

# *Shaping the Future: Using Analytics Ecosystems to Improve Student Success and Institutional Outcomes*

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# About UMBC

**Founded: 1966**

**Located 10 minutes from Baltimore, Maryland and 30 minutes from Washington, DC**

## **Student Enrollment, Fall 2018**

- **Undergraduate: 11,260**
- **Graduate: 2,507**
- **Total: 13,767**
- **Roughly 50% of students are transfers**
- **Slightly less than 50% enter as STEM majors**
- **Carnegie Classification – Doctoral Universities (Higher Research Activity, approximately \$100 million per year in funded research)**

# Similarities with our host

- **We are both very young (1998 and 1966)**
- **And although we are 7000 miles apart we are both accredited by the Middle States Commission on Higher Education**
  - **And have both recently, and successfully, completed their very challenging and demanding accreditation process**
  - **The Middle States Commission stresses assessment that is “useful and meaningful” and helps to build or maintain a “culture of continuous improvement”**
  - **Using data and analytics effectively “closes the loop” on certain types of assessment and demonstrates that commitment to improvement**

# Most importantly, our missions overlap

- **I found this quote from Zayed University's Self Study to be especially powerful and meaningful**
  - **"Excellence in education and knowledge is the route to glory. This can only be achieved through continuous efforts and academic progress. Education is the main pillar of progress and development.... The state has a dire need of the efforts of all its educated citizens in the development process" Zayed University Catalog 2012-2013**

# Why I joined the administration

- **Demographics in the US and in many other countries are unfavorable for many important things, including public higher education**
- **Funding is growing increasingly scarce and the cost of a college education is growing steadily making it increasingly unaffordable**
- **College is transformative, a reliable pathway to a stable life, and important to the State. I want to make sure others have the same opportunities that were given to me**

# The top three takeaways

- **Institutions are under pressure to graduate more students, maintain access, keep prices down, and earn accreditation**
  - **A well designed analytics ecosystem can help**
- **Using it effectively requires a solid infrastructure, good organizational design, and using tools creatively**
- **To make data and analytics part of your culture requires a willingness to use what you learned**

# Today's presentation

- **The environment facing higher education (focused on the US, but similar to many countries)**
- **Today's analytics ecosystem at UMBC**
- **Organizing ecosystems**
- **Using ecosystems: Some early results and pilots**
- **Our plans for the near future**

# The Strategic Environment Facing Public Higher Education

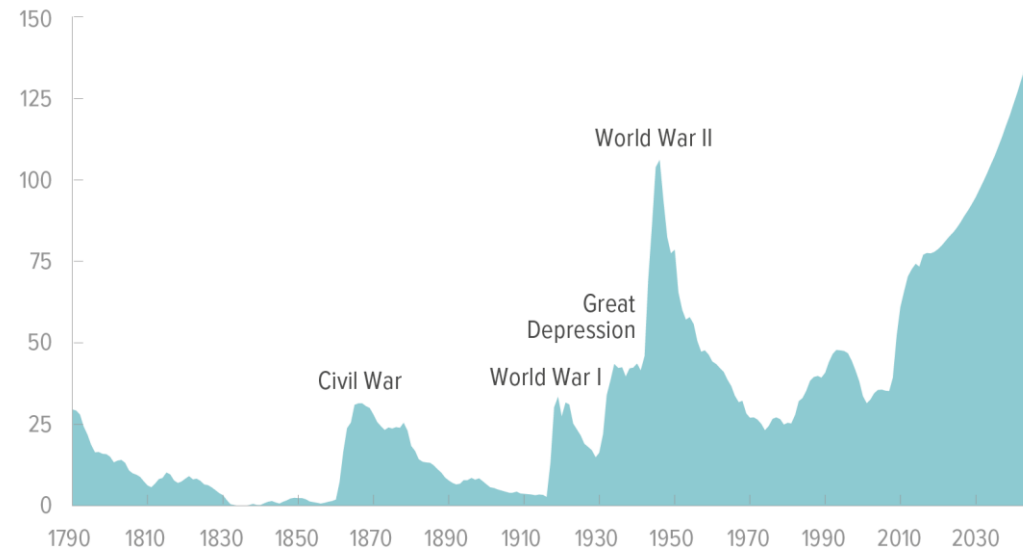


# Our federal funding is going to dry up

- **Age-based spending (driven by demographic trends and low fertility rates common to many countries) will put pressure on federal budgets**

## Federal Debt Held By the Public

Percentage of GDP



# Our state funding is going to dry up

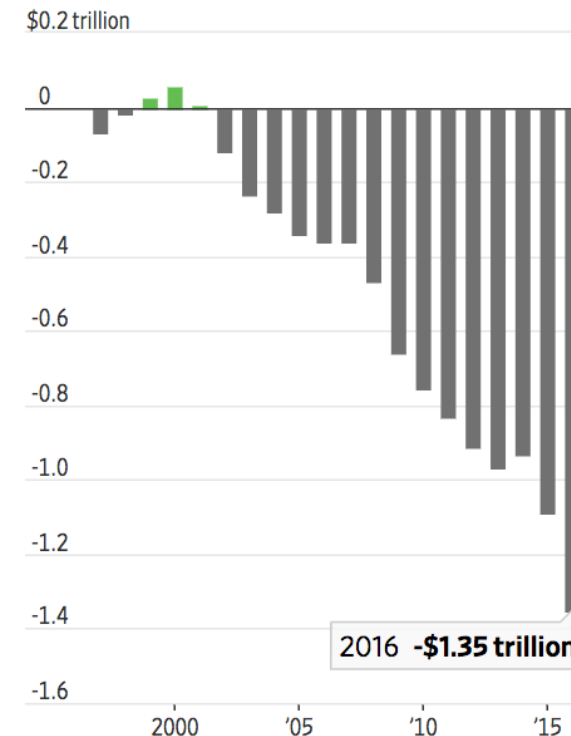
- These same forces will put pressure on state budgets

## THE WALL STREET JOURNAL.

### The Pension Hole for U.S. Cities and States Is the Size of Germany's Economy

Many retirement funds could face insolvency unless governments increase taxes, divert funds or persuade workers to relinquish money they are owed

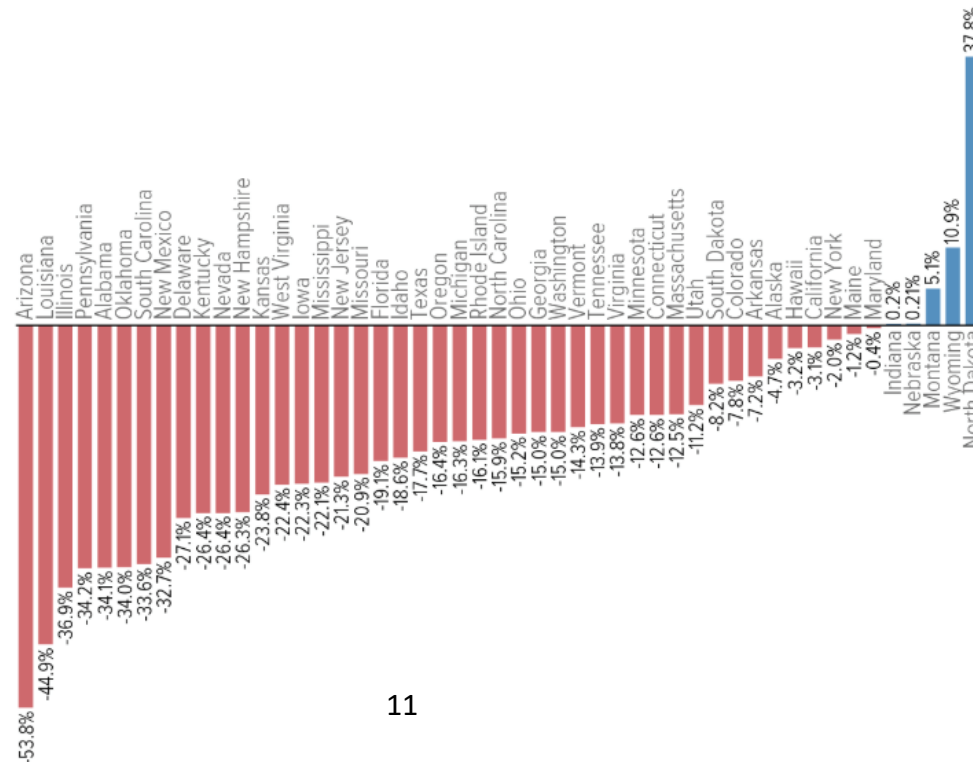
State pension deficits have grown steadily over the past two decades.



Source: Pew Charitable Trusts

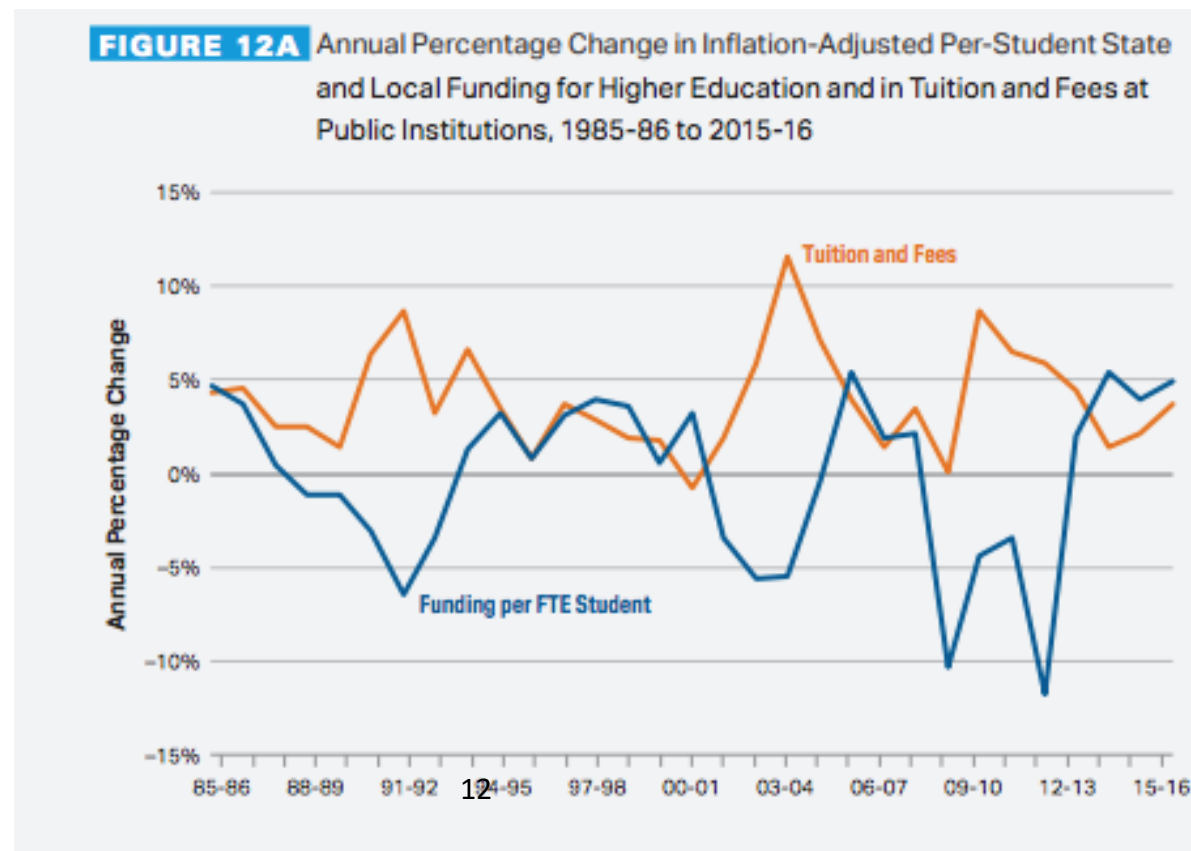
# It's already happening

- Funding for public higher education is flat or has declined in 47 of 50 states and is unlikely to recover to its former path
  - Percent change in state spending per student, inflation adjusted 2008-17 (source: Center on Budget and Policy Priorities)



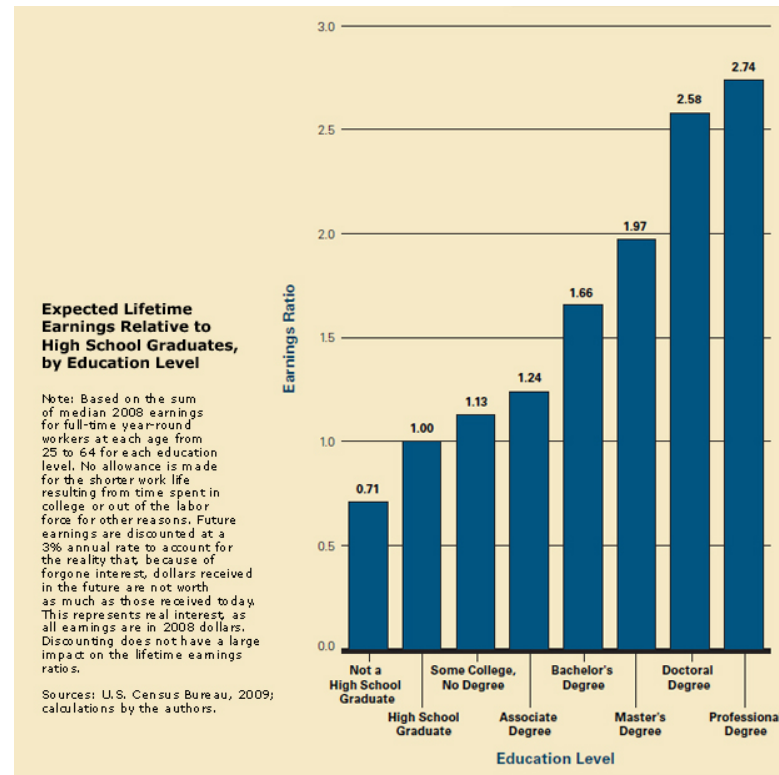
# We can't continue to raise prices

- Because our costs are relatively fixed, when funding goes down, prices go up; access and affordability goes down (source: The College Board)
  - The average growth rate of tuition and fees is twice that of median family income in the US over the past ten years



# The value of a degree has never been higher

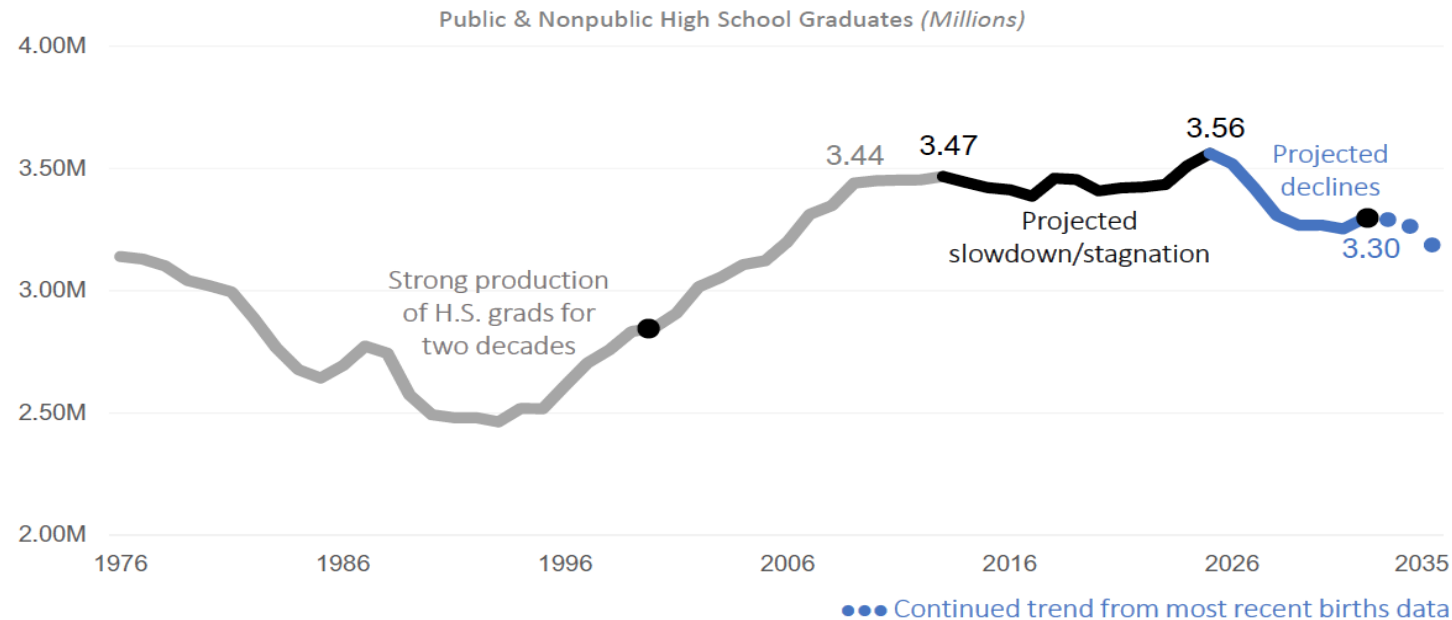
- But only if students finish!
- Those with some college earn 13 percent more than those with none. Those who finish earn 68 percent more (over their lifetime).
- A degree is worth a million dollars



# Our base of traditional “customers” will shrink

- Similar age-based demographic trends exist in much of the world’s largest economies

## Slowdown & Decline of Traditional-Age Students



- In addition, competition for students is becoming more global as more countries build world-class institutions

# The bottom line: change or be changed

- **Prices are rising more rapidly than family incomes, threatening access to degrees that are ever more valuable**
  - **With higher prices comes more accountability**
- **We face pressures from the marketplace. The pool of students is shrinking**
- **We graduate too few students (US average = 60%) leaving many with large debt and without access to higher paying jobs**
- **Improving our performance is both a business and a moral imperative**

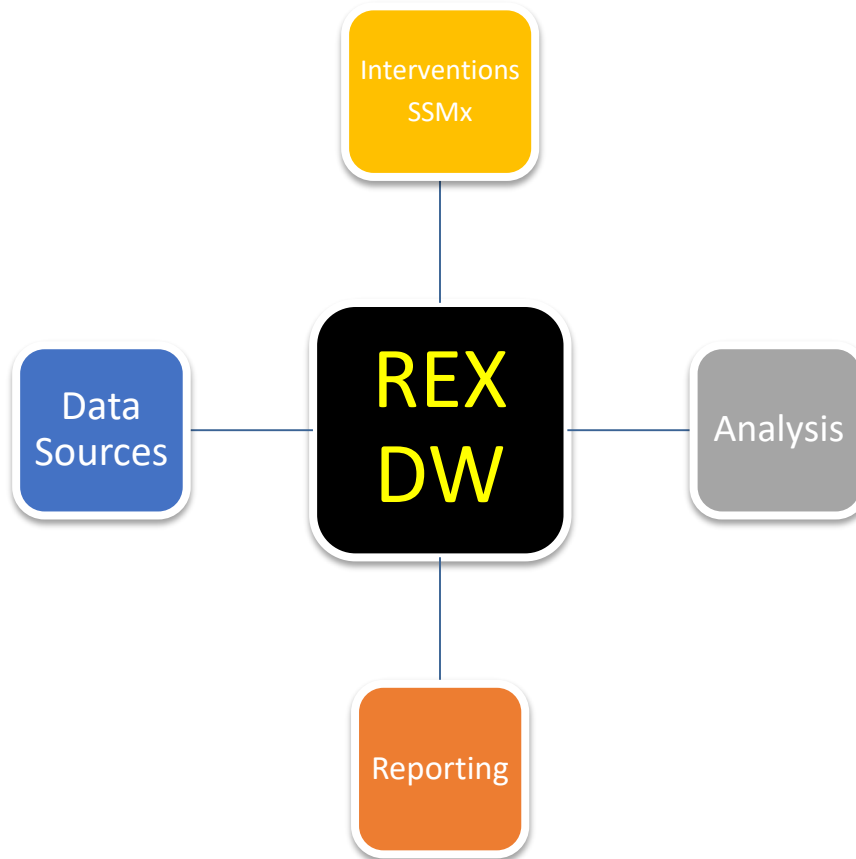
# Building an Ecosystem: Infrastructure and Foundation



- **We have a solid foundation to build upon**
  - **Over the past two decades, UMBC's leadership recognized the importance of developing our business intelligence (BI) systems to keep pace with our growing size and the need to assess**
  - **A key component of our BI infrastructure is our data warehouse, which we call REX ("report exchange")**

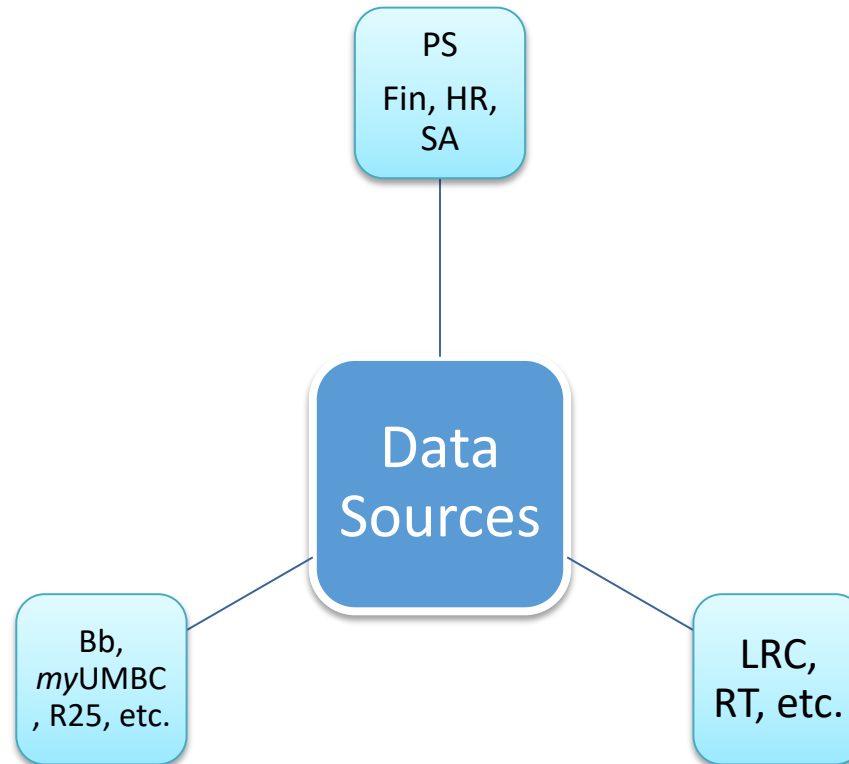
# Report Exchange (REX) Data Warehouse (DW)

- Developed in 2006
- Key benefit: We have been able to add and use multiple data sources



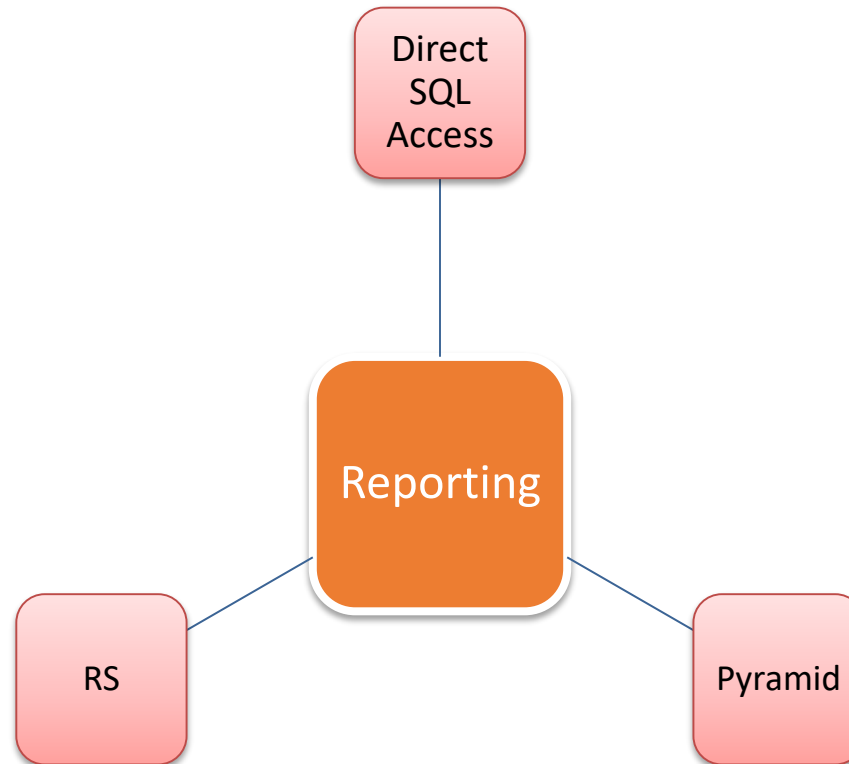
# Data Sources

- Typically, transaction systems are not suited for simultaneous reporting at scale. They would grind to a halt
- Information is pulled from the transactions systems nightly and placed into our DW



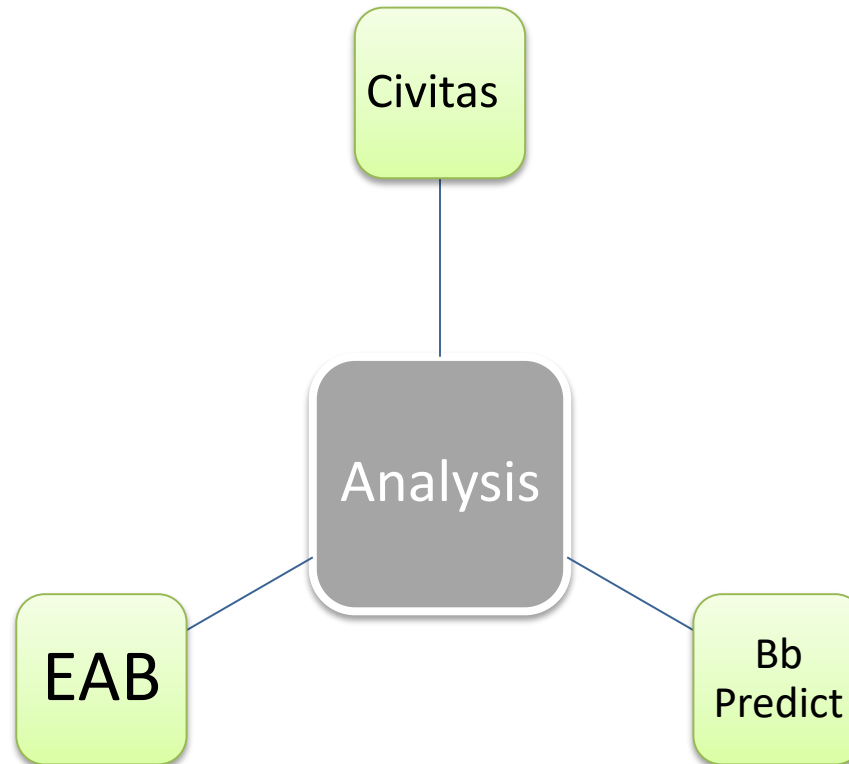
# Reporting

- Once transactional data is loaded in REX, there are three ways to report on it
  - Structured Query Language: (SQL): Used only by a handful users
  - Pyramid For power users. Also lightly used
  - Reporting Services (RS): Most common. Pre-written reports based on requests to our institutional research office
  - The success of RS may also be its weakness. Over 900 reports with hundreds more planned. It is a challenge to maintain and use



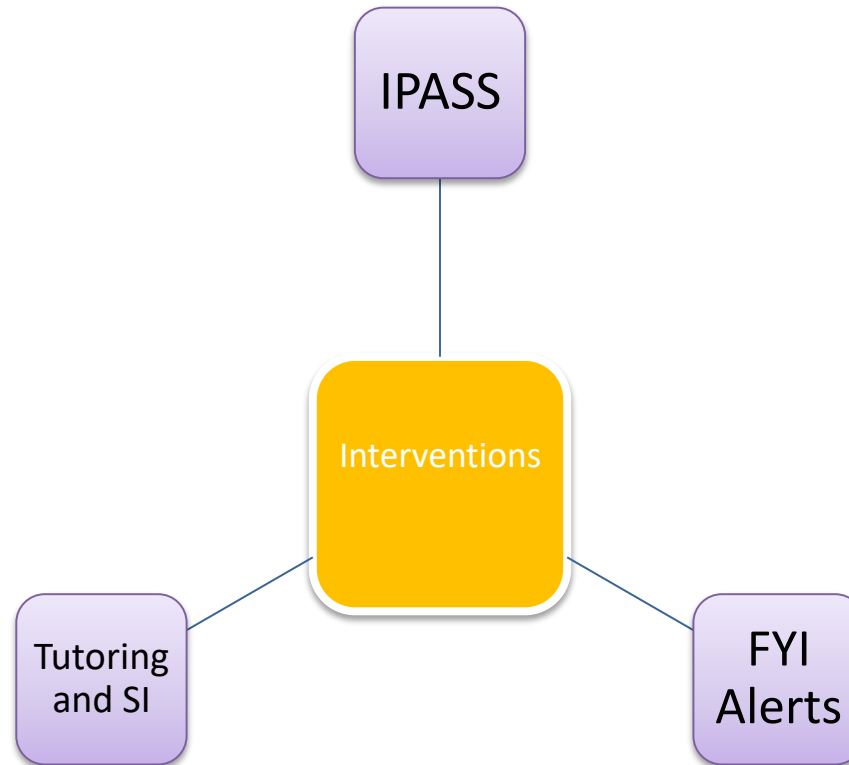
# Analysis

- We are forming partnerships and developing our own in-house capabilities. Our tools have different purposes:
  - [Civitas Learning](#): Predictive models for student persistence. Evaluating the impact of interventions
  - [Blackboard Predict](#): A model forecasting course-level success
  - [Educational Advisory Board \(EAB\)](#): Focused on resource utilization



# Interventions

- Key for making assessment useful and meaningful and accreditation. Examples (for later):
  - Tutoring or supplemental instruction (SI)
  - First Year Intervention (FYI) Alerts
- To analyze any intervention's “lift” or impact, we need to track who participated and who was eligible. The DW gives us this capability



# Organizing the Ecosystem for Results

# How to structure analytics for student success

- This is a new area within higher education
- Many institutions are struggling to get this right
  - A few have made big news by making dramatic organizational changes
- How do we organize the work?



# Current conditions matter

- **UMBC, for example, is highly regarded and well run**
  - **Our six year graduation rates is approaching 70 percent**
  - **UMBC is among the fastest-growing research universities in the country**

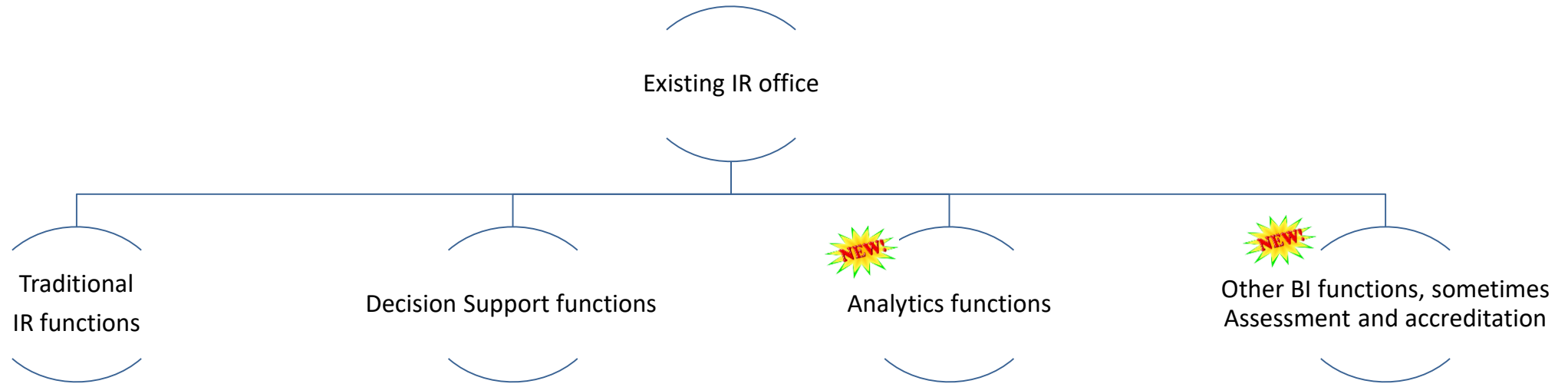
# Culture matters

- Experienced senior leadership team, many have worked together for years
- Long-tenure president, who has placed a strong stamp on the culture
- Collaborative, inclusive, strong shared governance
- Relationships mitigate the need for formal change, but are less durable than formal incentives

# Options

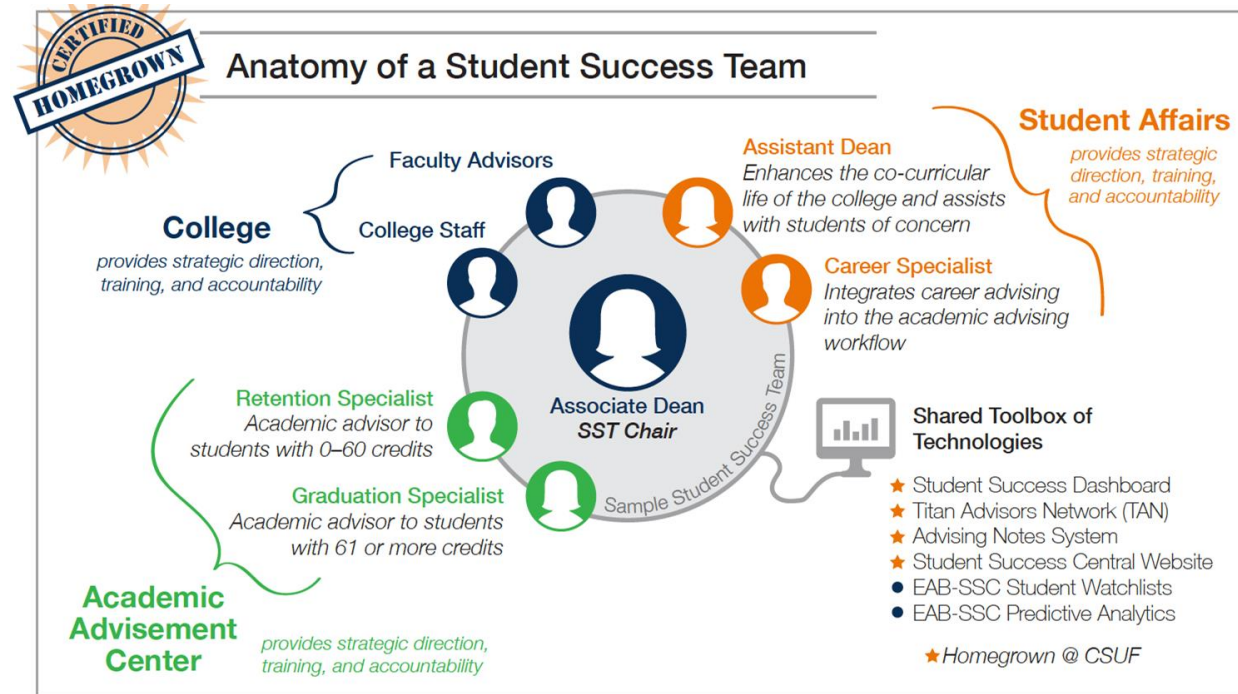
- **Four common structures institutions have used to organize their student success work**
- **Ranked in order of “disruptiveness” they are:**
  - Embed the advanced analytics in the existing IR or Business Intelligence structures
  - The committee model
  - The specialized analytics unit
  - Major reorganizations across the institution
- **Sample org charts and tradeoffs**

# Embed analytics in Institutional Research



- **Advantages:** Very close to the status quo at many institutions, so minimal disruption. May be only option for small institutions
- **Disadvantages:** As analytics becomes more embedded in teaching and learning, some conflict with faculty may emerge
- **Best when:** There is a strong group of engaged stakeholders from academic units

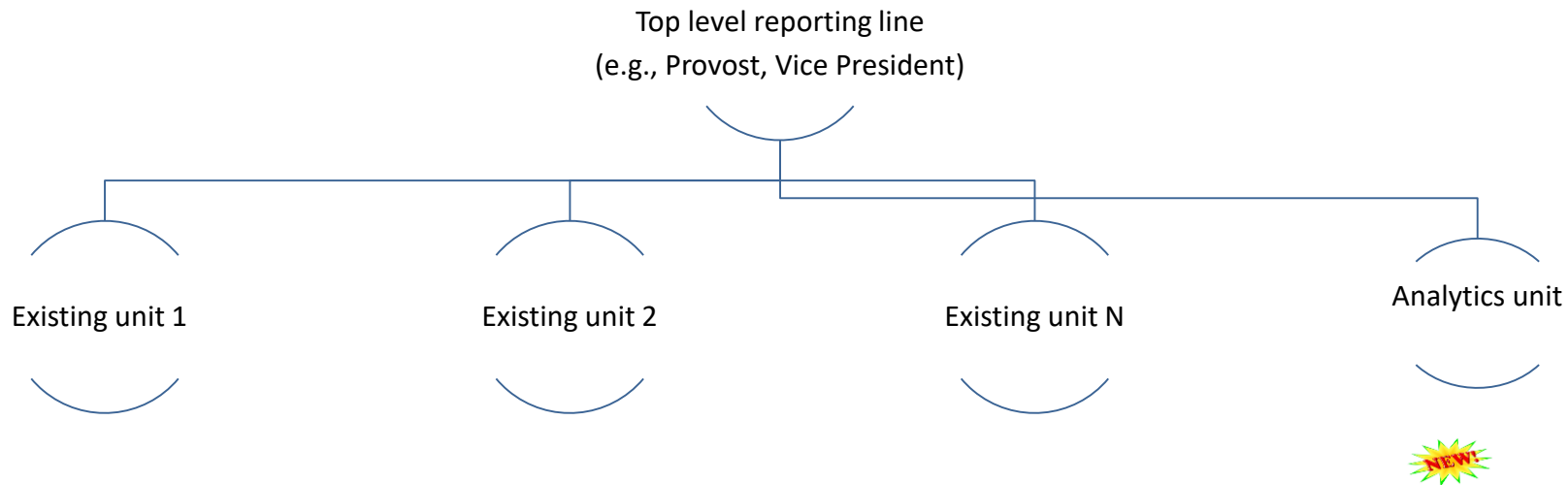
# The committee model



- **Advantages:** Coordinated approaches that link analytics with action are possible with this structure. Disruption associated with reorganization is avoided
- **Disadvantages:** Committee structures often build consensus. Consensus policies may not lead to large enough or quick enough changes. Who is accountable?
- **Best when:** A very high-level stakeholder (President or Provost) is actively engaged to coordinate action

# Create a specialized analytics unit

- **Student success functions is often spread across institutions**
  - **This model leaves those responsibilities in place**



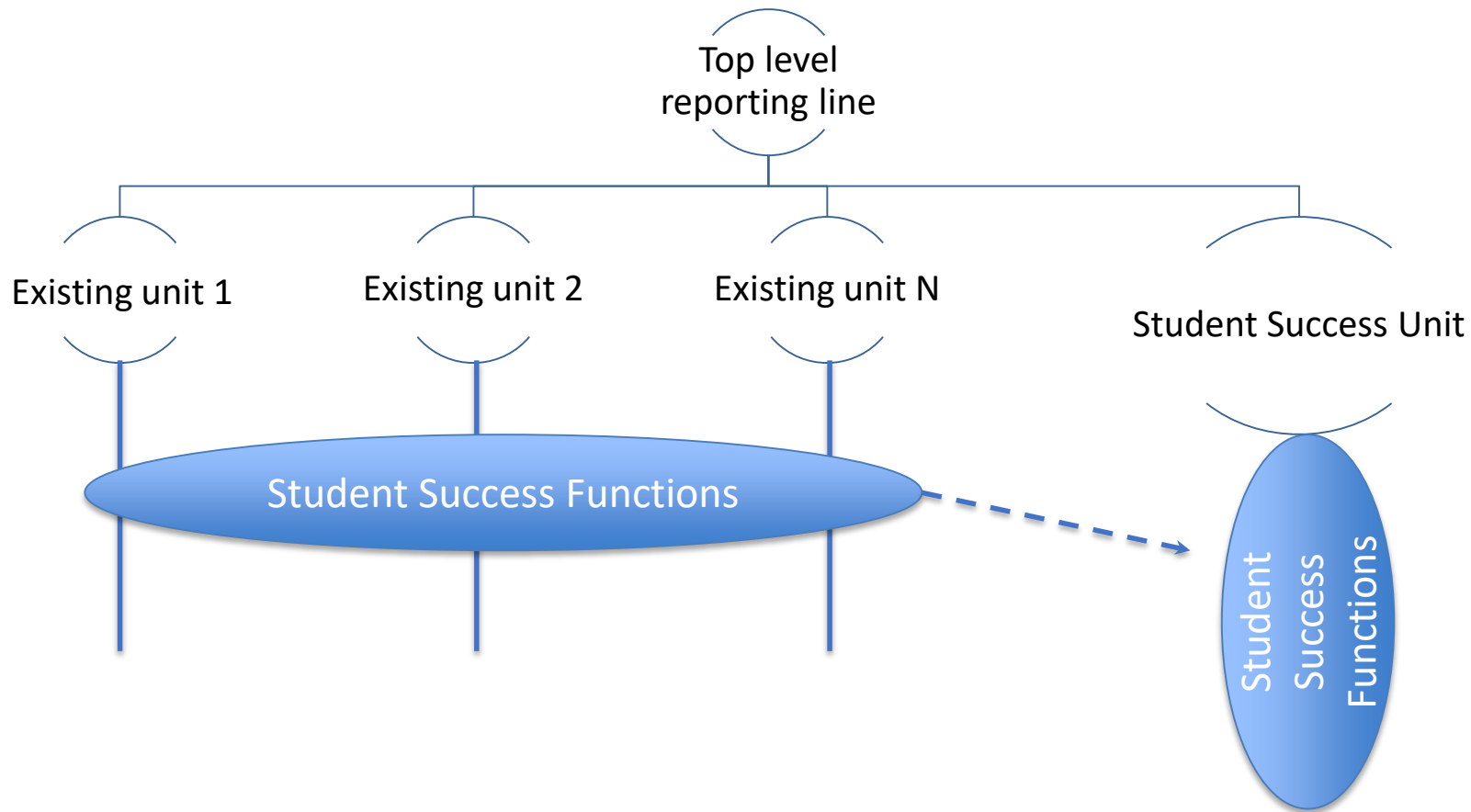
**Advantages:** Places a large number of specialized resources in one unit

**Disadvantages:** Finding the resources to build a new unit. Duplication of efforts

**Best when:** The top level reporting line resides in academic affairs

# Major reorganizations

- In this model the student-facing functions in different units are combined with an analytics group and placed into a new reporting line



**Examples: Georgia State University, University of South Florida**

**Advantages: Clear accountability for success**

**Disadvantages: Creates substantial disruption that can effect performance**

**Best when: Substantial gains in success are an imperative**



# Which to choose?

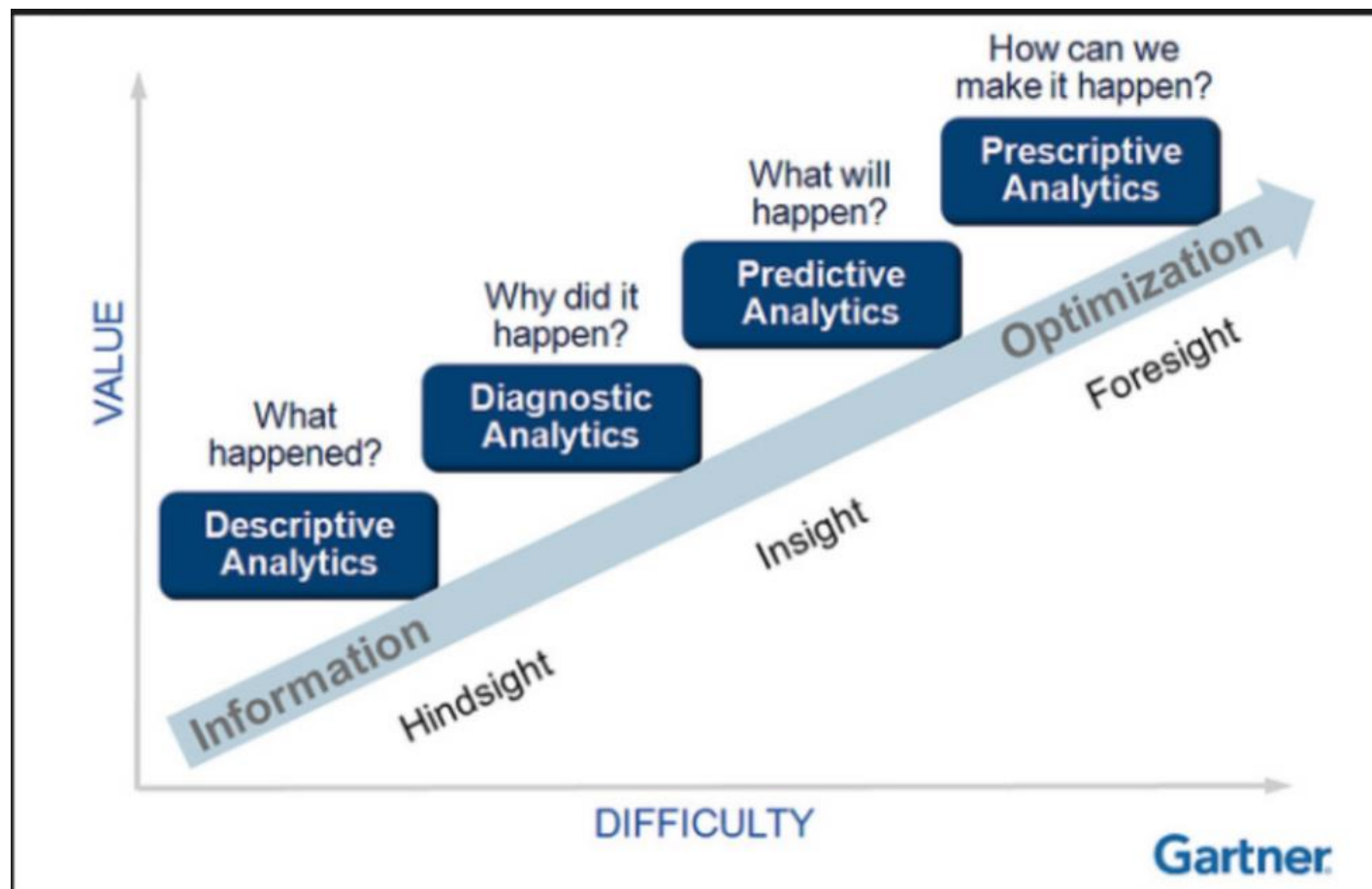
- The path to the “best” design depends on the history and culture of the institution, which is sometimes in tension with where the institution must go
- It depends on the degree of change the institution is willing to incur (risk / reward tradeoff)

# **Analytics, data science, & business intelligence**

- **We have established an advanced data and analytics group split between IT and Academic Affairs divisions (in addition to a separate IR office)**
- **The component parts:**
  - **A Data Science Team (comprised of students!)**
  - **A Business Intelligence and Student Success Technologies Group**
  - **And colleagues that constitute "a coalition of the willing"**
- **We conduct analysis for prediction and assessment, design academic innovations, and construct advanced visualizations for improved decision support**
- **Our overarching goals are to lower the cost of using information by**
  - **Curating key pieces of information to make it easier to find**
  - **Creating visualizations of the data to make it easier to understand**
  - **Produce results and fund academic innovations to translate insight to action**

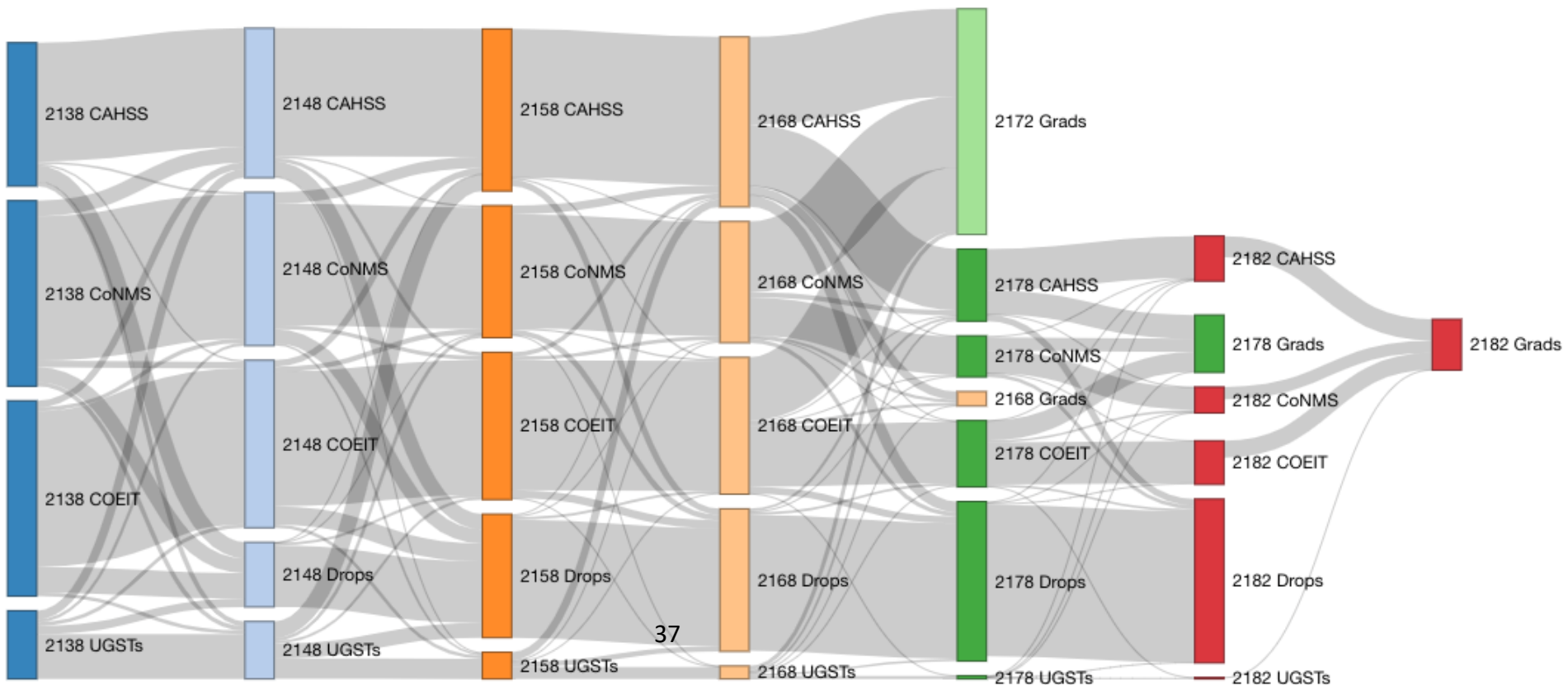
# Using the Ecosystem's Tools

# Different types of analytics (with examples)



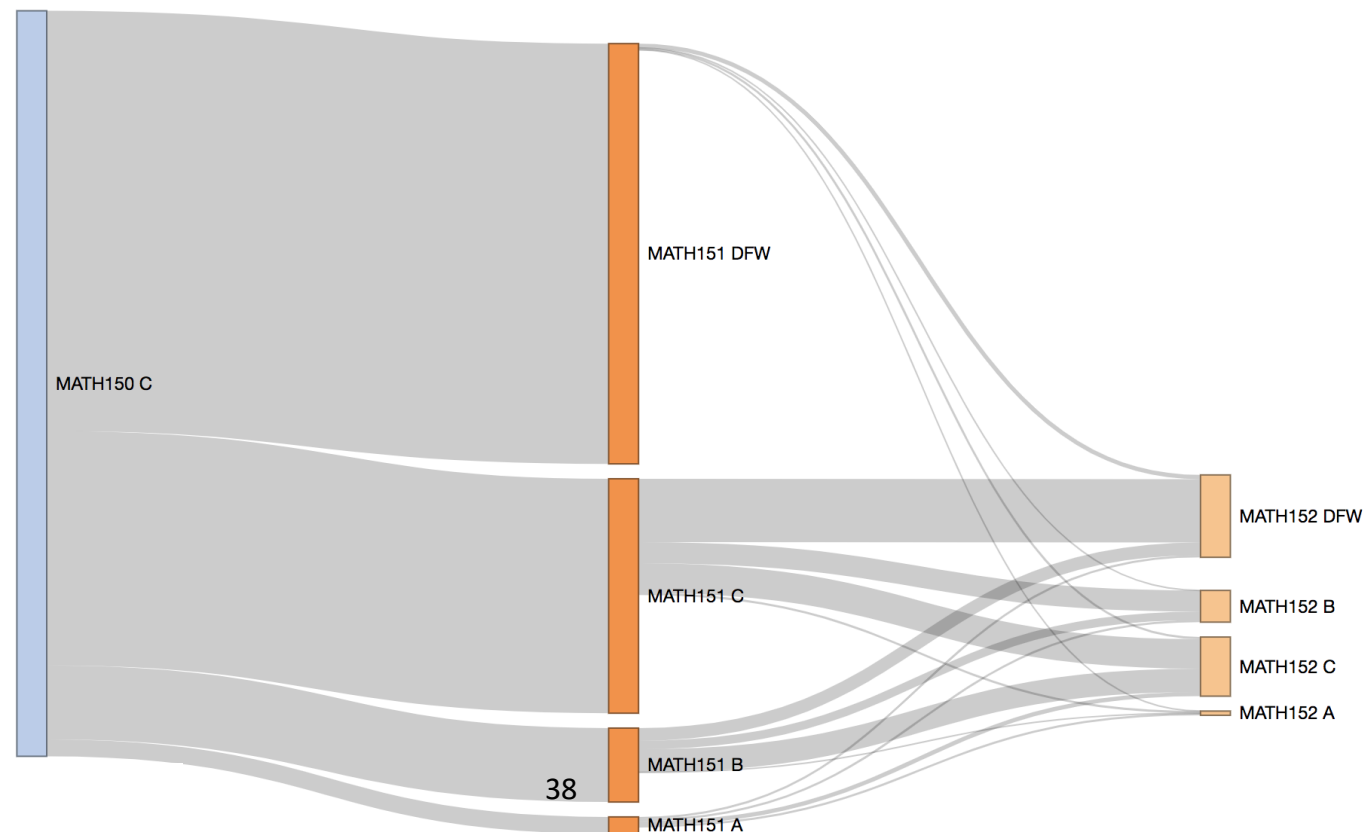
# Can we better describe student pathways?

- The diagram shows movement between colleges, graduation, and leaving UMBC. It's easy to understand
- Migration between colleges is smaller than we thought, and is dominated by migration out of the university



# Can we better describe pathways through course sequences?

- A grade of “C” in Pre-Calculus indicates an challenging path to a passing grade in Calculus II
  - Exceptionally important in a university with many STEM students

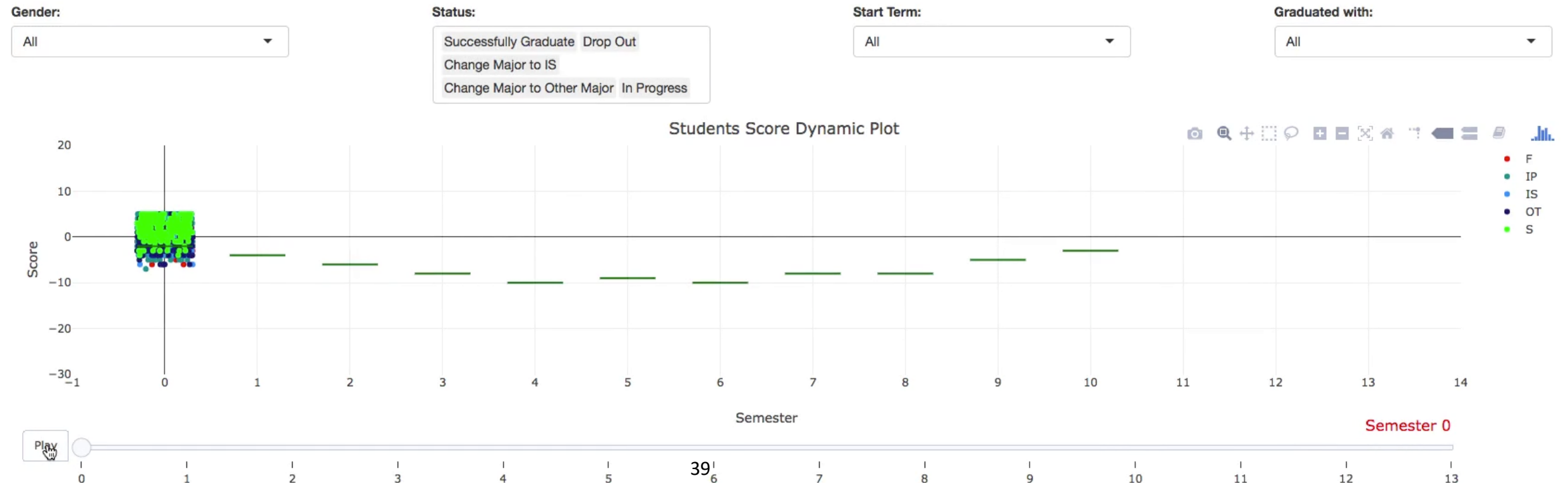


# Can we diagnose and predict why students may not succeed in a program?

- This scoring model includes threshold values where less than 10 percent of students successfully complete the major (short green

bars)

## Computer Science Student Scoring System



# Can we predict how many students will return?

- **Key for budget projections and to forecast resource requirements**
  - We have been using historical retention rates with informal adjustments
- **We've adapted information from our student success predictions and constructed a simple model that is more than 99 percent accurate six-months ahead**

Cohort Term	Cohort #	Actual		Predictions Scenarios (2)					
		Ret after 1Y	Ret after 2Y	Midpoint Prediction	Prediction Error	# students	Modified Prediction	Prediction Error	# students
Fall 2016	1517		78.7%	78.2%	-0.5%	-8	78.9%	0.2%	3
Fall 2017	1759	87.2%		87.3%	0.1%	2	87.9%	0.7%	12



# Can we use analytics to prescribe interventions? The case of math tutoring

- Enrollment in 100-level math courses is substantial over the period Fall 2009 – Spring 2016 (about 23,000)
- Here are the key numbers
  - 1 out of 3 students taking a 100-level math course will not succeed
  - 1 out of 2 students taking it a second time will not succeed
  - 1 out of 5 seats in 100-level math courses is occupied by a repeater
  - Only 1 out of 10 students use math tutoring

# Math tutoring helps

- Using a propensity score matching model, we found that use of the math tutoring reduces DFW rates (DFW= grade below a “C”) in 100-level math courses
- The estimated is especially large for course repeaters. The treatment effect is -17 percent

Course Attempt	Treatment Effect	Std. Err. of Treatment Effect	Mean Model Bias	Median Model Bias
First Time	-3.3%	1.1%	0.5%	0.3%
Repeating	-17.0%	2.5%	0.9%	0.6%

# Taking action based on the results

- Repeating students are given messages that inform them how *much* using math tutoring can increase their chances of passing the course
- The sample size is still too small a complete assessment, but
  - Students who receive the message use math tutoring about 20% more frequently
  - Our models show that tutoring continues to have a large, beneficial, treatment effect for repeaters

# Can we develop “better” early alerts?

- **The First Year Intervention Program (FYI) is a manual process that notifies students in their first year at UMBC that they are in danger of receiving a D or F in a course**
- **It prescribes, but does not require, additional support resources**
- **Faculty are encouraged to submit alerts at approximately the 6<sup>th</sup> week of a fifteen week semester**

# Faculty participation rates are relatively high


- **Over the past three years between 68 and 78 percent of faculty with an “FYI eligible” student enrolled participated in the program by submitting a report**
- **Courses with very low success rates sometimes also have very low instructor participation rates**

# Can we use analytics to do better, sooner?

- **We used a vendor-provided predictive model to identify students at risk**
- **We first selected 10 different classes to validate the model and compare them to the existing FYI program**
- **We found that faculty are better at predicting who will fail. The predictive model is better at predicting who will succeed**

# The two processes together are very accurate

- Green and red shaded categories show "agreement" between FYI Alert and the predictive model

		BIOL 302L		PHYS 111		PSYC 100 (2060)		PSYC 100 (2061)		CHEM 352	
		<i>Predicted DFW</i>		<i>Predicted DFW</i>		<i>Predicted DFW</i>		<i>Predicted DFW</i>		<i>Predicted DFW</i>	
<i>Received FYI Alert</i>		No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
No		91%	89%	97%	59%	99%	93%	99%	83%	92%	58%
		54	37	77	87	80	28	83	30	71	43
Yes		.	0%	100%	27%	68%	43%	67%	77%	.	0%
		.	1	1	11	19	23	3	13	.	3
		CHEM 101		GES 110		MATH 150		MATH 152		SCI 100	
		<i>Predicted DFW</i>		<i>Predicted DFW</i>		<i>Predicted DFW</i>		<i>Predicted DFW</i>		<i>Predicted DFW</i>	
<i>Received FYI Alert</i>		No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
No		95%	72%	94%	67%	92%	55%	99%	53%	94%	78%
		44	170	69	48	38	29	68	72	81	18
Yes		57%	23%	67%	14%	0%	27%	.	.	.	0%
		7	69	3	47 14	1	11	.	.		1



# Taking action based on the results

- In the pilot, students who were assigned a predictive alert received an empathetic message
- Students who received a faculty alert and a predictive alert received an empathetic, more strident message
- Students who received only the faculty alert received the existing message
- The numbers are very small, but every student who received the predictive model alert and the faculty alert reacted to the message and passed the class
- Five of six students who received the predictive model alert (but not the faculty alert) passed the class.
- This was a proof of concept. We have expanded the pilot to include several additional classes this term

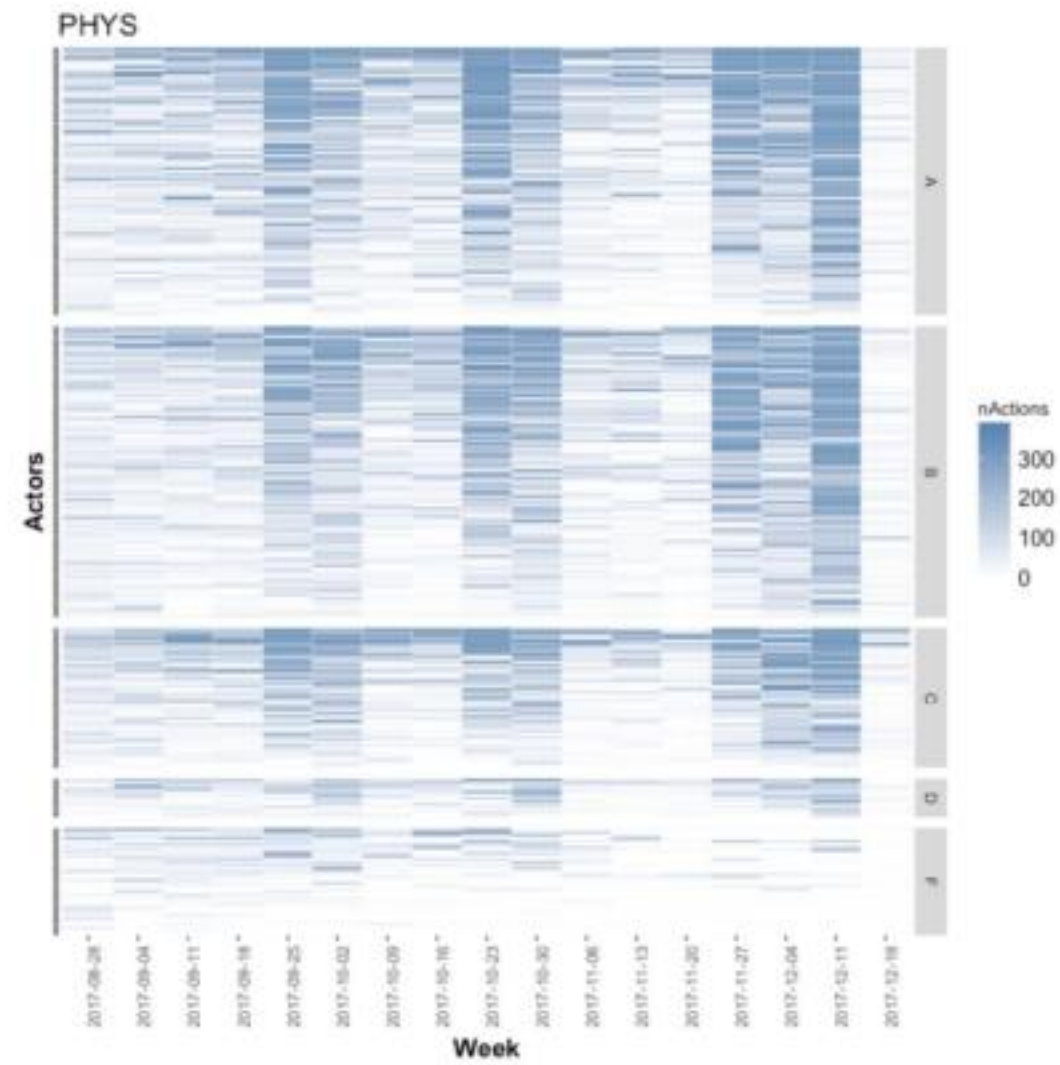
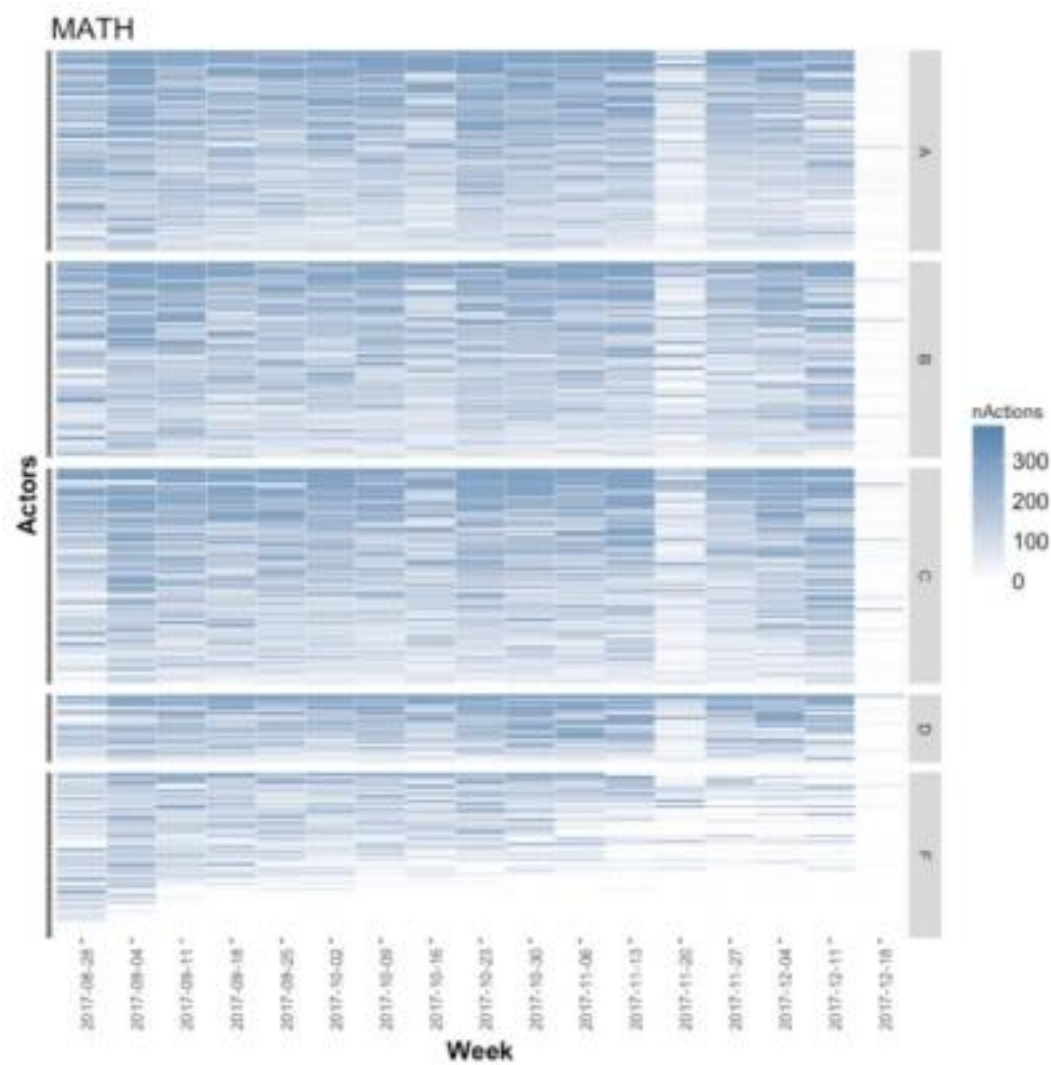


# Where do we go from here?

- **For this generation of business intelligence tools, our goal is to make using analytics easier. Less time = more use**
- **Our model of shared governance will best accommodate working with individual faculty on pilots to implement insights, then broadening those pilots as trust is built**
- **We're also looking ahead to some very interesting new directions and developments**

# A five year work plan

- **Adaptive release and individualized pathways**
- **Efforts to gather data on student engagement and electronic textbooks**
  - **A sample visualization**
- **Gathering information on the student experience at shorter frequencies (a place where Explorance and the Blue can help)**
- **Designing ways to use rapidly growing information streams**
- **Documenting, tracking, assessing interventions with a CRM**
  - **Accreditors: “if you didn’t document it, you didn’t do it”**



# Wrapping up

- **What does an analytics ecosystem look like in 10 years?**
  - Scale and synthesis, making changes based on results to close the loop
- **Addressing organizational challenges**
  - Student success requires coordinated actions across many areas of the university, which is in fundamental tension with decentralized governance
  - Given the strategic environment, how does this get resolved? Either top level intervention to centralize functions, a budgetary model, or key performance indicators that provide accountability and incentives
  - If we don't do this proactively, our external stakeholders may insist
- **Change or be changed**