction. But due to the array of

available specializations in industry categories, selecting the best fit for their interests is a big challenge for engineering students. This paper focuses on using AI to help students choose their engineering program.

Using ChatGPT

ChatGPT is a chatbot launched by OpenAI in November 2022. It is built on top of OpenAI's GPT-3 family of large language models and is fine-tuned with both supervised and reinforcement learning techniques. We tried to use ChatGPT as a trained AI system to answer this question, "How ChatGPT helps students to select their program."

ChatGPT answer was:

"ChatGPT is a large language generation model developed by OpenAI that can generate human-like text based on a given prompt. While ChatGPT itself does not have the capability to help students select their programs, it can be used to generate text that may be helpful for students in making their decision. For example, a developer could use ChatGPT to generate text that describes various programs and their requirements, outcomes, and career prospects. However, the actual selection of the program should be guided by the students' research and best fit of their educational and professional goal, not just by a generated text."

We tried to ask the question in a different way, "How does ChatGPT help students to select their BS Engineering program that most fit their abilities."

ChatGPT answer was:

"ChatGPT, a language generation model, can be used to generate text that describes the different BS engineering programs available and their requirements, outcomes, and career prospects. This information could be helpful for students in determining which program aligns best with their interests, abilities, and career goals.

A developer could also use ChatGPT to generate questions or prompts that help students to reflect on their abilities and how they align with specific programs or careers. However, the actual selection of a program should be made after a student has researched and considered multiple options, and not solely based on text generated by ChatGPT. Additionally, student's abilities should be assessed via the academic and standardized test scores, recommendation letters and the overall academic record. It is recommended to consult with their academic advisor, career counselor or other experts on the field to make final decisions."

According to that answer, we tried to propose a deep learning system that can be trained to help the students in their selection by taking into consideration all the points mentioned in the ChatGPT answers combined with AI benefits. AI allows organizations to make better decisions and improve core business processes by increasing both the speed and accuracy of strategic decision-making processes [14].

The proposed system- Dataset

In Engineering college, most departments focus on one industry category and under each category there are concentrations (programs). When the students start their journey through college, they focus on a specific concentration that they think they will succeed in. Some students, after starting some of the courses, find that their selected area of focus no longer fits with their abilities or their interests. Some of them try to change their concentration, program, or college, while some of them leave college because they think that their ability is not enough to continue studying.

The proposed system uses Deep Learning Neural Networks to help students choose a path of study that best fits their abilities and their goals, and that prepares them for successful careers. There are many features that can be taken into consideration to be the input to the proposed system. These features were selected carefully to enable the system to provide the best advice to the student. The proposed system will be designed to help students and provide some advice whether to continue in the same concentration or to change it. The authors identified two alternative approaches for design of the proposed system. The first one advises the student whether to continue in the same concentration or not, while the second proposed system suggests the best concentration that the student can move to.

The proposed system assumes that the students start their journey through college on a specific concentration that they think they will succeed in without getting any help from the designed system. Usually, during the first year, the students take some general education courses that are related to their program. The designed system will use the data which will be collected from these courses, such as:

1. The grades: it can be the final grade or sub grades, such as the grades of the Midterm Exam, quizzes, assignments, projects, and discussions. The ability to collect the sub grades depends on two factors. The first factor is the course outline if it has these sub grades. The second factor is the tools that are available under the Learning Management System (LMS) used by the university, such as Canvas and Bright Space.
2. Numbers of hours that the student spent on each course's materials. Some LMSs have tools that record the time that the students spent working/ reading on each component of the course. Collecting this data will be an important feature in our proposed system.
3. Questionnaires that collect the opinions of the students about the content of each course. By using this survey, we can know more about students' expectations.
4. Questionnaires about the course(s) that the student enjoyed the most. For example, if the students enjoyed studying physics as general study courses more than the general education study courses that are related to chemistry.

Each University has different programs offered in its engineering college/ department. For example, our university has an engineering school that has five relevant undergraduate degrees (programs): BS in Computer Science, BS in Cybersecurity, BS in Construction Management, BS

in Electrical and Computer Engineering, and BS in Manufacturing Design Engineering. Also, each university has different general education courses, some of them are university graduation requirements and some of them are program requirements.

In addition to the general education courses, we need to ask the students about their preferred career specialization. This is done by using a Questionnaire that addresses careers that are related to the programs offered at the university.

There are also two other key factors that should be taken into consideration while we are designing our smart system: the kinds of subjects the student enjoys studying and the soft skills that the students have. The subjects can be selected from the courses that are listed under each program.

Questionnaires

As explained above, there are four questionnaires for collecting data from the students. The questions in these lists are selected to be easily used with the deep learning neural network. The contents of each questionnaire are shown below:

1. The first questionnaire collects the opinions of the students about the content of each general education course and the course(s) that the student most enjoyed. This survey may have a list of the general education courses and the student opinion as useful or not as shown in table 1. We include the selection of the course(s) that the student enjoyed the most. In this table, we assumed that there are 6 general education courses.

Table 1: General Education Course Survey

General Education Course	Useful (1-5) <i>Where 1 represents "I strongly disagree" and 5 represents "I strongly agree", and 3 represents "Neutral"</i>	Like (1-5) <i>Where 1 represents "I strongly disagree" and 5 represents "I strongly agree", and 3 represents "Neutral"</i>
Course 1		
Course 2		
Course 3		
Course 4		
Course 5		
Course 6		

2. The second questionnaire has the careers that are related to the programs offered at the university. Table 2 shows the options of the careers that may fit the goal of the student. To help the students better understanding the career requirements (the programs that cover them), a description for these requirements is included in the table. The number of careers in table 2 depends on the programs that are offered in the university.

Table 2: Careers Preferred by the Student

Career	Preferred (1-5) <i>Where 1 represents "I strongly disagree" and 5 represents "I strongly agree", and 3 represents "Neutral"</i>	Required Program(s)
Career 1		
Career 2		
Career 3		
Career 4		
Career 5		

3. The third questionnaire includes the kinds of subjects the student enjoys studying, such as Math, Chemistry, Physics, Biology, and so on. Usually, this list includes the subjects that help to differentiate between the programs offered at the university. Table 3 describes this list.

Table 3: Subjects the Student Enjoys Studying

Material	Enjoy (1-5) <i>Where 1 represents "I strongly disagree" and 5 represents "I strongly agree", and 3 represents "Neutral"</i>
Math	
Physics	
Chemistry	
Biology	
Coding (programming)	
Robotics	

4. The fourth questionnaire includes the kinds of soft skills the students have, such as solving puzzles, building things, music (listening or playing), and so on. Usually, this list includes the soft skills that are preferred to exist in the students that will register for the programs offered at the university. Table 4 describes this list.

Table 4: Student Soft Skills

Soft skills	Have (1-5) <i>Where 1 represents "I strongly disagree" and 5 represents "I strongly agree", and 3 represents "Neutral"</i>
Solving Puzzles	
Building things	
Music- listening	
Music- playing	
Reading	
Talking	
Traveling	

The proposed system- Deep Learning Neural Network

The deep learning neural network [15]- [18] that will be used for this system is Multilayer Perceptron (MLP). This neural network will multi-classification according to the inputs. The multi- classification corresponds to the possible path of study that best fits the student abilities and their goals, and that prepares them for successful careers. The number of these possible paths equals the number of concentrations (programs) that the university offers. The number of programs in our school is 5, so we need 5 neurons at the output layer of our neural network. Each neuron represents one of the programs as shown in table 5.

Table 5: Output neurons

Program	Output
BS in Computer Science	1
BS in Cybersecurity	2
BS in Construction Management	3
BS in Electrical and Computer Engineering	4
BS in Manufacturing Design Engineering	5

The proposed neural network is shown in figure 2. The input of the neural network should be a numeric or binary value, so we need to translate all information to be ready to be used in our designed system. There are 43 neurons in the input layer, the descriptions of these inputs are listed below:

1. The grades of the general education courses. If we have 6 courses, there will be six inputs, each input receives a grade corresponding to one of the courses. In figure 2, inputs 1 through 6 represent these grades inputs. Each grade will be represented as an integer value. Because the grades are stored as letter grades, then we will use table 6 to convert the letter grade to a numeric value.

Table 6: Grade from letter to numeric value

Letter Grade	Integer value
A	95
A-	90
B+	87
B	83
B-	80
C+	77
C	73
C-	70
D+	67
D	63
D-	60
F	50

2. Numbers of hours that the student spent on each course subject. In figure 2, input 7 through 12 represents the number of hours of each of the six courses.
3. General Education Course survey results will be collected by using table 1. In figure 2, inputs 13 through 18 represent the usefulness of the course for the student goal, 5-point Likert Scale offers five different options for the respondents to choose from, where 1 represents “I strongly disagree”, 5 represents “I strongly agree”, and 3 represents “Neutral”. If the students left the field blank, the input will be ignored by the system. Also, inputs 19 through 24, represent how much the student liked each course by using the 5-point Likert Scale offers five different options for the respondents to choose from, where 1 represents “I strongly disagree”, 5 represents “I strongly agree”, and 3 represents “Neutral”. If the students left the field blank, the input will be ignored by the system.
4. The careers list survey result is collected by using table 2. According to table 2, there are 5 careers, each career selection will be an input to our designed system as shown in figure 2. However, inputs 25 through 29 represent this selection by using the 5-point Likert Scale offering five different options for the respondents to choose from, where 1 represents “I strongly disagree”, 5 represents “I strongly agree”, and 3 represents “Neutral”. If the students left the field blank, the input will be ignored by the system.
5. The materials the Student Enjoys Studying survey result that is collected by using table 3. According to table 3, there are 6 materials, each selection will be represented by using the 5-point Likert Scale offers five different options for the respondents to choose from, where 1 represents “I strongly disagree”, 5 represents “I strongly agree”, and 3 represents “Neutral”. If the students left the field blank, the input will be ignored by the system. In figure 2, inputs 30 through 35 represent student selection for each material.
6. The Soft skills the student has will be evaluated by the students themselves through filling up table 4 form. The students will use the 5-point Likert Scale which offers five different options for the respondents to choose from, where 1 represents “I strongly disagree”, 5 represents “I strongly agree”, and 3 represents “Neutral”. If the students left the field blank, the input will be ignored by the system. In figure 2, inputs 36 through 42 represent the 7 soft skills ability that the student has.
7. In Figure 2, input 43 represents the current program of the student. Because our college has 5 engineering programs, the value of this input can be any value between 1 and 5.

At the end, the proposed neural network has 43 neurons at the input layer, 5 neurons at the output layer, and 3 hidden layers. The number of neurons per hidden layer are 100, 150, and 50, respectively. The number of hidden layers and the number of neurons per one of them are tunable. The output layer classifies inputs into neurons representing the programs 1- 5. We will use SoftMax activation function to convert values of these 5 neurons into classification probabilities. The neuron with the highest probability represents the prediction for the program that best fits the student’s goal and abilities.

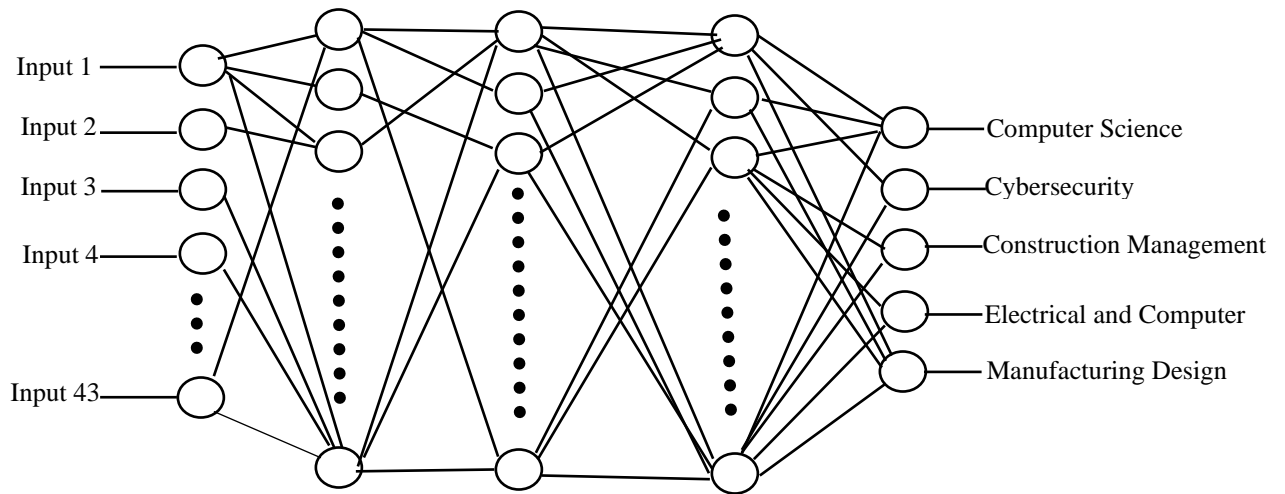


Figure 2: The structure of the proposed neural network

The dataset that should be used to train this deep learning network is still not ready, yet we are working on it. Deep learning neural networks need a big dataset [15], [18] to train on. We are going to collect the data according to the descriptions in this paper and when this dataset becomes ready, we will train the proposed system and tune its parameters according to the loss function result. This will be shared in future work. The dataset will be created by using the 43 inputs for each student and the advisor's decision for the best program that best matches the 43 inputs. The selected program may be the same as the current program for the students or maybe one of the other 4 programs that we have in our college. After collecting enough samples, we will train our proposed neural network.

Potential for AI bias

Much has been written about the potential for AI systems to be biased. Because our university has a diverse student body, we believe our data is being derived from a source that is not inherently biased. Nevertheless, we are aware of this potential and the need to work to ensure that our data does not contain such biases.

Concluding remarks

At the end of this work, there are several important conclusions that we would like to summarize:

1. Most of the AI systems focus on improving the education process by helping students learn better and faster when paired with high-quality learning materials and instruction. Meanwhile, there is no AI system available that helps students select their best fit specialization in a specific category which represents the goal of this paper.

2. ChatGPT is an AI tool that helps to answer many questions. We used it to generate the answer for our question, “How does ChatGPT help students to select their BS Engineering program that most fits their abilities.” Its partial answer, included in ChatGPT section above, is, “... student's abilities should be assessed via the academic and standardized test scores, recommendation letters and the overall academic record. It is recommended to consult with their academic advisor, career counselor or other experts on the field to make final decisions.” This answer supports our designed system.
3. By using the proposed system, we will be able to automate a repetitive task that was previously done manually (by the advisor), without feeling any fatigue or having to take breaks like a human employee would need to do. Also, there are 43 inputs that the advisor needs to consider for every student.
4. The designed system can be easily updated to match the programs of any Engineering college in any university. Also, the dataset will be created according to that university.
5. The designed system has some similarities to Aptitude tests but goes beyond such tests.
6. If data is incomplete, it may not be representative and therefore it could include bias.
7. For future work, we will focus on applying the dataset to train the designed deep learning system and evaluate the result. Also, we may add more majors (programs) that are related to Engineering.

References

- [1] Grieve. Patrick, “Deep learning vs. machine learning: What’s the difference?”, <https://www.zendesk.com/blog/machine-learning-and-deep-learning/>. [Accessed April. 12, 2023].
- [2] B. Brown, et al., "ChatGPT," 2020.
- [3] A. Alabdulhadi and M. Faisal, "Systematic literature review of STEM self-study related ITSs," *Education and Information Technologies*, vol. 26, pp. 1549-1588, 2021.
- [4] D. Azcona, I. H. Hsiao, and A. F. Smeaton, "Detecting students-at-risk in computer programming classes with learning analytics from students’ digital footprints," *User Modeling and User-Adapted Interaction*, vol. 29, no. 4, pp. 759-788, 2019.
- [5] P. Blikstein, M. Worsley, C. Piech, M. Sahami, S. Cooper, and D. Koller, "Programming pluralism: Using learning analytics to detect patterns in the learning of computer programming," *Journal of the Learning Sciences*, vol. 23, no. 4, pp. 561-599, 2014.

- [6] F. J. Cantú-Ortiz, N. Galeano Sánchez, L. Garrido, H. Terashima-Marin, and R. F. Brena, "An artificial intelligence educational strategy for the digital transformation," *International Journal on Interactive Design and Manufacturing*, vol. 14, no. 4, pp. 1195-1209, 2020.
- [7] R. C. Deo, Z. M. Yaseen, N. Al-Ansari, T. Nguyen-Huy, T. A. M. Langlands, and L. Galligan, "Modern artificial intelligence model development for undergraduate student performance prediction: An investigation on engineering mathematics courses," *IEEE Access*, vol. 8, pp. 136697-136724, 2020.
- [8] J. M. García-Gorrostieta, A. López-López, and S. González-López, "Automatic argument assessment of final project reports of computer engineering students," *Computer Applications in Engineering Education*, vol. 26, no. 5, pp. 1217-1226, 2018.
- [9] J. L. Martin Nunez and A. Diaz Lantada, "Artificial Intelligence Aided Engineering Education: State of the Art, Potentials and Challenges," *International Journal of Engineering Education*, vol. 36, no. 6, pp. 1740-1751, 2020.
- [10] W. Xu and F. Ouyang, "The application of AI technologies in STEM education: a systematic review from 2011 to 2021," *International Journal of STEM Education*, vol. 9, pp. 59, 2022.
- [11] The Muse, "The 11 Best Career Quizzes to Help You Find Your Dream Job," <https://www.themuse.com/advice/the-11-best-career-quizzes-to-help-you-find-your-dream-job>. [Accessed Jan 17, 2023].
- [12] Open Colleges, "Career Quiz," <https://www.opencolleges.edu.au/careers/career-quiz>. [Accessed Jan 17, 2023].
- [13] Brainmanager.io. [Online]. Available: https://brainmanager.io/career-test?utm_source=google&utm_medium=cpc&utm_campaign=career_test&gclid=Cj0KCCQiAq5meBhCyARIsAJrtdr6c0Np5PcAnqAwSXVtQ-K7aD8dHb94iHaZWPPrxXqsfmd1g4_CkM6gaAh4zEALw_wcB. [Accessed Jan. 17, 2023].
- [14] "Why is AI Important?," <https://csuglobal.edu/blog/why-ai-important>. [Accessed April. 12, 2023].
- [15] Geron, A., *Neural networks, and deep learning*. O'Reilly Media Inc., 2018.
- [16] Galeone, P., *Hands-on neural networks with TensorFlow 2.0*. Packt Publishing, 2019.
- [17] Loy, J., *Neural network projects with Python*. Packt Publishing, 2019.
- [18] Krohn, J., *Deep learning with TensorFlow, Keras, and PyTorch*. Addison-Wesley Professional, 2020.