Please Be Advised

Netflix meets Google meets academia. How **data mining** is reshaping the college experience.

*Swiped ID card, Starbucks, 2:01 p.m. and 4:44 p.m.*

*Psych major.*
*She's got mail:*  
*Take statistics now.*

*Likes: tattoos, photography, education.*

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*Swiped ID card, Starbucks, 2:02 p.m. and 4:43 p.m.*

*Are you friends?*

*Likes: tattoos, photography, education.*

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*25 math lessons to go before Monday.*

*Get cracking!*
AMPUSSES are places of intuition and serendipity: a professor senses confusion on a student’s face and repeats his point; a student majors in psychology after a roommate takes a course; two freshmen meet on the quad and eventually become husband and wife. Now imagine hard data substituting for happenstance.

As Katie Allisone, a freshman at Arizona State University, hunkers down in a computer lab for an 8:35 a.m. math class, the Web-based course watches her back. Answers, scores, pace, click paths — it hoovers up information, like Google. But rather than personalizing search results, this data shapes Ms. Allisone’s class according to her understanding of the material.

With 72,000 students, A.S.U. is both the country’s largest public university and a hotbed of data-driven experiments. One core effort is a degree-monitoring system that keeps tabs on how students are doing in their majors. Stray off-course and a student may have to switch fields.

And while not exactly matchmaking, Arizona State takes an interest in students’ social lives, too. Its Facebook app mines profiles to suggest friends. One classmate shares eight things in common with Ms. Allisone, who “likes” education, photography and tattoos. Researchers are even trying to figure out social ties from anonymized data culled from swipes of ID cards around the Tempe campus.

This is college life, quantified. Data mining hinges on one reality about life on the Web: what you do there leaves behind a trail of digital breadcrumbs. Companies scoop those up to tailor services, like the matchmaking of eHarmony or the book recommendations of Amazon. Now colleges, eager to get students out the door more efficiently, are awakening to the opportunities of so-called Big Data.

The new breed of software can predict how well students will do before they even set foot in the classroom. It recommends courses, Netflix-style, based on students’ academic records.

Data diggers hope to improve an education system in which professors often fly blind. That’s a particular problem in introductory-level courses, says Carol A. Twigg, president of the National Center for Academic Transformation. “The typical class, the professor rattles on in front of the class,” she says. “They give a midterm exam. Half the kids fail. Half the kids drop out. And they have no idea what’s going on with their students.”

As more of this technology comes online, it raises new tensions. What role does a professor play when an algorithm recommends the next lesson? If colleges can predict failure, should they steer students away from challenges? When paths are so tailored, do campuses cease to be places of exploration?

“We don’t want to turn into just eHarmony,” says Michael Zimmer, assistant professor in the School of Information Studies at the University of Wisconsin, Milwaukee, where he studies ethical dimensions of new technology. “I’m worried that we’re taking both the richness and the serendipitous aspect of courses and professors and majors — and all the things that are supposed to be university life — and instead translating it into 18 variables that spit out, ‘This is your best fit. So go over here.’”

What’s the next math lesson? Who’s falling behind? The software knows all.

By Marc Parry

The old system let students explore without much structure. A student could major in engineering to please his parents, only to pack his schedule with “Chinese Thought” and music, says Elizabeth D. Capaldi, the provost. No longer. Technology has redrawn the road map.

Under Arizona State’s eAdvisor system — in use from 2008-9 and based on a similar effort at the University of Florida — students must pick a major freshman year and follow a plan that lays out when to take key courses. (Students can still study broadly, by choosing from five “exploratory” majors, like “arts and humanities” or “science and engineering,” and staying in them for 45 credits.) If they fail to sign up for a key course or do well enough, the computer cracks a whip, marking them “off-track.” Wander off-track two semesters in a row, and a student may have to change majors.

If that sounds harsh, there’s a rationale: One way to ensure that students will reach the finish line is to quickly figure out if they’ve selected a suitable track. So the A.S.U. system front-loads key courses. For example, to succeed in psychology, a student must perform well in statistics.

“Kids who major in psych put that off, because they don’t want to take statistics,” Ms. Capaldi says. “They want to know: Does their boyfriend love them? Are they nuts? They take all those courses, then they hit statistics and they say: ‘Oh, God, I can’t do this. I can’t do experimental design.’ And so they’re in the wrong major. By putting those courses first, you can see if a student is going to succeed in that major early.” Arizona State’s retention rate rose to 84 percent from 77 percent in recent years, a change Ms. Capaldi credits largely to eAdvisor.

For students who run off-track, the outcome can sting. Ms. Eriven was shocked to learn she would have to change her major after the system flagged her. She cried, called her mother, and recalibrated her plans. In a meeting with an adviser, she detailed her interests. She likes science. She is family-oriented, interested in music, and good at writing. The adviser suggested a few possible majors, including psychology, family and human development, and creative writing.

Writing. It would involve only a couple of classes each semester. She could still take science and, hopefully, switch back to biology. So that’s what she chose. “I didn’t really have, like, a backup plan,” Ms. Eriven says.

But what if you could rewind this story and shape a student’s path before reaching such a crossroads?

YOU WILL PASS (OR NOT)

When Adam Lange began working full time at Rio Salado College in 2008, he was still an undergraduate at nearby Arizona State, a 22-year-old computer science major with a budding obsession with data. Over time, that obsession would shape the learning experience for thousands of students — and drive his fiancée bonkers.

Mr. Lange’s idea of fun is converting his home into a surveillance lab. He outfitted his cat Sammy, who has an eating disorder, with a device that is read by a scanner every time the cat cranes his neck over the bowl. Mr. Lange monitors the logs and feeds Sammy a treat if he hasn’t eaten. He also rigged a webcam next to his fish tank, logging the coordinates of his Betta fish several times a second to find out what common paths it takes and how far it travels (90 feet in one hour). At Rio Salado, a com-

This article is a collaboration between The New York Times and The Chronicle of Higher Education, a daily source of news and opinion for professors, administrators and others interested in academe. Marc Parry is a technology reporter for The Chronicle.
Many educators are now asking similar questions. Do you help students who succeeded in the past? Use that to identify students who may cease to be places that are going to be increasingly populated by software that runs Web courses. Records of when they logged in, opened a syllabus, turned in homework — all of it just sitting there. Could you mine it to model patterns of behavior that are going to be inaccurate over a period of about five days. An internal analysis found no surge in the number of students dropping classes. An improved system is promised for fall.

**Your records**

The system has access to your previous college grades, your high school grade-point average and all of your standardized test data, including ACT and SAT scores.

**Grade database**

Software searches transcripts of students who have taken classes or tests in common with you. The database includes more than 500,000 grades.

**Grade correlations**

Every grade in the database is connected to grades in other courses. The system finds correlations. Grades in calculus, for example, have a strong correlation with grades in statistics.

**Predicted grades**

To predict your success in a given course, the software combines your grades in correlated classes with other grades and scores you have received. The more correlations, the more weight in the prediction.

**Requirements**

The system knows the requirements for your major and the core curriculum, and knows which of these you have already fulfilled.

**Recommendations**

Courses are given a star rating based on your predicted grade as well as their importance to requirements.

Advising by Algorithm

At Austin Peay State University in Tennessee, a program called “Degree Compass” provides students with a customized list of course recommendations based on degree requirements as well as predicted grades. Here is how the lists are generated.

At Arizona State, algorithms figure in course content, too. Thousands of A.S.U. students now take math courses through a system that mines performance and
behavioral data, building a profile on each user and delivering recommendations about what learning activity they should do next. The system, created by a start-up company Knewton, gives the university a fresh way of addressing the continuous problem of students being unprepared for college math. But it also offers a glimpse into what many more students will experience as teaching increasingly shifts from textbooks and lectures.

Mr. Mazur and his colleagues came up with a novel solution: take students out of the matching. Their software, called Learning Catalytics and now in use at various campuses, is intended to force students to defend their ideas by matching them with classroom partners who have different opinions.

When Merri Su Ruhmann sits down in a graduate seminar on student development, she checks in to her seat on a map of the classroom displayed on her iPad. Then the lecturer, Cassandra Alvarado, poses questions in Learning Catalytics. If there is enough divergence in answers, she clicks a button on her laptop and students are automatically grouped. Ms. Ruhmann obeys her prompt: Please discuss your response with Jessica Khalaf behind you.

“It forces them to either have certainty, and to really defend their idea or, it gives them that moment of cognitive uncertainty, which is really powerful for learning,” Ms. Alvarado says.

The responses can be educational for Ms. Alvarado, too. At times, she has planned to fly through what seemed like easy questions, only to discover students had major gaps in understanding. “I have data now,” she says. “Not just a feeling.”

MATCHMAKING University of Texas students are grouped based on their responses to questions, then must defend their answers.

Mr. Mazur, a Harvard physics professor, has long worked to supplant lectures with more interactive classes. Students, he found, assimilate new material better by working on conceptual problems in class and debating their conclusions with peers. But they tend to pair up with the same friends, which can be unproductive.

THE SOCIAL NETWORK

These experiments are only the beginning. Colleges will likely dig deeper into the data at their disposal, touching more and more aspects of student life. Already, some researchers are eyeing the next frontier: social life.

Research shows that social ties can be critical to academic success. If students are more integrated into campus life, they’re more likely to stay in school. If a friend drops out, they’re more likely to as well.

“If the university could model, at a high level, the social network of the college, that would be a very useful data layer,” says Matt Pittinsky, who co-founded Blackboard, a company that provides a platform for online classes, and later became an assistant research professor in the sociology program at Arizona State. A university might reach out to a student who is not showing evidence of social integration,” Mr. Pittinsky says, pointing out extracurricular activities and communities that might tie them more deeply to the institution.

Working with computer scientists, Mr. Pittinsky started an academic research project that tip-toes toward a better understanding of social connections. The research team’s raw material: anonymous logs from swipes made with Arizona State ID cards. When students use these cards, be it to buy food on campus or access the fitness center, the transaction gets recorded. The question that struck Mr. Pittinsky was whether or not you could infer social ties from those trails.

Say two students swipe within 5 or 10 seconds of each other at different times of day in different contexts. Are they more likely to be friends? And can you predict attrition by pinpointing changes in how a student uses a campus? Say someone goes to Starbucks at 2 p.m. every day before 2:15 p.m. class. Then stops. “If that happens three weeks in a row,” Mr. Pittinsky says, “and we’re not seeing log-ins into Blackboard, and maybe you’ve made a request at the registrar to have your transcript sent somewhere, there ought to be an adviser with a really big red flashing light saying, reach out to this student.”

The prospect of card-swipe surveillance discomforts Mr. Zimmer. He worries authorities might misuse location data to do things like track foreign students or instigators of a student protest.

But the broader issue of privacy hangs over even less Orwellian efforts to collect and monitor personal data. In his own courses, Mr. Alvarado includes a disclaimer on his syllabus disclosing what he can see through Milwaukee’s online-learning platform, including “the dates and times individual students access the system, what pages a student has viewed, the duration of visits, and the IP address of the computer used to access the course Web site.”

For his part, Mr. Pittinsky stresses that the card-swipe research is “very focused on the ability to protect anonymity.”

As for students, they’ve never been too fond of adults meddling on Facebook, let alone getting all Big Brother with card swipes. “Creeping on us,” says Ms. Allsone. In the first card-swipe project, Ms. Allsone has managed to keep one aspect of her life — she hopes to transfer — from any “creeping.” But that, too, may change.

Arizona State monitors requests for transcripts to be sent elsewhere, according to Ms. Capaldi, the provost. “Which,” she says, “is kind of sneaky.”