Using Machine Learning to Analyze Learning Styles of Lawrence Technological University Students Across Each College

Kim Lam, BS Computer Science Candidate, CAS; Sydney Ross, BS Computer Science Candidate, CAS; Justin Light, BS Computer Science Candidate, CAS; CJ Chung, PhD, Professor, Advisor, CAS

Abstract

Knowing the learning styles of students across each college of Lawrence Technological University (LTU) is very useful to both professors and students. Taking an annual account of the different learning styles on campus can help professors focus their teaching techniques to better reach the students in their department. The current study tools that are available to students vary in degrees of usefulness and accessibility, and especially during the rise of online learning in the pandemic, it is important to know how students learn and what can be done to educate students in a better way. Many of the online sites that some students use are sometimes unreliable, unknown, or not fully encompassing enough to aid them.

Therefore, by utilizing machine learning, data analysis techniques, in hand with on-campus surveys and research, the Student Study Assistant Web Application (http://sross1.pythonanywhere.com/) will assist LTU professors and students. This application will analyze the different learning styles, track student progress in courses, and allow students to personalize their studying to be better suited for themselves. From the survey results and analytics, it was found that there are a lot of correlations between a student's study habits and their learning styles, besides the baseline personality of each student.

Introduction and Data Gathering

So what are learning styles? A learning style is a preferred way of using one's abilities to acquire knowledge and is a general term to describe how one learns most efficiently. Studies on this subject matter is rather controversial, where many theories of learning style are "debunked" or described as having little impact on education.

However, in recent light of the Covid-19 Pandemic, education has been tough on students with online learning. To combat this, needs of students are required to be taken into consideration to help better teach them inside and out of the classroom.

Taking on this mission, this project aims to look at student habits and personalities to create an application to allow them to better their studying.

To begin the data collection process, a Google Form Survey with 37 questions was released to the general LTU student population through email/other online contact. The survey results had ~150 participants with students from different LTU departments. The three main categories of learning styles we used in this study are tactile, auditory, and visual.

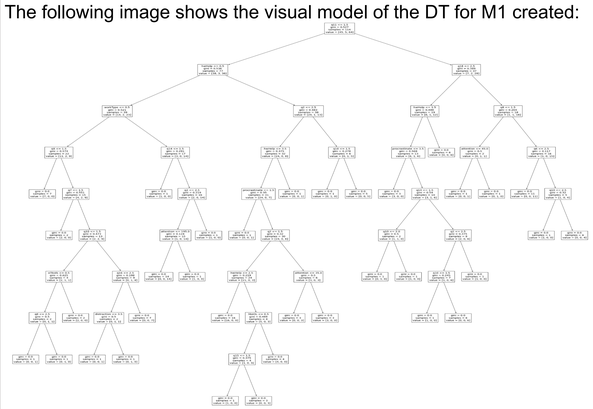
Machine Learning: Decision Trees

Using the data collected from the survey, Machine Learning (ML) was used to help predict a student's learning style and preferred online class type. In contrast with generic learning style quizzes available on the internet (such as the one that we used as apart of the study: https://tinyurl.com/hdnsyj6n), the use of ML and extra student study habit identifying questions allows us to create a more holistic view of how a student learns and what tendencies they have.

Using Google Colab to process the survey data collected from Google Forms, the data was preprocessed and applied to a decision tree (DT) to predict the learning style of a student. Three models were created: Model 1 (M1) used the 20 generic personality questions and 9 extra questions about study habits; Model 2 (M2) only used the 20 personality questions; and Model 3 (M3) that predicted a student's preferred online class type (synchronous, asynchronous, or both) used the same information as M1.

Decision Trees (cont.)

The following image shows the visual model of the DT for M1 created:



[Figure 1: Visualization of Decision Tree Predicting Student Learning Styles] This DT shows a in detail breakdown of how the DT determines a student's learning style.

The overall accuracy of M1 versus M2 showed stark differences: M1 had an accuracy of ~90% using the student's guess of their learning style to train this model, while M2 had an accuracy of ~45% using the mode of the 20 personality questions to train the model on a student's learning style.

	precision	recall	f1-score	support
1	0.87	0.93	0.90	56
2	1.00	0.83	0.91	6
3	0.95	0.91	0.93	81
accuracy			0.92	143
macro avg	0.94	0.89	0.91	143
weighted avg	0.92	0.92	0.92	143

Accuracy score: 0.916083916083916

[Figure 1: Accuracy Score of M1] This accuracy score output shows the accuracy of guessing each learning style and the overall accuracy of M1.

	precision	recall	f1-score	support
1	0.59	0.47	0.53	76
2	0.60	0.12	0.19	26
3	0.34	0.63	0.44	41
accuracy			0.45	143
macro avg	0.51	0.41	0.39	143
weighted avg	0.52	0.45	0.44	143

Accuracy score: 0.45454545454545453

[Figure 1: Accuracy Score of M2] This accuracy score output shows the accuracy of guessing each learning style and the overall accuracy of M2.

The overall accuracy of M3 was ~87% in guessing correctly a student's preferred online class type.

	precision	recall	f1-score	support
0	0.88	0.90	0.89	68
1	0.81	0.84	0.83	31
2	0.88	0.84	0.86	44
accuracy			0.87	143
macro avg	0.86	0.86	0.86	143
weighted avg	0.87	0.87	0.87	143

Accuracy score: 0.8671328671328671

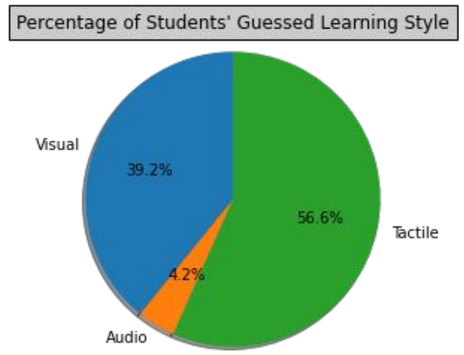
[Figure 1: Accuracy Score of M3] This accuracy score output shows the accuracy of guessing each online class type and the overall accuracy of M3.

Findings and Results

After numerous adjustments and versions of the decision tree models to predict a student's learning style, M1 was chosen to be used in the Student Study Assistant web application.

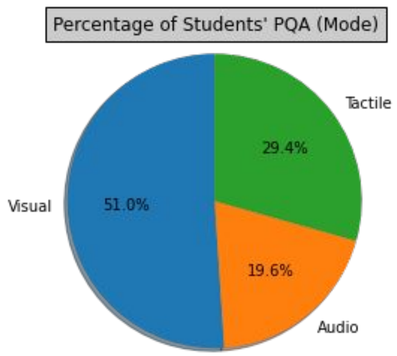
We found that generic learning style questionnaires are not sufficient in predicting a student's learning style, and that other habits need to be included (like M1).

Looking at the predicted output of M1, it can be seen that over half of the students who partook in the survey are Tactile (hands on) learners:



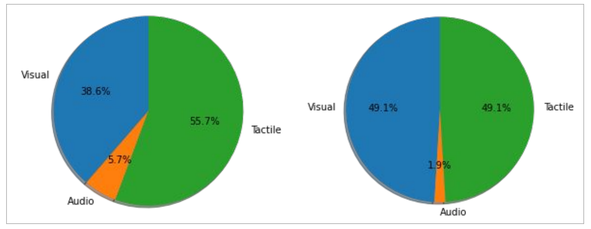
[Figure 1: Pie Chart of a Student's Learning Style Based on a Student's Guessed Learning Style] This pie chart shows, based on the M1 model, most students are tactile learners.

On the other hand, the predicted output of M2 gives an incorrect view of more students being auditory and visual learners:



[Figure 1: Pie Chart of a Student's Learning Style Based on Mode of Personality Questions] This pie chart shows a big difference in the errors M2 has in guessing more students as auditory/visual learners instead of tactile learners.

Here is the breakdown of LTU STEM students versus non-STEM students:



[Figure 1: (Left) Pie chart of the learning styles of STEM students vs (Right) Pie chart of the learning styles of non-STEM students] These two pie charts show the comparison of learning style distributions between STEM and non-STEM students at LTU. Over half of the STEM students are tactile learners, while it is almost a half split of visual and tactile for non-STEM students.

Findings and Results (cont.)

Other interesting findings include interesting correlations between a student's habit of procrastination and how often they get distracted.

	AttentionSpan	Distraction	Procrastinate	ClassType	StudyTools	HWhelp	WorkPref	OnlinePref	GuessedStyle
AttentionSpan	1.000000	-0.397118	-0.140558	0.025732	-0.070733	0.002677	-0.138749	0.048088	0.125918
Distraction	-0.397118	1.000000	0.460679	0.065955	0.149038	-0.116304	-0.066206	-0.003328	-0.038333
Procrastinate	-0.140558	0.460679	1.000000	0.064211	0.122644	-0.155268	-0.149384	-0.031752	0.069462
ClassType	0.025732	0.065955	0.064211	1.000000	-0.006572	0.234918	-0.032223	0.006369	-0.036067
StudyTools	-0.070733	0.149038	0.122644	-0.006572	1.000000	-0.011212	-0.068983	-0.103994	-0.034012
HWhelp	0.002677	-0.116304	-0.155268	0.234918	-0.011212	1.000000	0.045792	-0.083761	0.067733
WorkPref	-0.138749	-0.066206	-0.149384	-0.032223	-0.068983	0.045792	1.000000	-0.129732	-0.221161
OnlinePref	0.048088	-0.003328	-0.031752	0.006369	-0.103994	-0.083761	-0.129732	1.000000	0.122518
GuessedStyle	0.125918	-0.038333	0.069462	-0.036067	-0.034012	0.067733	-0.221161	0.122518	1.000000

[Figure 1: Correlation Table of the 9 Study Habit Questions] This table shows the correlations between the 9 study habit questions in the distributed survey.

Web Application Design

The web application was first developed in Google Scripts and the Google Suite, but was then ported over to a Python heavy application utilizing Flask, MongoDB, and PythonAnywhere. The following is a screenshot of the homepage of the application:

[Figure 1: Homepage of the Student Study Assistant Web Application] This is the landing page of the Student Study Assistant application developed 2021-2022.

Future Work

Research:

- Further testing and surveying with more LTU students
- Deeper analytics of other factors that may be impactful on a student's learning habits

Web Application Updates:

- Analytics page to see the statistics of all LTU students
- Professor tools to help gauge the learning styles and needs of their students currently enrolled each semester

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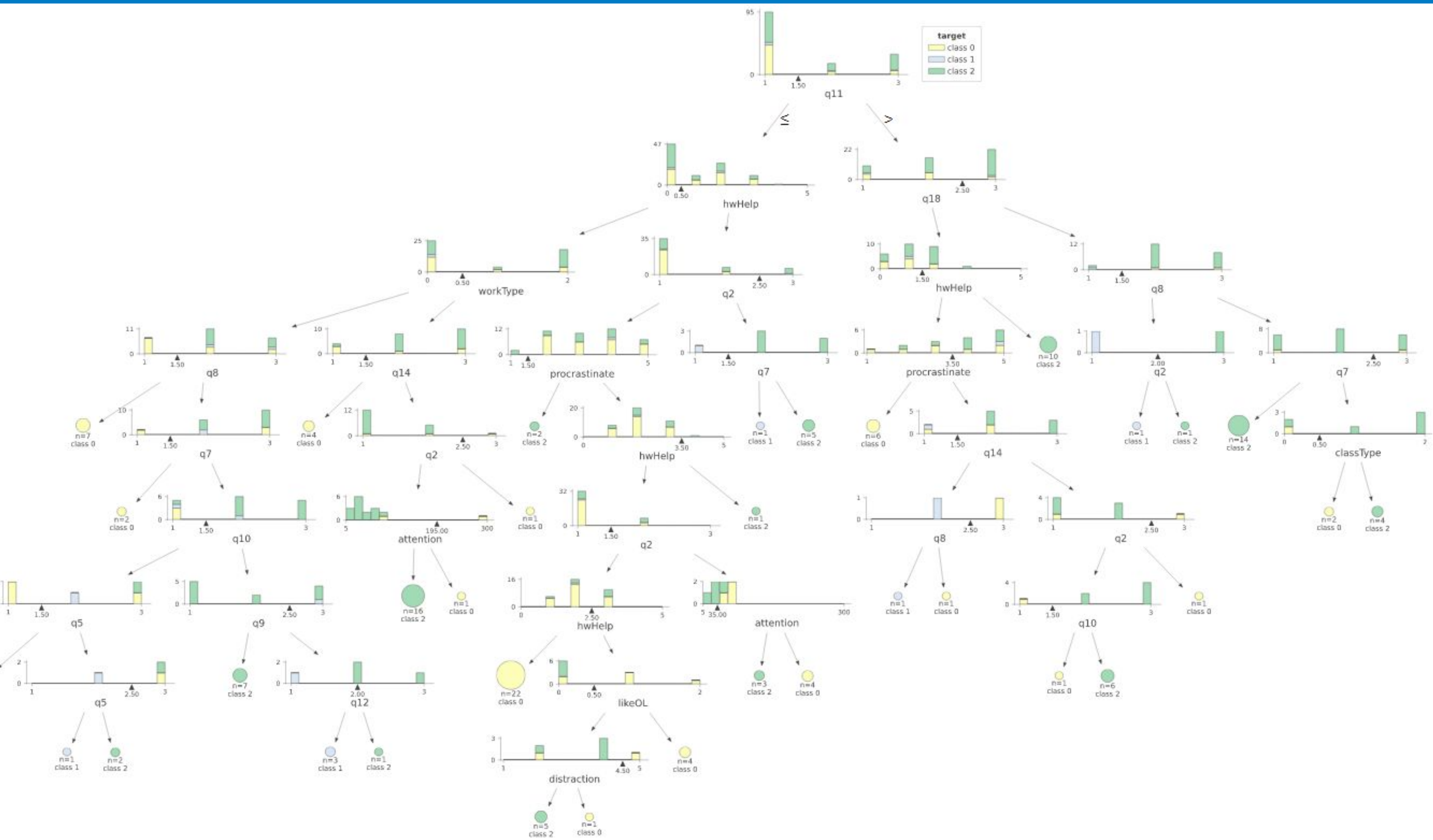
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