

# Scarlet Navigator: A Modern Solution to Course Planning at Rutgers University

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#### Abstract

In this report, the author talks about the uncertainty Rutgers students face when planning out their path towards graduation and the need for a new and modern course planner to enable student success. The author argues that due to recent increases in student enrollment, decreases in course openings, and possibilities of course cancellations, a student's intended course plan is highly volatile and subject to change. Furthermore, the author points out deficiencies in informational resources and the dissatisfaction with the advisor system. These factors, the author argues, adds friction for those striving to graduate on-time with minimal debt. What Rutgers must do, the author insists, is to develop a tool that helps enable students to be agile in their path towards graduation and proactive in designing their academic roadmap. There are many solutions of the past that have successfully helped students in this manner. The author pulls research from student solutions (Princeton and Rutgers University), enterprise solutions (uAchieve), Rutgers administrative solutions (Curriculum Mapping Subcommittee), and other university solutions (University of Washington). The author synthesizes key features from these past solutions to add to the base solution: Scarlet Navigator, an existing drag-and-drop planner for the Rutgers community. The author argues that the solution is entirely free by mentioning the computational prowess possessed by Rutgers and the vibrant student development community willing to volunteer their skillset. The author recommends that Rutgers University adopts this solution during the institution's pivotal moment of change; the author insists that because the project is free, empowers students to collaborate, and enables students to be proactive towards graduation, integration of this software can only be a net positive.

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# **Executive Summary**

The adoption of a new, modern course planner for Rutgers University students will increase retention rates, graduation rates, and will help students graduate on-time—a pillar of student success as defined by the Academic Master Plan.

The Academic Master Plan will "serve as the roadmap for Rutgers-New Brunswick's future" (Rutgers University, 2021). It is composed of four pillars, one of which is "student success" (Rutgers University, 2021). A priority of student success is "on-time graduation with minimal debt" (Rutgers University, 2021). The issue of "minimal debt" becomes more dire when you consider that 31.5% of undergraduates face food insecurity and that staying at the university for more than six years leads to higher accumulation of student debt (\$40,658 on average), a violation of the Academic Master Plan's mission (Rutgers University, 2021; Cuite et al, 2020).

In its more than 250-year history, Rutgers University welcomed its largest class (13,500 students) in the Fall of 2022 (Rutgers University, 2022). The following year, a similar number of students were welcomed (Rutgers University, 2023b). However, the number of writing section programs in the Fall of 2024 is "drastically lower than [Fall of 2023]" and 29 of 31 adjunct writing lecturers will not return for Fall 2024 (Rutgers AUUPT-AFT, 2024). This scarcity in sections is not isolated to the Writing Program since 2 of 16 Computer Science electives for the Fall of 2024 were open as of April 23rd, 2024, as seen in Figure 2. When you consider that to graduate with a B.S. in Computer Science requires 7 electives, the lack of open electives is an issue for many students (Rutgers University Department of Computer Science, n.d.) Thus, hundreds of students rely on student-made services to be notified when a course is open (hattvr, 2023; thedru, 2023; schedru, 2018; better\_off\_now, 2021). Furthermore, courses can be canceled, forcing students to make immediate changes to their plan (Bri-xox, 2023; jkakk-, 2021). When asked if they anticipate graduating in four years, some students "noted that it could be difficult to find courses or get into them" (Rutgers University, 2023a, p. 140). This unpredictability for students is detrimental to the university's reputation, which is heavily entwined with the successful graduation of its student body (White, 2015).

Although Rutgers provides advising services, many students are dissatisfied (Rutgers University, 2023a, p. 139). SAS has a student to advisor ratio of 741:1, which is 2.58 higher than the recommended standard of 250:1 for large universities (Boyer 2030 Commission, 2022, p. 33; Rutgers University, 2023a, p. 139). Students are often "shuffled from advisor to advisor" and struggle with scheduling and waiting for appointments (Rutgers University, 2023a, p. 139). Other than advising, most responses to the question "What are some things you like least about [Rutgers]?" focused on the difficulty of finding resources and information on Rutgers websites; some students noted that Rutgers-New Brunswick websites "were often out of date" (Rutgers University, 2023, p. 138; Rutgers University, 2023a, p. 139). Even if the university improved the shortcomings, the institution's ability to help the 2,407 students that withdrew from the university in 2022 due to "anticipation of poor academic performance" or "personal issues" is limited (Rutgers University, 2023a, p. 55). The necessity of a student's self-reliance becomes more evident when you consider that even most faculty do not feel it is their responsibility to advise students in the same manner as full-time advisors; only when it's in their fields of study do they find student advising relevant (Allen, 2008).

There have been many solutions in the past that have helped enable students to be confident in their path towards graduation. uAchieve Planner/Degree Audit is an enterprise solution that provides a dashboard for students and advisors to plan multiple paths towards graduation (CollegeSource, n.d.a). The software has a GPA calculator, course recommendation system, prerequisite validation, major/minor sorting by progress, etc. (CollegeSource, n.d.a). Since implementation, Harding University increased their four-year completion rate by 5%, and Ivy Tech Community College increased their "credential production" by 23% (CollegeSource, n.d.b). TigerPath is another course planning solution created by students at Princeton University (Chu, 2018). The program differs from uAchieve in its user experience: drag and drop capabilities and dashboard layout (Chu, 2018). However, this solution is insufficient for the Rutgers community since it's constrained to only four-year plans; as implied by the Curriculum Mapping subcommittee in recommendation 6.1, an exact four-year curriculum cannot define the vastness of academic experience (Rutgers University, 2023a). Scarlet Navigator, a studentproject that implements TigerPath's features, is a course planning solution for Rutgers University. It contains the essence of TigerPath's functionality, along with other features such as accommodations for non-traditional students (Monisit, 2022a). Over 800 Rutgers students have used it, citing its user-friendly experience—winning an award by the Rutgers Computer Science Department (Monisit, 2022b).

Rutgers University's Curriculum Mapping subcommittee were tasked to create major maps that demystifies career and academic pathways (Rutgers University, 2023a, chapter 6). They created templates that suggest academic courses and actions at reasonable milestones (Rutgers University 2023a, p. 181; Rutgers University, 2023a, p.198). These templates are a synthesis of major map templates of other large universities (The University of Utah, n.d.; UC Berkley, n.d.; Rutgers University, 2023a, p. 66). Similarly, the University of Washington has a program that suggests course recommendations called The Virtual Academic Advisor System, or VAA (Vijjapu, 2019). They used machine learning and graph algorithms to recommend students valid course sequences based on preferences and prerequisites (Vijjapu, 2019). When compared to human benchmarks, the system had a mean recall and precision rate of 83% (Vijjapu, 2019).

Using what we know from previous solutions, Rutgers will establish the base of its new course planner as Scarlet Navigator. The project will integrate curriculum milestone recommendations by the Curriculum Mapping subcommittee (Rutgers University, 2023a). Then, it will utilize VAA's graph representation of prerequisites to validate student's plans via a graph search (Vijjapu, 2019; Centeno, n.d.). After, it will integrate major/minor/certificate sorting by total progress (CollegeSource, n.d.). Next, it will provide GPA calculations and course recommendations as seen in VAA, uAchieve, and the subcommittee recommendations (Rutgers University, 2023a; Vijjapu, 2019).

The total cost of Scarlet Navigator will be free. If Rutgers servers are leveraged, hosting this service will cost virtually nothing. If Rutgers uses volunteer student developers, as seen in many of its existing organizations, development will be free (HackRU, n.d.; HackHERS, n.d.). As Chancellor Conway put it, "[Rutgers] can't be braced for change, [it] must create it in order to thrive in the 21st century" (Rutgers University, 2021). Rutgers is, indeed, at a pivotal moment of change. Directing the zero-cost efforts of the Rutgers student community into a project that is free can only be a net positive.

# **Statement of Need**

#### The Need to Graduate

Based on Rutgers' internal auditing, the academic advising resources that Rutgers provides students are insufficient (Rutgers University, 2023a, p. 139). Navigating degree requirements and ensuring timely graduation is an extremely important process that demands deliberate attention and difficult decisions from the student. Students must have the means to precisely track requirements as missing a single requirement will delay their graduation, undermining student success—a pillar of the Academic Master Plan (Rutgers University, 2021). As Rutgers states, a priority of student success is "on-time graduation with minimal debt for all students." According to the Discovery Advantage Report, Rutgers New Brunswick (Rutgers-NB) students who graduate in four years or less have, on average, \$27,734 in debt (Rutgers University, 2023a, p. 177). In contrast, those who graduate in six years or more have \$40,658. These statistics are more disturbing when you account for the Rutgers population. Cuite et al. (2020) found that 6.2% of undergraduates and 5.6% of graduate students are homeless; 31.5% of undergraduates and 29.9% of graduate students face food insecurity. Additionally, there are other possible hurdles. For example, let's consider the common scenario of a student wanting to switch majors. The School of Arts and Sciences (SAS) of Rutgers-NB requires a student to fulfill nine goals across 33 credits (Rutgers School of Arts and Sciences, n.d.). These goals are fulfilled alongside major(s) and/or minor(s) requirements. Often, courses can fulfill multiple cores, leading to many overlaps that provide students leverage to switch majors. Across all universities in the United States, around a third of undergraduates in degree programs have changed their major within 3 years of initial enrollment, and about one in ten students changed their majors more than once (National Center for Education Statistics, 2017). Students must understand the requirement overlap between one major and another before they re-declare; they must also consider costs such as "delayed graduation" or the "emotional costs associated with the perception that a 'mistake' was made" (Thompson, 2009). Tracking requirements in combination with personal and emotional implications is difficult. Reducing the mental burden of requirement tracking will allow students to make more confident and informed decisions.



Rutgers–New Brunswick Average Debt by Graduation Rate Groups, Academic Year 2016-17 to 2020-21

Figure 1: Rutgers---New Brunswick Average Student Debt

#### The Need to be Agile

A student's path towards graduation is subject to change and is never set in stone. Consider the course offerings for Computer Science students for the Fall of 2024. At the time of writing (April 23rd, 2024), 2 of 16 electives are open as seen in Figure 2. "Computer Security" and "Introduction to Computational Robotics" are both advanced electives that require high-level prerequisites, which means these electives are not open to everyone (Rutgers Computer Science Department, n.d.b; Rutgers Computer Science Department, n.d.c). To graduate with a B.S. in Computer Science, a student must complete 7 electives (Rutgers Computer Science Department, n.d.c). To be granted access to closed sections, students must apply for at most two rounds of SPNs (special permission numbers) to register (Rutgers Computer Science Department, n.d.d). Being granted an SPN is never guaranteed. Furthermore, recent scarcity in course offerings is not limited to the Computer Science program. Just recently, the Writing Program, which teaches "one-third of the 40,000 undergraduates on campus," will have similar issues (Koruth, 2024). At least 29 of 31 adjunct writing lectures will not be returning to the program in the fall. This means that the "number of Writing Program sections being offered next fall is drastically lower than last fall" (Rutgers AUUPT-AFT, 2024). To make matters worse, in the Fall of 2022, Rutgers welcomed its largest incoming class in its 256-year history of more than 13,500 students (Rutgers University, 2023a). The following year, Rutgers welcomed over 13,400 in first-year enrollment (Rutgers University, 2023b). What was then record-breaking is now the general baseline in terms of enrollment. Decreasing course offerings and welcoming record-breaking numbers of students will only increase the scarcity of course offerings.

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Figure 2: Fall 2024 Computer Science Elective Offerings

To acquire courses, students resort to external tools. Hundreds of students rely on paid services built by students to "snipe" courses in the few seconds they become available because many important courses are filled too quickly (hattvr, 2023; thedru, 2023; schedru, 2018; better\_off\_now, 2021). Course offerings, especially those necessary for graduation, can be unpredictable in availability due to high demand. Moreover, some courses can be canceled before the semester starts, forcing students to make immediate changes to their overall academic plan and possibly delay their graduation (Bri-xox, 2023; jkakk-, 2021). To have one's preferred academic path and/or timely graduation contingent on reaction time rather than academic ability is an unfortunate situation. Addressing this issue is beyond the scope of this project; thus, it will be assumed this is the reality that Rutgers students must endure. It stands to reason that providing tools for student success that aid in handling unforeseen events is paramount since an institution's overall reputation is entwined with the successful graduation of its student body (White, 2015).

SAS does provide advising services. However, according to answers given in student focus groups, the Discovery Advantage Report found that many students were "dissatisfied with advising" (Rutgers University, 2023a, p. 139). These findings are not surprising for the following reasons. According to a recent study, large and "academically demanding research universities" should have a 250:1 ratio of students to professional advisors (Boyer 2030 Commission, 2022, p. 33). Nevertheless, SAS has a 741:1 ratio, 2.58 times higher than the recommended standard (Rutgers University, 2023a, chapter 6). This leads to complaints about "being shuffled from advisor to advisor" and "having to wait for appointments" (Rutgers University, 2023a, p. 139).

Another resource is Degree Navigator (DN); it describes itself as a "flexible, easy-to-use degree audit and academic advising system for undergraduate programs" with the goal of helping students manage their "general education" (Rutgers University. n.d.). Yet, many students have voiced unfavorable opinions. One student online mentioned that "having to navigate degree navigator was a pain," and another student created a post titled "degree navigator is the worst website I have ever used," garnering more than 100 likes (Monisit, 2022b; davidmcfc\_, 2023).

#### The Need to be Resourceful

While the Discover Advantage Report does not provide quantifiable data to underline this sentiment, it uses quantifiers (Rutgers University, 2023a, p. 138). The topics in these focus-group surveys highlight issues of incomplete or confusing web of information. Their summary of the responses to the question "What are some things you like least about [Rutgers]?" was that "*most*" responses centered around "difficulty finding resources [...], scheduling courses, getting courses, or figuring out what they needed to do, as well as advising. [...] numerous complaints about [missing information on Rutgers websites like broken links]". The scattering of incomplete information can be cognitively challenging for students since research has shown that constant task switching leads to error-prone decisions as well (Monsell, 2003).

If academic advisors fail, students may want to turn to faculty advising. According to Dr. Allen (2008), a professor of education at Portland State University, 75% to 90% of "academic advising in American colleges and universities" is conducted by faculty. Because the faculty members often carry a lot of external responsibilities (research, papers, teaching, etc.), they cannot provide

the best advice. Dr. Allen (2003) concludes that most faculty at Johns Hopkins university do not believe it is their responsibility to help students with "big" questions, such as integrating their "academic, career, and life goals" with aspects such as "type of degree to pursue." Students must answer their big questions about career and life goals by being champions of their success first and foremost.

According to (personal communications, February 9, 2024) David Goldman—Director of Teaching, Learning, and Assessment of RU-SAS—students often have "difficulty" knowing when their major's courses will be offered and that the call for departments to post information of when to offer courses is not being followed fully. One example is the Department of Physics and Astronomy. In their course catalog, not every course has information on when they will be offered. For example, the course "Principles of Astrophysics" (01:750:341) has no information offering availability and does not appear as an available course for Fall 2024 (Rutgers University Department of Physics and Astronomy, n.d.; Rutgers University, 2024b).

Based on personal communications (February 7, 2024) with Sharon Stoerger—Assistance Dean for Programs and Assessment—the Curriculum Subcommittee even considered using artificial intelligence tools to help students manage the complexities of graduation. In fact, A.I. chatbots was recommended by the curriculum mapping subcommittee in the Discovery Advantage Initiative Report (Rutgers University, 2023a, p. 82). The use of ChatGPT in an academic advising context has been explored by Dr. Daisuke Akiba (2023), a faculty member of the City University of New York. In the paper, the authors played the role of a student asking about the educational and career roadmap for becoming an elementary school teacher in New York State. From the advice they received from ChatGPT, they asserted that while the answers could be helpful, they cannot "necessarily replace human advisors." Furthermore, according to Dr. Li (2023), a fellow at Stanford Law School, the "unverified" information generation caused by ChatGPT leads to "confidently but unjustified and unverified deceptive responses" devoid of "actual understanding or reasoning." Even with the assistance of large language models such as ChatGPT, students must be willing to put in the work to understand the nature of their major. According to White (2015), when students do not understand "the nature of the curriculum they have chosen to study," retention rates in a higher education institution will not improve. Therefore, ChatGPT can only play a minimal role in assisting with academic plans; students must bear the burden of studying the overall context of their intended studies.

In summary, the road to graduation is riddled with unforeseen events, traps, and challenges, requiring students to be nimble and proactive. Even if the university addresses the shortcomings, it cannot control all student events, such as class failure and/or extreme life circumstances. There were 1,050 students that withdrew from the university in Spring 2023 (Rutgers University, 2023a). Additionally, many students cited "anticipation of poor academic performance" and other "personal issues" (Rutgers University, 2023a).

Therefore, a tool that helps students adjust to sudden changes would be invaluable.

# **Research Rationale**

### **Discovery Advantage Initiative**

In July of 2021, Rutgers University's Academic Master Plan revealed four pillars that will guide Rutgers' resource allocations for the years to come (Rutgers University, 2021). The recommendations were based on multiple internal Rutgers reports from the past decade. Furthermore, new research that corroborates these recommendations includes 1,575 faculty and staff survey respondents of all academic and administrative areas, 2,440 students of "great diversity" of both "undergraduate and graduate bodies," and collaboration with other institutions to analyze these results. Most relevant to this project are the recommendations of the Curriculum Mapping Subcommittee. In chapter 6 of the Discover Advantage Report, a subcommittee was tasked with developing "major maps" that clearly define a particular curriculum's career and academic pathways to "help students easily navigate the university" (Rutgers University, 2023a, p. 62). Furthermore, they had to define common areas that can be integrated across all curriculum maps, such as when to meet with an academic advisor (0 – 30 credits) or consider studying abroad (31 – 90 credits).

#### **Recommendation 6.1**

To prioritize the diversity of student experiences, the subcommittee suggests in recommendation 6.1 not to be prescriptive; that is to say, maps should not presuppose year but, instead, opt for three stages: "First Year," "Middle Years," and "Final Year." Appendix Q and Appendix V of the Discovery Advantage Report showcase the tabular templates each "major map" should follow (Rutgers University, 2023a, p. 80). Furthermore, they recommend that this map can be tailored to specific majors to "demystify aspects of the college journey." Beyond recommended classes, the subcommittee added important resources and recommendations at critical milestones as well, such as when to consider studying abroad, to be involved with their local community, to reach out to faculty for research, etc. (Rutgers University, 2023a, p. 80)

#### **Recommendation 6.4:**

The subcommittee recommends that the curriculum map is "interactive" so that students are "empowered to build an advising map based on their own desired pathways" (Rutgers University, 2023a, p. 82). One way the subcommittee recommends making the map interactive is to equip the advising website with "an AI-generated chatbot for the first layer of referral needs, which can answer simple questions about available resources and direct students to appropriate advising and academic support offices" (Rutgers University, 2023a, p. 82). Furthermore, the subcommittee suggests adding links to relevant resources and directories. For those with assigned advisors, students with informational needs will have the ability to "identify the advisor(s) and their contact information." For advisors, the same website should provide "links to accurate information on academic requirements at the school and department levels as well as up-to-date contact information for making referrals" (Rutgers University, 2023a, p. 82).

Although no efficacy data exists for these recommendations, we can consider other large universities that use "major maps." In fact, the following incomplete list of examples served as paradigms for the subcommittee: UC Berkeley and the University of Utah, to name a few (Rutgers University, 2023a; UC Berkley, n.d.; The University of Utah, n.d.). These tabular

templates have successfully helped thousands of students visualize their pathway to a particular degree.

#### Appendix V

Curriculum Mapping Template

	1 <sup>st</sup> Year	Middle Years	Final Year	What will I learn in my
Get the courses you need	<academic courses=""></academic>			major? <learning goals="" of<="" td=""></learning>
Get Involved & Discover your interests	Institutional campus opportunities and programs <experiential aresty,<br="" education,="">research opportunities wifaculty, fellowship, campus organizations, FIGS instructor, peer leader&gt;</experiential>			major>
Connect with Community and Engage with the World	Community-based campus events <rutgers Day, speaker series, on-campus conferences- And Non-compus related community activity cvolunteering &amp; community service, attending a festival, visit an exhibition, study abroad, join a professional association&gt;</rutgers 			What can I do after graduation?
Prepare for life beyond The Banks.	<internships, &="" career="" events="" exploration="" networking="" success,=""></internships,>			<example careers,<br="">graduate programs&gt;</example>
Wellness				
	Flex Section below the chart. Some ideas quote, academic checklist, develope	.Key facts/stats, "Did you know?", student d skills, employers, student groups.		The number of new hires in <industry> has come from <major> has increased 11% in the last three years. Data shows it is only growing!</major></industry>

Figure 3: Curriculum Mapping Template Appendix V

# uAchieve Planner/Degree Audit

There exists an enterprise solution that enables student success: uAchieve Degree Audit and Planner. uAchieve Degree Audit, software used by academic advisors, states that it helps students and advisors "easily gauge satisfactory academic progress and quickly identify the next steps needed to graduate on time" (CollegeSource, n.d.). uAchieve Planner, mainly used by students, states that it helps students and staff "build personalized plans validated against degree audit data" (CollegeSource, n.d.). There are many overlaps in features between the two solutions. To begin, I will begin with key features of uAchieve Planner:

- **Real-time academic progress**: students have access to a progress bar that indicates the completion percentage of their intended degree which immediately updates when needed.
- *Invalid course plan*: "warning messages on the plan alert students when they have course conflicts with availability and/or pre-requisite requirements"
- *Multiple paths toward graduation*: students are given the "ability to create what-if plans to model different paths to graduation."
- **Course Recommendations**: "Automatically creates term-by-term pathways with intuitive course recommendations for students from declared program requirements"
- **GPA Calculator**: calculate GPA for each semester

<u> M</u> uAchi	eve®	Home	Students 🔻	Encoding -	Tools 🔻	Reports	Security 🔻		A- 0-
Student: Melissa Br	rooks / MELISSA 🖭	•		Audits	Plans	Courses -	Exceptions	Transfer Evaluations	Comments
Psychology	Progra	am: BS Psychology -	B5-PSYC Catalog: Fall	2022 Update Plan Set	tlings (rorornum)	Degree Pr	ogress		
Graduation Projected Cu	Goal GPA: 0.000 umulative GPA: 2.667			Vis	Approval History	Total Prog	ress anned and in-progress courses		
Add Term				Restore	Save Progress	Courses P	46% lanned	Sections To Do:	
Fall 2022 0/11 IP Hou	ırs				~	3 Planned	27 Not Selec	tted 4	
REQUIRED	ENG 2110 - CRITICAL REA	DING, THINKING, AF	ND WRITING : 3 Hours	•		🗇 Open All S	Sections To Do	All Se	ections
REQUIRED	KINS1010 - WELLNESS : 2	2 Hours		•		> 🖾 то	otal Hours/GPA		
REQUIRED	PSY 2400 - DEVELOPMEN	TAL PSYCHOLOGY :	3 Hours	•		> 🖾 U > 🖾 Er	pper Level Hours nglish Minor		
SELECT COURSE	Kinesiology				SELECT	> 🛛 Li	beral Arts Requiremen	ts D OF ANALYSIS ***********	*****
SELECT COURSE	Textual Bible				SELECT				
ADD COURSE OR NOT	re				ADD -				

Figure 4: uAchieve Student Planner Dashboard

Key features of uAchieve Degree Audit:

- *Major/Minor/Certificate Sorter*: based on the requirements that your schedule fulfills, you can sort majors/minors/certificates by total progress regardless of whether or not you've declared in any of them
- *GPA vs Credit hour graph*: see your total performance on different credit loads by looking at a GPA vs. credits graph

Many institutions, from large state schools to community colleges, have used uAchieve to enable student success, such as The University of Utah, University of Southern California, San Diego State University, University of Maryland, Harding University, etc. (CollegeSource, n.d.). By the nature of this fact, uAchieve has helped tens of thousands of students in graduating. Both Harding University and Columbia College of Chicago were able to increase their four-year completion rate; Harding University explicitly stated their four-year completion rate increased by 5% (CollegeSource, n.d.b). A representative of Ivy Tech Community College stated that since they've implemented uAchieve, the ability to sort majors/minors/certificates regardless of major declaration has helped them increase "credential production by 23%" (CollegeSource, n.d.b). A representative of The University of Utah stated that "[uAchieve helps us] focus on the whole student and not just the classes they need to take" (CollegeSource, n.d.b). It stands to reason that a modern solution to course planning and degree auditing like uAchieve has much potential for positive impact on educational institutions of all sizes.

# **TigerPath and Scarlet Navigator**

There exists a drag-and-drop four-year course planner created by students at Princeton University that helps students decide which "courses to take and when to take them," simplifying the process of determining whether or not pursuing or switching majors/minors is a "viable option" (Chu, 2018). Requirement progress for majors/certificates is clearly and dynamically displayed based on what "courses they have taken as well as those they are planning on taking during future semesters." In other words, requirements that have or have not been satisfied are listed based on the student's created course schedule. For students, there is much discussion to be had beyond creating an academic plan (Bryant, 2015). This software enhances interactions between students and advisors by making meetings more productive; students would have deliberately analyzed potential plans before their meeting, leading to more fulfilling conversations. In summary, the main features of TigerPath are the following:

- Drag and drop capabilities
  - Search a course and drop into your schedule
- Track major requirements based on planned schedule
- Customize requirements fulfilled through AP credits, summer classes, etc.

Although efficacy data cannot be found for TigerPath, we can turn to an implementation of the methodology: Scarlet Navigator, a course scheduler for the Rutgers community. As the Curriculum Mapping subcommittee expressed, an exact four-year curriculum cannot fully define everyone's academic experience (Rutgers University, 2023a). Therefore, changes and additions were made to TigerPath's features to complement the vastness of student experiences here at Rutgers. Briefly, here are the features of Scarlet Navigator:

- [features from TigerPath]
- Credit tracking per semester and by semester basis
  - In each semester header, there are two numbers to the right. The top right number is the sum of credits for that semester alone. The bottom right number is the total number accumulated at that semester. Refer to figure 5 for a visual representation of semester headings.
- Accommodations for non-traditional students
  - TigerPath is prescriptive in that it forces the student to plan for four years only. Scarlet Navigator allows students to have many semesters. Furthermore, they can start their academic journey at a nontraditional time, such as Winter or Summer.
- Display course information on the same page
  - When a user clicks on a course, they can have information on the course such as number of credits, which campuses the course is being offered on, what school it belongs to, and so on. This is not possible in TigerPath. This is especially helpful since it consolidates information to one page, reducing the negative cognitive effects of context switching between multiple resources (Monsell, 2003).
- Save multiple plans
  - Students can model multiple paths towards graduation, like the previous paradigm uAchieve. At maximum, students have three plans to build where each one is a blank slate at the start. Consequently, each plan has their own

requirement progress information making each plan independent from one another

Scarlet Navigato	r (Beta)						ABOUT	СНА	ANGELOG FEEDBACK KEVIN MONISIT 👻	
Search coµrses 🛛 🛩	←Back								Course Core Settings	
LDRSHP&MGMT PRACTCM	Spring 2022 Freshman	12 29	Fall 2022 Sophomore	14 43	Spring 2023 Sophomore	13 56	Fall 2023 Junior	10 66	Core Curriculum	
77:705:499	EXPLORING	×	INTR DISCRET	×	INTRO ENV	×	DATABASE	×	School of Arts and Sciences	
LRSHP & MGMT-	LANGUAGE		STRCTI		SCIENCE		MGMT SYS		The Osheel of Arts and Oslanda	
RNS	FIGS SEMINAR	×	NETWRK&INT	×	INTERNSHIP	×	BLACK WRKRS	×	(SAS) requires that all students	
77:705:497	THE WORLD OF	×	TECH		SAS		AMER SOC		complete a goal-based Core Curriculum.	
SR HONORS	INSECTS		SOC MED ARTS	×	COMPUTER	×	INTR DISCRT	×	Please confer with a counselor about	
PROJECT I	CALC IL FOR X	ONLINE		ARCHITECTUR		STRCT II		core fulfillment. This feature has not been fully implemented/tested and		
77:705:495	MATH		SYSTEMS	×	DSGN&ANAL	×			the info may be incorrect.	
SCHOOL NURSE PRACT	THE BYRNE	×	PROGRAMMI		DS&ALGOR I				If you'd like to see a list of courses for each core, check out this link.	
77:705:481	SEMINARS								Contemporary Challenges 2/2     Natural Sciences 1/1	
TEACHG IN	Spring 2024 Junior	0	Fall 2024 Junior	0	Spring 2025 Junior	0	Fall 2025 Junior	0	NS (6/6 credits)     Social and Historical Applying 1/2	

Figure 5: Scarlet Navigator Example Dashboard

Completed in August of 2022, it became the top post of the month on the Rutgers subreddit (/r/rutgers), an unofficial online forum with 62,000 subscribed users at the time of writing (Monisit, 2022b). With 429 upvotes and 46 comments, students commented on its userfriendliness and how easy it was to see "core requirements" that still needed to be fulfilled. In a survey of 21 volunteer responses (see Figure 7), users were asked to answer the following questions on a scale from 1 to 5: "Would you recommend [Scarlet Navigator] to a friend?" "Do you think [Scarlet Navigator] is easy to use?" "How would you rate the design [...]?" The percentages of responses that were above a 4 were 95.3%, 85.7%, and 85.7%, respectively (see Figure 6). With over 800 users at the time of writing, both new and returning students continue to log in or sign up for Scarlet Navigator despite being advertised only on two occasions: being advertised on Reddit (/r/rutgers) over a year ago and being awarded "Best Fullstack Project" by the Rutgers Computer Science department in a university-wide software project showcase (Monisit, 2022b; Monisit, 2022a). See Figure 6 to see a collage of positive Scarlet Navigator feedback from Rutgers students (Monisit, 2022a).



Figure 6: Scarlet Navigator Feedback Collage



Figure 7: SN (Scarlet Navigator) Survey Feedback

For the small percentage of the Rutgers population that used it, implementing TigerPath for the Rutgers community saw positive feedback.

### Virtual Academic Advisor

The last paradigm to be explored is an academic planning software called the Virtual Academic Advisor System (VAA), created by Erika Parsons at the University of Washington (Vijjapu, 2019). This system aimed to "overcome problems such as the disproportionate ratio of studentsto-faculty." This system combines traditional deterministic algorithms and machine learning methods to give students a ranked set of study plans based on their preferences. Specifically, the author uses supervised classification models to rank study plans of a "synthetic" dataset; the data is generated from extracted feature vectors (i.e., quantifiable properties), which can be found in Table 4.1 of the referenced paper (Vijjapu, 2019). For each plan, a team of advisors used a rubric to designate a score, which can be found in Table 4.2 of the paper. To generate a valid plan, prerequisites must be considered. The author represents course prerequisites mathematically by considering them as a directed acyclic graph. This is an important concept since it enables new ways to interact and validate courses on a student's schedule. Using distance-based collaborative filtering, study plan ranks can account for the similarities between other users. A similarity score is determined by taking two users and finding the overall Euclidean distance between their feature vectors. Repeat this process for all users, and you can account for previously successful study plans with other metrics. The efficacy of these recommendation systems can be measured by how they match with the human benchmarks (the advisors' ratings). The optimal multi-class classifier used in the study had an accuracy rate of 83% and a precision rate of 84%, demonstrating its effectiveness in generating the most suitable schedule based on a student's parameters. These rates were validated using k-fold cross-validation, which prevent biases (Vijjapu, 2019; Amazon Web Services, n.d.).

Paradigm	Takeaways
uAchieve	<ul><li> Prerequisite validation</li><li> Sorting majors/minors by progress</li></ul>
TigerPath/Scarlet Navigator	<ul><li>Drag and drop capabilities</li><li>Fulfilled requirements</li></ul>
Curriculum Subcommittee	• Inserting helpful information at critical milestones
Virtual Academic Advisor System	Directed acyclic graph representation for prerequisites

# **Paradigm Synthesis**

# **Plan of Action**

### **Step Zero: The Base**

I will begin by establishing the base of the project: Scarlet Navigator (SN). I will build on this base using features we've explored. Refer to Figure X for more information.

#### Step One: Integrate Curriculum Milestone Suggestions (Subcommittee)

I will integrate the Curriculum Mapping subcommittee's recommendations for creating "major maps" into SN. Both SN and major maps have an important similarity: their goal. Both paradigms attempt to give students an at-a-glance overview of their academic journey, giving them a clearer understanding of what to expect. The difference between SN and curriculum maps is that SN is a dynamic software application, whereas degree maps are static informational diagrams. To eliminate the need to cross-check between multiple resources constantly, SN will integrate these maps into the schedule in a responsive manner. In SN, semesters are divided into blocks; these blocks contain courses added by the student for that semester, and each block has a certain number of credits. I will calculate a running credit count starting at the first block/semester. The first block that reaches a certain milestone—like 33 credits—an informational module will appear directly after. This module will have recommended actionable tasks a student should take at that stage, such as attending a career fair (Rutgers University, 2023a). This will be repeated for each milestone defined by the advising or academic department associated with the student's parameters. In this manner, the spirit of curriculum maps remains the same while digitizing it in a way that responds to a student's possibly volatile schedule. This aligns with recommendation 6.1 since recommendations appear dynamically and aren't presupposed. Furthermore, recommendation 6.4 suggests that the templates should be interactive (Rutgers University, 2023a). I will make the list of suggestions "checkable" and include hyperlinks to the correct resources. By "checkable," I will allow the user to click items on the suggestion checklist to cross them out, allowing them to focus more on what they have not done; this will increase personal satisfaction of completion (Sawhney, 2022).

Fall 2022	0	Spring 2023	0	Continuing my Journey!
Freshman	15	Freshman	30	31 to 90 credits
				<ul> <li>Meet with an <u>academic advisor</u></li> <li>Participate in the Involvement Fair</li> <li>Apply to teach with <u>FIGS</u></li> <li>Consider taking a <u>community-engaged</u> <u>learning course</u></li> <li>lorem ispum</li> </ul>
Fall 2023	4	Spring 2024	0	
Sophomore	34	Sophomore	34	

Figure 8: SN with Curriculum Milestone Suggestions

### Step Two: Prerequisite Validation (uAchieve and Virtual Academic Advisor)

Both uAchieve and the Virtual Academic Advisor give students and advisors the ability to generate valid course sequence suggestions (CollegeSource, n.d.a; Vijjapu, 2019). For these sequences to valid, they must be ordered in a manner that does not violate existing prerequisite specifications. The Virtual Academic Advisor explicitly uses a directed acyclic graph to represent prerequisite dependencies. Let us assume the following prerequisite graph in Figure 9. In this graph, each "node" or circle represents a course. An arrow pointing to one course to another course indicates a prerequisite. To take course E, you must take course A (likewise for course B).



Figure 9: Example Prerequisite Directed Graph



Figure 10: SN Example Dashboard with Labeled Courses

Let's assume we have the following course plan in Figure 10. Course A is the root prerequisite of course B, E, and C. I will describe how we check the prerequisites in a way that mirrors the steps of a traditional breadth-first search (Cormen et al., 2022, p. 554). In Fall 2022, we do not have any conflicting prerequisites. In Spring 2023, B and E are valid courses since course A has been satisfied in Fall 2022. In Fall 2023, the plan includes course C. This is valid because course C is satisfied by B which is satisfied by A. This means that we have a valid course ordering. Now, let's assume we switch the places of courses C and B. When we perform the same breadth-first search algorithm, we will find that Spring 2023 expects to see course B, but instead finds course C in Spring 2023. By looking at Figure 11, we can see that this does not adhere to the prerequisite graph. Like uAchieve, I will let the user know that their planned course sequence is invalid by highlighting the problematic semester and indicating the courses that are causing the issue (CollegeSource, n.d.b). In this case, the problematic courses are C and B—appropriately highlighted in dark red. Integrating this is vital in freeing up the mental burden of tracking prerequisites, as software automation like this generally reduces human errors and increases productivity (McKinsey Global Institute, 2017).



Figure 11: SN with Prerequisite Validation

# Step Three: Sort Majors (uAchieve)

According to a representative of Ivy Tech Community College, sorting majors, minors, and certificates by completion progress regardless of what their declared degree is led to a 23% increase in credential production (CollegeSource, n.d.b). To the left of the main dashboard, I will have a segment dedicated to listing majors. I will then store requirement fulfillment information from the courses on the dashboard and the courses that the student has fulfilled prior to enrolling into Rutgers. Because the user can plan ahead of the current semester, I will ask the user to indicate whether requirement fulfillment should include courses after the current semester (using the current date and time). This way, the student can gain a greater intuition of possible degree fulfillment of their future while not confusing the student on their progress towards certain degrees. Then, I will sort all possible majors/minors/certificates by the number of requirements that have already been fulfilled as seen in Figure 12.

Majors	Fall 2022 <sup>0</sup> Freshman <sub>15</sub>	Spring 2023 <sup>0</sup> Freshman <sub>30</sub>	Continuing my Journey! 31 to 90 credits
Major 3	А	С	Meet with an <u>academic advisor</u> O Participate in the Involvement Fair     Articipate in the Involvement Fair
87%		E	O Consider taking a <u>community-engaged</u> <u>learning course</u>
Major 1			o lorem ispum
67%			
Major 4	Fall 2023 <sup>4</sup>	Spring 2024 <sup>0</sup>	
48%	Sophomore <sub>34</sub>	Sophomore <sub>34</sub>	
Maior 2	B	radantial Sorting	by Drogross

### Step Four: GPA Calculation Semester by Semester (uAchieve)

uAchieve has a GPA calculator in their student planner solution. Like the credit counter, I will have two numbers to the left side of each semester header. The bottom left number indicates the GPA of the semester. The top left number indicates the overall GPA up to that semester. For example, consider Figure 13. Both overall and semester GPA are 2.5 in the first semester. In the following semester, they differ in value.



Figure 13: SN with GPA Calculation

### Step Five: Course Recommendations (Subcommittee, VAA, and uAchieve)

In three of the paradigms, there were course recommendations for students. Looking into Figure 3, we can see that the "Curriculum Mapping Template" developed by the subcommittee has a row for "Get the courses you need" which include "academic courses" of some major (Rutgers University, 2023a). The mapping template has three columns: "1st Year," "Middle Years," and "Final Year." Although this mapping isn't as prescriptive as detailing exact major courses a student must complete at a particular year, we can still create recommendations that are

generalizable for all Rutgers student experiences. For the Computer Science B.S., there exists a sample B.S. schedule as seen in Figure 14. This schedule assumes that the student is beginning at Rutgers in their freshman year and will take four years to complete their degree. However, this is contrary to recommendation 6.1 which states that recommendations should not be presupposed (Rutgers University, 2023a). If recommendations are not presupposed, then the academic course suggestions of the middle column, "Middle Years," may be convoluted.

What I will do instead is let the student choose how many semesters they wish to take to graduate; this is a feature found in both uAchieve Degree Audit and Scarlet Navigator. Then, based on the number of semesters they intend to take, I will first tell them if this is possible. The Virtual Academic Advisor gives us a representation of prerequisites via a directed acyclic graph, which we call digraphs. There exists an algorithm taught in the Data Structures course at Rutgers University New Brunswick called topological sorting that can create a valid course sequence from digraphs (Centeno, n.d.). This course sequence can then be split into several semesters. Using information from the student's schedule and the number of semesters the student intends to graduate by, I will let them know if that is even possible by comparing the number of semesters needed and the number of semesters wanted. If it possible, I will insert course recommendations into the correct informational blurbs as seen in Figure 15. In other words, at certain milestones I will let the user know which courses they need to take or should have taken based on three dimensions: the number of semesters they have left, the courses they have finished at that milestone, and the sample schedule of their intended major. To reiterate, the sample schedule of the student's major can be made into a four-year plan; using the number of semesters a student wants to graduate in, I can spread out or compress the recommendations of these courses throughout the plan in a way that conforms with valid prerequisites.

1st year	FALL	Credits	SPRING	Credits
	640:151 Calculus I	4	640:152 Calculus II	4
	198:111 Introduction to Computer Science	4	198:112 Data Structures	4
	SAS signature course or other general elective	3	general elective	3
	general elective	3	general elective	3
	Byrne seminar or First-year Interest Group seminar	1	Byrne seminar	1
		15		15
Credits: 30				

2nd year	FALL	Credits	SPRING	Credits
	198:205 Discrete Structures I	4	198:206 Discrete Structures II	4
	198:211 Computer Architecture	4	CS elective I	4
	640:250 Linear Algebra	3	general elective	4*
	general elective	4*	general elective	3
		15		15
Credits: 60				

3rd year	FALL		Credits	SPRING		Credits	
	198:344 Design and Analysis of Algorithms			4	CS elective III		4
	CS elective II			4*	CS elective IV		4
	general elective			4*	general elective		4*
	general elective			3	general elective		3
				15			15
Credits: 90							
4th year		FALL	Credits	SPRING		Credits	

CS elective V 4 CS elective VII 4 Figure 14: Computer Science BS Sample Schedule

Majors	<sup>2.5</sup> Fall 2022 <sup>0</sup> <sub>2.5</sub> Freshman 15	<sup>2.81</sup> Spring 2023 <sup>0</sup> <sub>3.20</sub> Freshman <sub>30</sub>	Continuing my Journey! 31 to 90 credits
Major 3	Α	С	Meet with an <u>academic advisor</u> — Participate in the Involvement Fair     — Apply to teach with <u>FIGS</u>
		E	Consider taking a <u>community-engaged learning</u> <u>course</u> lorem ispum
Major 1			At this point, you should take the following courses to stay on track for major X: 01:108:101, 01:66:0:152
67%			
Major 4	<sup>2.98</sup> Fall 2023 <sup>4</sup>	Spring 2024 <sup>0</sup>	

Figure 15: SN with Course Recommendations

### The Cost of Student Success

The units that Scarlet Navigator is composed of are the following: Scarlet Navigator, the development of the features explored in the tentative plan, and the hosting of this service. In this section, I explore the cost of integrating this as a service for the Rutgers community.

#### **Scarlet Navigator**

The cost will be nothing. The base of the tentative plan is Scarlet Navigator; it is a product of, at minimum, 150 hours of my time in the summer of 2022. However, I do not wish to charge any money for this software. uAchieve is an enterprise solution developed by a for-profit company called CollegeSource (CollegeSource, n.d.). Using uAchieve, or any other enterprise solution for that matter, over Scarlet Navigator will cost more than the baseline price of zero dollars.

#### Development

The cost will be nothing. Scarlet Navigator should be developed by a team of volunteer student developers. There are many examples of non-trivial projects developed by self-organized volunteer student developers. HackRU, Rutgers University's largest hackathon, has supported a 24-hour event for, at times, 800 students from all over the east coast over the last decade (HackRU, n.d.). As the director of HackRU's Research and Development team—leading over a dozen students since my time—I've seen how capable students are in the Rutgers community. In HackRU alone, they've built mobile apps, chat bots, judging systems, backend systems, and frontend pages across multiple technologies (HackRU, n.d.). Other student clubs include RUMAD, a "student-led tech club dedicated to educating the Rutgers community [...] with mobile app development," and HackHERs, "New Jersey's Largest Women and Non-Binary Centric Hackathon" (HackHERS, n.d.; RUMAD, n.d.).

Another option for sourcing student development is through in-house Rutgers organizations that pay students developers. Although this is not technically free, the cost of development would offset the price significantly since it will leverage existing organizations. Rutgers Open System Solutions is a student-driven organization under the Rutgers Office of Information Technology that maintains and develops features most famously for go.rutgers.edu, the official link shortener for Rutgers University (Rutgers Open System Solutions, n.d.). With over 80,000 links and 3,000 users (mainly faculty and staff), it is used greatly throughout the university. It is an example of the capabilities that the student Rutgers community possesses regarding developing non-trivial software.

#### Hosting

The cost will be, generally, nothing. I will explore two hosting possibilities for Scarlet Navigator. The first hosting possibility is the use of a third-party cloud hosting solution. I will demonstrate that the cost of a cloud hosting solution is minimal and that the computational resources to host Scarlet Navigator is also minimal.

#### Third-Party Cloud Solution (Background)

A full-stack project must be hosted on a server to be accessible to users (IBM, 2024). Maintaining the physical server infrastructure can be costly, and there are many companies that maintain this infrastructure to partition servers for customers at a profit (DigitalOcean, n.d.; Microsoft, n.d.). Scarlet Navigator uses Firebase, a subsidiary of Google Cloud, for its database and operational services (Monisit, 2022a; Firebase, n.d.). In Firebase, there is a free tier (Firebase, n.d.). In other words, until a project reaches a certain threshold in computational resources, the project is free. Currently, Scarlet Navigator costs zero dollars to maintain. From April to May 2024 (nearly two years since its release), there were 61 monthly active users. At its peak between April and May 2024, there were 24 users in one day (see Figure 16). Altogether, over 820 students have signed into Scarlet Navigator at the time of writing. With such low usage, there are no service fees since the usage is covered by the provided free tier. However, making Scarlet Navigator an official Rutgers service may take the service out of the free tier, assuming Firebase will be used as the server host and thousands of more students use it. I will explore the potential cost of this option.



Figure 16: Scarlet Navigator Recent Usage from April to May 2024

Let us assume 50,000 users. At Rutgers University-New Brunswick alone, there are 43,859 students enrolled (Rutgers University). The Firebase database is called a NoSQL database (Google Cloud, n.d.). In a NoSQL database, we can partition the database into two collections: users and courses. Each user will have an entry into the user collection—this is called a document. A document contains data of the user. First, let's focus on user documents. A user document cannot have an infinite number of courses since it will be explicitly capped. Therefore, the size of a user document is uniform. Along with textual user metadata and course plans, a user document would be at most 50KB, or 0.05MB. Again, users are not asked to store sizable images or files—their entire database presence consists of text. At 50,000 users, the user collection. In Scarlet Navigator's database, there are over 4,500 courses stored in a file of 19.1 MB (Monisit, 2022a). Using the Firebase free tier, 2.5 GB of storage is given for free (Firebase, n.d.). Therefore, we can calculate how costly it will be to store 50,000 users.

Collection	Amount of Data
User Collection	2.5 GB
Course Collection	19.1 MB
Total	2.5191 GB

#### **Database Storage Calculation**

Using the free tier, we can calculate the total cost using rates provided by Firebase (n.d.).

#### **Total Monthly Storage Cost**

1 GB (no cost storage) + (1.5191 \* 0.18/GB) =\$0.27 per month

#### Third-Party Cloud Solution (Operations)

There are two main operations: read and write. Users must read from the database to see their schedule and search for courses. They must also write to the database to update their schedule. Generally, writing operations are more costly than reading operations (Firebase, n.d.). Given our population of 50,000, let's assume an extreme overestimate of 20,000 daily active users.

#### **Monthly Operational Cost**

Operation	Monthly Cost
Read (logging in and searching for courses)	20,000 * 1 (login) * 20 (course search) = 400,000 read operations per day

	<b>50K No-cost reads</b> (free tier) + (350,000 reads at \$0.06/100k) = \$0.21 per day \$0.21 / day * (30 days) = \$6.30 per month
Write (updates to schedule)	20,000 * (50 updates to schedule) = 1,000,000 write operations
	<b>20K No-cost writes</b> + (0.98M writes at \$0.18/100k) = \$1.764 per day
	\$1.764 / day * (30 days) = \$52.92 per month
Total Cost per Month	\$59.22

## Rutgers Infrastructure Solution

Hosting Scarlet Navigator is virtually free. Rutgers University is home to large amounts of computational power (Rutgers Office of Advanced Research Computing, n.d.; Rutgers Laboratory for Computer Science Research, n.d.). Every student who takes a computer science course is given access to more than 50 machines with terabytes of storage and memory (Rutgers Laboratory for Computer Science Research, n.d.). A terabyte is one thousand gigabytes. Furthermore, there exists Amarel, a "computing environment developed to serve the university's wide-ranging research needs" (Rutgers Office of Advanced Research Computing, n.d.). Use cases of Amarel involve "traditional high-performance computing" and "Large memory systems." Amarel clusters are open to all Rutgers students, researchers, and faculty conducting research as over 4,800 have already used it—totaling to over "2 billion core compute hours since 2016." I list these high-performing computational resources to illustrate the following point: the computational need of Scarlet Navigator is a drop in the bucket of what is freely available for the Rutgers community. As I stated in the section entitled "Hosting," cloud computing companies offset the maintenance cost of server infrastructure by selling computational partitions at a profit.

However, Rutgers University already has in-house infrastructure to support many server needs. Leveraging Rutgers' computational infrastructure and hosting Scarlet Navigator is the most reasonable and cost-effective option. As we've seen in the section, "Third Party Cloud Solution (Operations)," the possible user actions are not equivalent to a resource-hungry service like YouTube which costs Google hundreds of millions to service user-generated content (Manjoo, 2009). There is no user-generated content except for a student's schedule, and the number of courses that can be added is capped. In conclusion, Scarlet Navigator's computational and storage footprint is extremely minimal and can easily be serviced by Rutgers servers.

#### **Cost Analysis**

Component	Cost
Scarlet Navigator	Free
Development	Free (using volunteer student developers)
Hosting	Free (leveraging Rutgers computational infrastructure)
Overall	Free

# Discussion

As Chancellor Conway put it, "[Rutgers] can't be braced for change, [it] must create it in order to thrive in the 21st century" (Rutgers University, 2021). In 2022, Rutgers University established the Academic Master Plan to deal with "shifting demographics and evolving student needs" (Rutgers University, 2021). Through town halls and thousands of survey responses, Rutgers University is re-aligning itself for the future. In other words, "higher education is at a crossroads" (Rutgers University, 2021). With record-high enrollment year after year and uncertainties with course registration, students are challenged with designing a degree roadmap that aligns with their interests while dealing with the volatility of course offerings (Rutgers University, 2022; Rutgers University, 2023b). At this pivotal moment of change, the plan that I have laid out is reasonable, actionable, and free. By leveraging and directing the existing and willing talent of the Rutgers community, Rutgers will offset the cost of development in comparison to a much more expensive enterprise solution like uAchieve.

To reiterate, the entirety of this project is devoid of unrealistic idealism. The preliminary version of Scarlet Navigator exists right now and is not an abstraction but an existing and currently running website (scarletnav.io) helping students plan their academic roadmaps. The steps in the "Plan of Action" are far from impractical to implement given the right amount of data and correct leadership.

Officially supporting this project will strengthen the Rutgers community through collaborative development —upholding the first pillar of the Academic Master Plan which encourages "scholarly leadership of intellectual communities" (Rutgers University, 2021). Furthermore, it will help students plan their path towards graduation. When communities have effective collaboration in an educational context, research has shown that students feel they can achieve goals that "otherwise [would] not be possible" (Griffiths et al., 2021). In this manner, students will learn that, collectively, they can positively affect their community and help their peers strive for success.

While I did not go over this in the "Plan of Action" section, I would like to discuss the possibility of opening this software to everyone in the world, no matter the university they attend or how

much money they possess. Allowing all students to use Scarlet Navigator will increase brand awareness for Rutgers. According to Yaping et al. (2023), brand awareness is a critical factor in a student's decision to enroll in a university and an area of heavy interest for Rutgers University (Rutgers University, 2023, chapter 3). Rutgers University ought to be a beacon of how an institution enables their students to create change far beyond themselves. Due to the simplicity of the computational operations of Scarlet Navigator, as laid out in the "Cost of Student Success" section, I do not foresee the cost of hosting outweighing the gains in reputation. The software engineering needed to give Scarlet Navigator the scaffolding to support all universities is beyond the scope of the project; however, it is something I wanted to mention and wished I had more time to explore.

Many people have suggested that this software should replace Degree Navigator, an existing degree auditing software at Rutgers University (see Figure 6). However, uAchieve has two solutions: Degree Audit and Planner. Due to the fluidity of Scarlet Navigator, I suggest that Scarlet Navigator should not replace Degree Navigator. I believe that it should complement Degree Navigator the same way uAchieve Planner complements uAchieve Degree Audit. In this scenario, we will be intentionally foregoing the complications that may arise with integrating Degree Navigator functionality into Scarlet Navigator.

Because this project is so new and unchained by the bureaucracy associated with enterprise solutions like uAchieve, Rutgers administration has the potential to mold and guide this project to fit the exact needs of the Rutgers community. In other words, change can happen fast.

Scarlet Navigator exists now. And the best time to empower students is now. Empower your students to make change and I truly believe the results will surprise you.

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