

# Partnering with Faculty to Nudge Students to Success

A Review of the Course Success Prediction Model

# History of Course Success Predictions

- Originally delivered as part of Blackboard Analytics to predict student success across all courses.
- Course Success Prediction 0.0 - Recreate a predictive model to assign probabilities a student would pass a course at 6 weeks and again at 8 weeks
- Course Success Prediction 1.0
  - Create course subset of high DFW courses
  - Add more features and attempt to produce predictions at 4 weeks and 7 weeks.
  - Develop a nudge and deliver to students based on course success predictions delivered through personal posts, encouraging students to use academic resources

# History of Course Success Predictions

- **Course Success Prediction 2.0**
  - Expand the nudge program to more students
  - Include a nudge for students who have received an EAA
  - Expand number of pilot courses to include CMSC 201 in similar subject areas and similar academic levels (100 and 200 level courses)
  - Creation of an app to filter and explore the data
- **Course Success Predictions 3.0 (*future*)**
  - Expand to more courses
  - Add more predictive models per subject area
  - Retrain model based on new data and new features (SAT Submitted, AP Credits, myUMBC interaction data, campus interaction data)

# Course Selection

- Selection of classes utilized in the model are shown in the following in the table. These course were chosen because they
  - Historically, have been known to have higher “DFW” rates.
  - Typically have large number of students enrolled each semester (100+ students) that can diversely be represented in our model.
  - Utilize Blackboard services more frequently, allowing for better intra-semester predictions
  - Are foundational prerequisites that have down stream impacts on student success

Course	Description	DWF Rate (Fall 2021)
MATH 152	Calculus II	44.5
MATH 155	Applied Calculus	43.3
MATH 106	Algebra and Elementary Functions	34.3
CMSC 201	Computer Science I	30.6
MATH 150	Precalculus	26.1
MATH 151	Calculus I	24.0
PSYC 100	Introduction to Psychology	12.1

# How the Model Works

- Student data from Fall and Spring 2013-2019 was used to train and test the model.
- 80% of this data was used to train the model to obtain feature weights, while 20% tested for evaluation
- Predictions are created with data up to week 4 and week 7 of the semester
- Students with a prediction value over .5 classified as receiving a D, F, or W.

# Course Success Prediction Life Cycle

## Prior Week 4

- Model does not perform well enough to generate precise predictions.
- Model can continue to gather more information on student progression in courses to increase preciseness.

## Week 4

- Predictions are generated
- Decisions on model output cutoffs and who will receive nudges are made.

## Weeks 4 to 7

- With the predictions created, we can nudge students that have high likelihood of receiving a D, F, or W.
- Students are able to adjust behaviors to improve in courses.

## Week 7

- Predictions are generated
- Re-evaluation of appropriate model cutoffs must be made.

## After Week 7

- Comparison between Week 4 and 7 predictions can be made.
- We can see how predictions have changed, as well as who: increased, decreased, or had no change in predictions.
- Generate a new list of nudges based on previous alerts.

# Model Selection

- We tested 3 candidate machine learning models.
- XG Boost provided the best performance.
  - The goal of this project is to intervene on students as early and **precisely** as possible, if they are at risk of receiving a D, F, or W.
  - Precision gives us the most insight on who will actually fail when semester grades are not yet finalized.
  - Since the XG Boost model gives us the highest precision, this is the model that will be used for prediction.

	Week 4			Week 7		
Diagnostics	Logistic	Random Forest	XG Boost	Logistic	Random Forest	XG Boost
Precision	.70	.72	.75	.72	.74	.77
Negative Precision	.81	.81	.80	.83	.83	.82
Recall	.47	.44	.43	.52	.52	.47
F1 Score	.56	.54	.54	.61	.61	.59
Accuracy	.79	.79	.79	.81	.81	.81
AUROC	.82	.83	.84	.85	.86	.87

# Model Features

## Student Demographics

- Age
- Gender
- Race
- First Generation
- Pell Grant Eligible
- Academic Level
- Major
- Is Military
- Pell Eligibility Status

## Blackboard Interaction Data

- Recent
  - Duration
  - Interactions
  - Rank
- Total
  - Duration
  - Interactions
  - Rank
- Percent
  - Grade
  - Grade Rank
- Normalized
  - Duration
  - Interactions
  - Grade

## Course Data

- Semester
- Course
- Course Level
- Course Size
- Semester Week
- DFW rate
- Class Type
  - Math
  - Spanish, or
  - Psychology

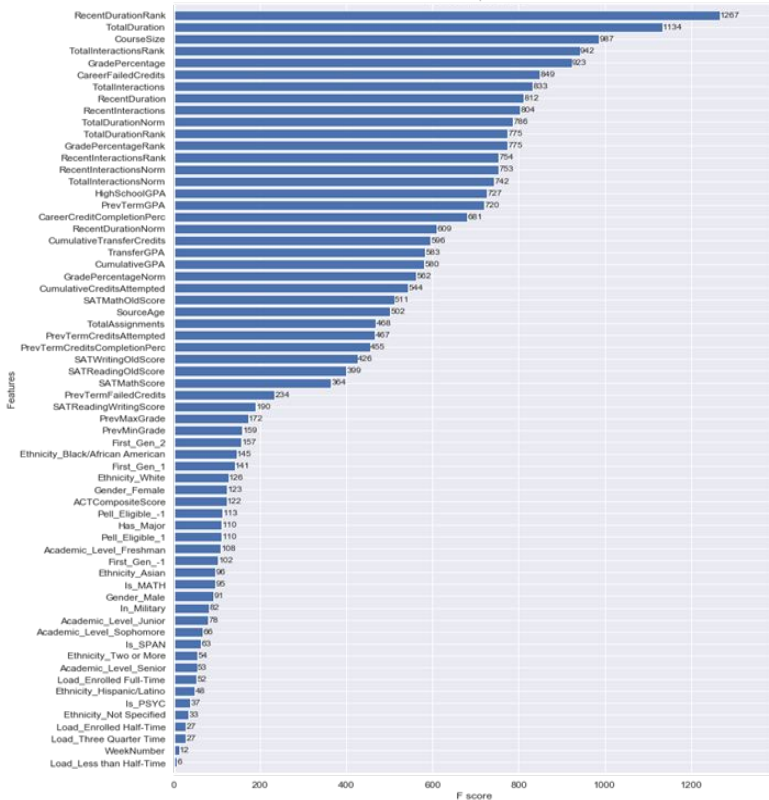
## Historic Academic Performance

- High School GPA
- SAT and ACT Scores (sunsetting)
- Student Academic Index (Sunsetting)
- Cumulative Credits Transferred, attempted, withdrawn course, and GPA
- Transfer GPA
- Previous Term Credits Attempted, credits completion percentage, and failed credits
- Previous Semester GPA
- Max and Min Grade
- Current Academic Load

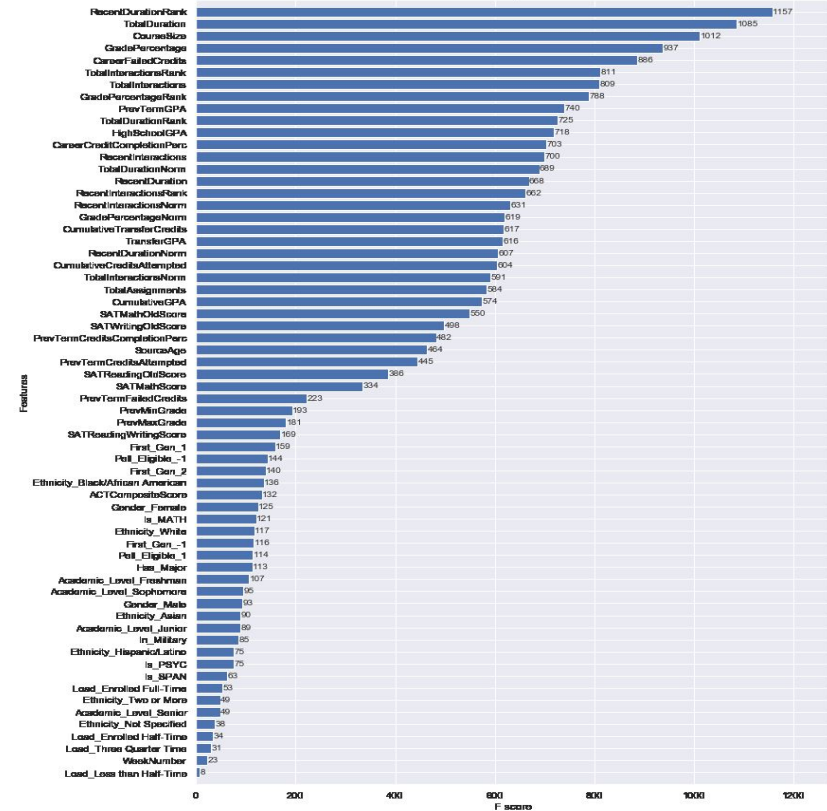




# Week 4 Feature Importance



# Week 7 Feature Importance



## Week 4 Feature Importance

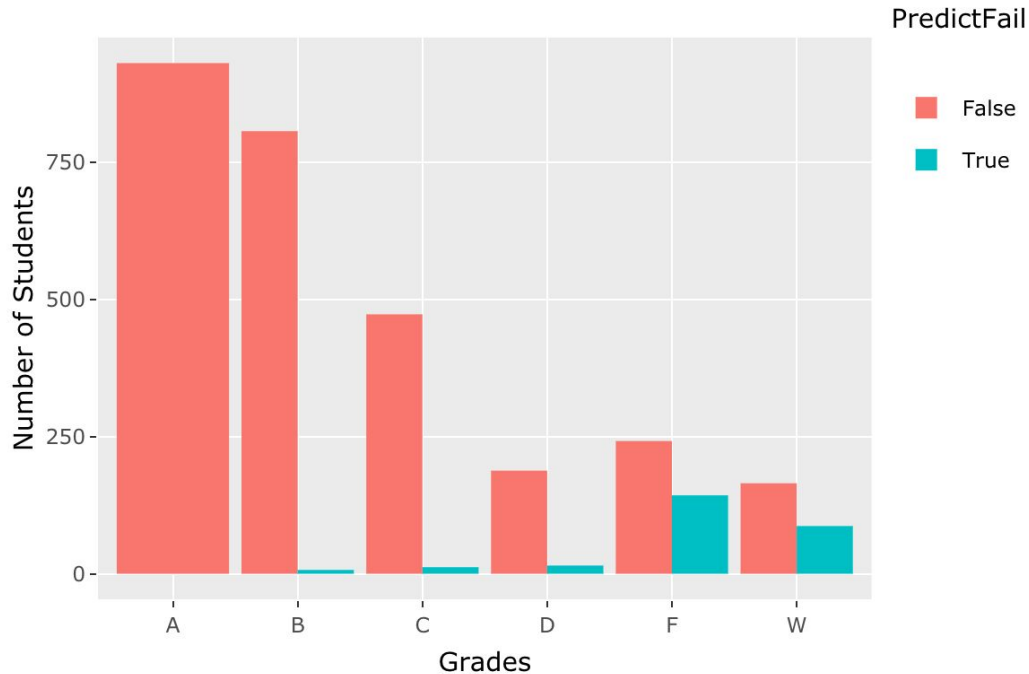
Top 5 Features
Recent Duration Rank
Total Duration
CourseSize
Total Interaction Rank
Grade Percentage

## Week 7 Feature Importance

Top 5 Features
Recent Duration Rank
Total Duration
CourseSize
Grade Percentage
Total Career Fail

# Model Performance Fall 2021

UMBC Fall 2021 Student Grades and Failure Predictions



# Model Performance Fall 2021

Final Grade	Predicted Fail	Total Grades
A	0	931
B	7	814
C	12	485
D	15	208
F	143	385
W	87	252

<b>Precision</b>	92.8%
<b>Recall</b>	30.1%

# The Nudge (“signed” by the course instructor)

**Week 4 or Week 7 Only nudge**

**Catchup from Prof. {{data.In}}, your  
{{data.cn}} Instructor**

Dear {{user.first\_name}},

I know this time of year can be busy and stressful, and while the end of the semester seems like it may take forever to get here, it will arrive before you know it. I am checking in with you to make sure that you are okay and to offer you some resources and support if you need them.

**Week 4 and Week 7 nudge**

**Catchup from Prof. {{data.In}}, your  
{{data.cn}} Instructor**

Dear {{user.first\_name}},

I wanted to follow up on the message I sent to you a few weeks ago. As we move into the second half of the semester, things can get even more busy and stressful. I wanted to check in a second time just to make sure that you're doing well and to remind you about some support resources and support.

# The Nudge

**(Week 4 and/or WEEK 7) and EAA**

**Catchup from Prof. {{data.ln}}, your {{data.cn}} Instructor**

Dear {{user.first\_name}},

**I'm writing to follow up on the EAA that you received in my class.** I know this time of year can be busy and stressful anyway, and an EAA alert can add to it. **Many people have received alerts in many UMBC classes and have gone on to pass them. You're not alone.**

# The Nudge

## All Nudges

Prior successful students have told me and my colleagues that the most useful steps they took were

1. To talk to their professor and see their advisor. Please make time to talk to one or both of us.
2. To use the Academic Success Center's free tutoring or SI PASS services
  - Schedule your own tutoring appointments
  - Questions about tutoring? [tutoring@umbc.edu](mailto:tutoring@umbc.edu)
  - Attend weekly SI PASS study sessions

I also want to let you know about the Academic Success Center's range of student resources .

Don't be reluctant to use these services and resources! Thousands of students take advantage of these every semester. They work.

My colleagues and I are here to help if you need it. Please e-mail me at the address below.

{{data.firstname}} {{data.in}}

{{data.facultycampusid}}@umbc.edu

# Read Rates For Fall 2021 Semester

	<b>Nudges Sent</b>	<b>Nudges Read</b>	<b>Open Rate</b>	<b>Links Clicked</b>	<b>Unique Links Click</b>	<b>Interaction Rate</b>
<b>Week 4</b>	845	708	83.8%	187	114	16%
<b>Week 7 Only</b>	666	579	86.9%	42	83	14%
<b>Week 4 and Week 7 no EAA</b>	594	503	84.7%	48	40	7%
<b>Any Week and EAA</b>	167	144	86.2%	39	26	18%



# An Aside on DFW Rates

Course	Description	DFW Rate (Fall 2021)	DFW Rate (Fall 2020)	DFW Rate (Fall 2019)
MATH 152	Calculus II	44.5	6.3	19.9
MATH 155	Applied Calculus	43.3	13.0	31.2
MATH 106	Algebra and Elementary Functions	34.3	13.1	33.2
CMSC 201	Computer Science I	30.6	32.2	26.4
MATH 150	Precalculus	26.1	11.3	20.8
MATH 151	Calculus I	24.0	14.0	29.6
PSYC 100	Introduction to Psychology	12.1	9.9	10.4

# DF Rates and W Rates by Fall Semester

Course	Description	DF Rate (Fall 2021)	DF Rate (Fall 2019)	W Rate (Fall 2021)	W Rate (Fall 2019)
MATH 152	Calculus II	29.1	13.1	15.4	6.8
MATH 155	Applied Calculus	24.4	22.3	18.9	8.9
MATH 106	Algebra and Elementary Functions	21.6	21.6	12.6	11.6
CMSC 201	Computer Science I	20.6	14.7	10.0	11.7
MATH 150	Precalculus	16.7	14.2	9.5	6.5
MATH 151	Calculus I	17.1	20.7	6.9	8.9
PSYC 100	Introduction to Psychology	10.4	7.8	1.8	2.6

# Spring 2021 Nudges

- Course Success Predictions directly inform who receives a nudge.
- Students are ordered by predicted probability highest to lowest.
- We know that sensitivity of the model is relatively low, and the nudge is both low cost and passive, so we find the probability (plus ties) that captures the maximum DFW percentage for our 6 pilot courses from the previous semester
- At the cost of some precision, we can nudge a few more students that may have predicted probabilities not far from the failure threshold.

Category	Nudges Sent
Just Week 4	225
Just Week 7	76
Both Week 4 and 7	201
Either week 4 or 7 and FYI	215

# Spring 2021 Nudges Continued

Total Population (including EAA Students)			
	Week 4	Week 7	Total
Total predictions	2087	2279	4366
Total Nudges sent	451	460	1075
Just EAA Students			
Total Predictions	319	317	636
Total Nudges Sent	189	183	372