

Office of the President

TO MEMBERS OF THE ACADEMIC AND STUDENT AFFAIRS COMMITTEE:

DISCUSSION ITEM

For Meeting of November 16, 2022

HOW UNIVERSITY OF CALIFORNIA RESEARCH INFORMS ACADEMIC PLANNING

EXECUTIVE SUMMARY

There is distinctive and important educational value of top research-intensive universities. This item illustrates how academic innovation from University of California (UC) research is propagated into new academic programs at UC and throughout California higher education. First is an example about how research about the climate change crisis is informing academic programs across multiple disciplinary areas. Second is an example of how the newly established and evolving data science discipline is transforming and accelerating research across the University of California and teaching across California higher education segments.

BACKGROUND

As California's primary State-supported academic agency for research, being preeminent in research is a key mission of the University and its ten campuses. Hiring the best faculty in the world and providing them the support to carry out their scholarly work is the main mechanism for research excellence. Research faculty are the backbone of the University of California. UC research yields important discoveries, scholarly works, inventions, and innovations. Faculty research more than pays for itself—the State's investment in UC and its faculty results in billions of dollars of federal and private research support for this research mission.

The value streams of research-intensive universities are synergistically inter-related. The research mission contributes to UC's excellence in its other missions of teaching and public service (i.e., technology transfer and medical service). Ladder-rank faculty are specifically appointed as, or to become, scholarly leaders in their disciplines who bring cutting edge knowledge into the classroom and enrich the educational experience, and this is recognized by students. Around 85 percent of undergraduates say "attending a university with world-class researchers is important" to them. UC's research and its application through UC's public service mission is important to California's economic, social, and cultural development. Addressing any of California's key societal challenges—be it climate change or equal access to education—depends on the application of new knowledge, concepts, and policies arising from university research. Investments in UC research constitutes an investment in UC education and training.

Addressing the question of how research gets infused into academic programs and curricula is both simple and complex. The simple answer is that UC has a model that is nationally and globally recognized as effective—individual research faculty advance their disciplines through their scholarship and creative activity and that knowledge informs their teaching and the content of their courses. The more complex answer demonstrates how UC faculty research informs the creation of new courses, majors, degree programs, and academic units—in essence, how new academic programs and units emerge and how existing ones evolve. This process is not self-contained within the University—it is happening in academia and society at large—but how UC research can inform and evolve academic programming is a place where the University can enhance its leadership in fostering new disciplines and academic structures. UC also collaborates with the other segments of California higher education, including California State University (CSU) and California Community Colleges (CCC), to ensure that California remains a leader and innovator in higher education and produces graduates in emerging fields that can meet critical workforce and industry needs.

RELATIONSHIP BETWEEN UC RESEARCH AND ACADEMIC PLANNING

Academic planning within the University takes place at many levels:

- As individual scholars, every ladder-rank faculty member embraces the responsibility to develop expertise in and a deeper understanding of subject matter to create new knowledge and transmit that understanding through the courses they teach.
- At the academic program unit, where faculty develop coherent curricula and major and minor degree programs that can continue to evolve and be informed by new knowledge gained through UC research. These can be individual departments, interdisciplinary groups, schools, colleges and larger academic divisions.
- At the campus level, where campus administrators and local Divisions of the Academic Senate work together to carry out campus strategic plans which can invest resources in new and/or expanding academic programs, disciplinary fields, and research areas.
- At the UC system, where all new graduate programs and significant new academic units are reviewed and approved at the system level to support rigor and academic quality. The goal is a high standard of excellence in academic programs across all ten campuses. Another goal is that campuses can share proposed new programs and collaborate when it makes sense (for example, in addressing intellectual and social challenges that could benefit from a combined effort) or they can develop distinctive strengths by avoiding unneeded duplication of effort and ensuring sufficient student demand in particular areas.

As part of the systemwide academic planning process, every two years UC campuses submit proposed new and/or disestablished academic programs and units over the next five years. UC Office of the President (UCOP) staff compile these submittals into a report which are discussed with the systemwide Academic Planning Council, a joint Academic Senate/Administration committee that addresses academic planning issues and policies related to the academic mission.

The *Five-Year Planning Perspectives* report¹ is designed to allow “for systemwide analysis of academic plans and creates an opportunity to promote coordination, synergy, and specialization. The preliminary picture offered by the *Perspectives* is especially useful because this systemwide context can prompt valuable discussion in the early stages of proposal development.”²

How UC research addressing climate change research is influencing UC academic programming

Addressing societal issues through a multidisciplinary lens provides a greater likelihood that one can understand and address the contemporary issues of today and tomorrow. For the problem of climate change, there is a need to describe the issue, predict how it will evolve, and control and hopefully reverse its damage. UC research expands our understanding about the science of a warming planet, along with societal and community responses to this information and proposed solutions. As UC researchers create new knowledge about this issue, one way they share it is by bringing it into the classroom. UC faculty in disciplines ranging from Swahili to music are creating new course materials reflecting innovations in theory, research, and practice to expose students—especially non-science majors—to climate change and sustainability concepts and research.

This opportunity differentiates the important educational contributions of teaching versus research universities. Because of the high need for broad and wide application and dissemination of new knowledge, teaching universities are more numerous than research universities and have curricula that ensure that students understand and can apply what they learn from a particular field. Research universities tend to be less numerous and have curricula that tends to emphasize theory and research in order to ensure students gain the latest knowledge and understanding of how that research was conducted. This allows them to develop skills from an inquiry-based education with a goal of advancing scholarship and innovation. This difference in emphases is one reason undergraduates choose the University of California, where three-quarters of undergraduate students report in the UC Undergraduate Experience Survey that “having courses with faculty members who refer to their own research as part of the class” is important to them.

In spring 2016, UCLA’s Institute of the Environment and Sustainability held a series of climate change curriculum workshops, aimed at faculty who do not normally deal with climate science in their classes, to help them develop new course material that incorporates climate change and sustainability into existing courses. These workshops, built on a model championed by the Association for the Advancement of Sustainability in Higher Education, gave professors who were interested in adding climate content to their courses a place to learn, share ideas, and find the resources to make it happen. Over 225 faculty representing over 160 different academic units participated in the workshops. The campus then held similar curriculum workshops with the other UC campuses and the Division of Agriculture and Natural Resources.

¹ *UC Five-Year Planning Perspectives*, UCOP Institutional Research and Academic Planning.
<https://www.ucop.edu/institutional-research-academic-planning/content-analysis/academic-planning/five-year-planning-perspectives.html>

² *Compendium: Universitywide Review Processes for Academic Programs, Academic Units, & Research Units*, September 2014, p. 6. https://www.ucop.edu/institutional-research-academic-planning/files/compendium_sept2014.pdf

Several examples of curricular changes include:

- UCSF expanding its curriculum to examine the impact of a warming climate on public health (e.g., air pollution, changing disease diffusion patterns, heat exposure)
- UC Davis' music department developed a course where students make their own electronic instruments by incorporating sustainable thinking into instrument design (e.g., minimizing or eliminating the use of lithium batteries)
- UC Berkeley's language course in Swahili revising its curricula so that students "understand and explain how global warming is affecting the region (e.g., melting of glaciers on Mount Kilimanjaro) and be able to write a report on the topic in Swahili."

Another example is a systemwide online interdisciplinary course called *Bending the Curve: Climate Change Solutions*. This course brings together students from many different disciplines to work together on "solution-focused projects" related to climate change. It has been offered across the ten UC campuses and now to the entire world. What began as single, credit-bearing undergraduate course offered at UC San Diego in a hybrid format now includes an online version of the course for UC students, an open-source digital textbook, and an online version of the course available to anyone in the world. This course was a spin-off of UC's Carbon Neutrality Initiative and received support from UC Online and the California Digital Library.

UC academic programs are evolving with new knowledge and expanding areas of research on ways to address climate change. In the 2020–2025 planning *Perspectives*, there were 11 programs in the areas of environment and sustainability and in the 2022–27 *Perspectives*, there are another eight programs in the environment classification. Many of these programs are pathways for students interested in addressing the grand challenges of the global climate crisis. For example, UC colleges in areas like environmental sciences, natural sciences, and natural resources are creating new programs focused on climate change research and sustainability efforts:

- UC Berkeley's proposed masters in Sustainability and the Environment
- UCLA's proposed M.S. programs in Conservation Practice and Sustainability and Environment and Sustainability-Conservation Practice
- UC Merced's proposed B.S. in Science of Climate Change

There are other academic programs influenced by climate change research that are being proposed in other schools and colleges, such as:

- UC Berkeley's proposed minor in Climate Change Engineering in Civil & Environmental Engineering and minor in Sustainable Business and Policy (a joint program with the College of Natural Resources and School of Business)
- UC Davis' proposed designated emphasis in Environmental Humanities will allow doctoral students to receive a Ph.D. in another discipline notated "with a designated emphasis in Environmental Humanities"

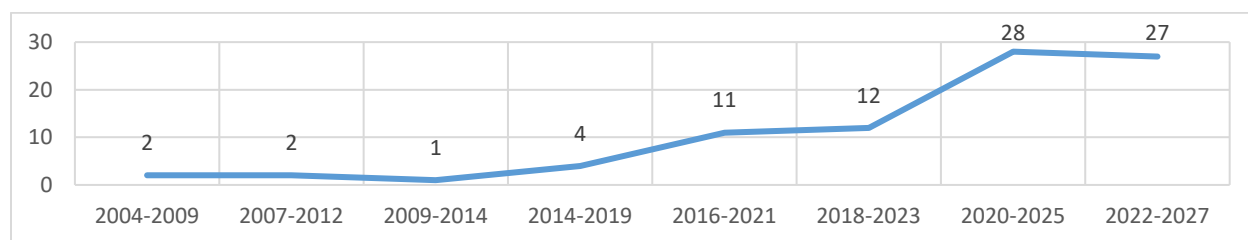
- UC Merced’s proposed B.A. in Environmental Justice in the School of Social Sciences, Humanities and the Arts and B.S. in Systems, Sustainability, and Management in the School of Engineering
- UC San Diego’s proposed B.A. in Communication and the Environment in the Department of Communications
- UC Santa Barbara’s proposed B.S. in Conservation Biology in its Ecology, Evolution and Marine Biology Division

How the data science discipline is changing UC academic programs and research, along with teaching across California’s higher education segments

A decade ago, the Harvard Business Review published an article “Data Scientist: Sexiest Job of the 21st Century” which highlighted the high workplace demand for graduates in this field. Today, these jobs are even greater demand, with the U.S. Bureau of Labor Statistics predicting data science will see more growth than almost any other field between now and 2029.³

UC proposals for new academic programs in data science are multiplying throughout the UC system. In the last two cycles of the *Five-Year Planning Perspectives*, UC’s ten campuses have proposed over 40 new degree programs in this area, with some standalone programs, others with majors in multiple departments, and some concentrations within existing programs. Both UC Berkeley and UC San Diego are each proposing the creation of a new college or school. New schools and colleges need to be approved by the Board of Regents, and these two proposals will come before the Regents in the next year and a half.

Figure 1: UC proposals for data science program establishments



Source: 2004-2009 to 2022-2027 *Five-Year Planning Perspectives*

The data science field often combines programs like computer science and statistics to apply data mining, machine learning, and artificial intelligence techniques across other disciplinary fields, including arts, humanities, and social science disciplines.

For example, UC Berkeley’s undergraduate Data Science major requires students to have a domain emphasis with 25 distinct areas.⁴ Many domain emphases include connector courses,

³ *Is Data Scientist Still the Sexiest Job of the 21st Century?* Harvard Business Review, July 15, 2022.

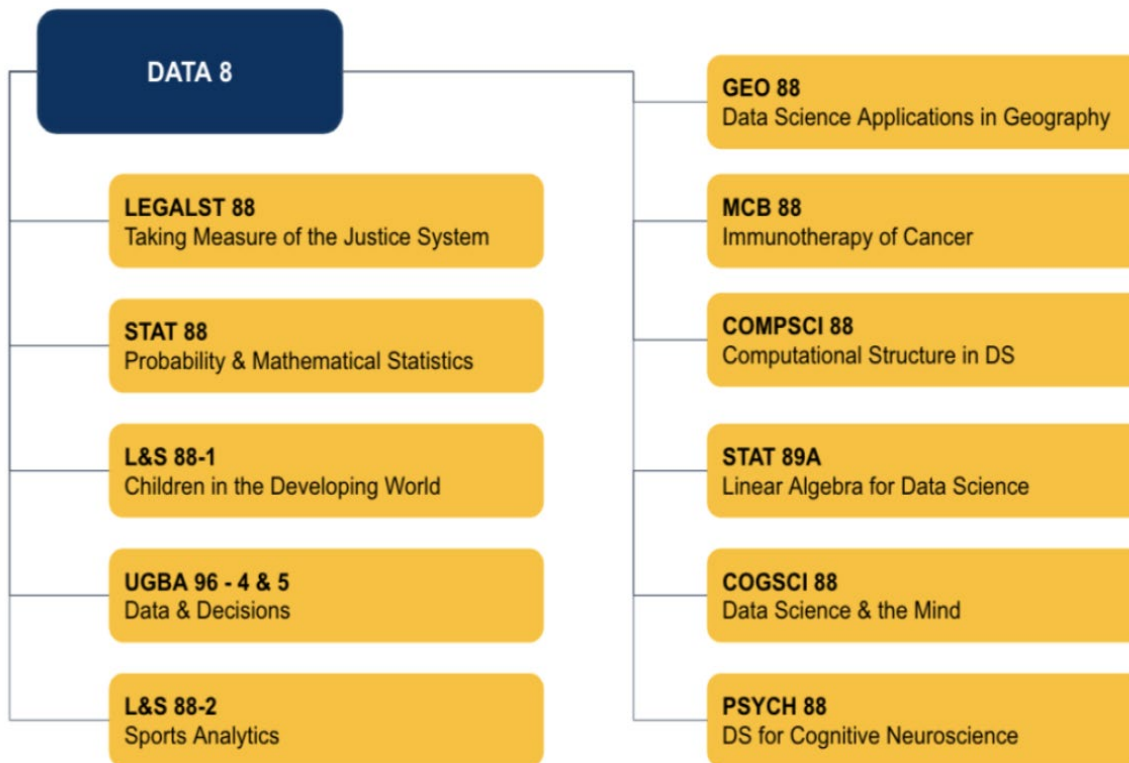
<https://hbr.org/2022/07/is-data-scientist-still-the-sexiest-job-of-the-21st-century>

⁴ Applied Mathematics & Modeling; Business & Industrial Analytics; Cognition; Computational Biology Methods; Computational Methods in Molecular & Genomic Biology; Data Arts & Humanities; Ecology & the Environment;

small and focused lower-division courses designed to be taken along with Data 8 (the Foundations of Data Science course) that weave together concepts and approaches from Data 8 with complementary ideas relevant to particular disciplines (see Figure 2).

This foundational course is designed for entry-level students from any major and does not require prior experience in statistics and computer science, broadening access to students who may not have had prior experience or interest in science, technology, engineering, and mathematics (STEM) fields. It teaches students the core concepts of inference and computing, issues like data privacy and bias, and the opportunity to work hands-on with real data to help explore the issues and attempt to solve problems of interest. As one student described, “I enjoy that you learn by doing—you look at the data yourself, analyze it, ask questions, and draw conclusions.”

Figure 2: UC Berkeley connector courses for Data 8 – The Foundations of Data Science



Data 8 can provide an illustration of how an academic field can evolve, and this evolution is redefining the research university for the digital age. It can accelerate breakthrough research

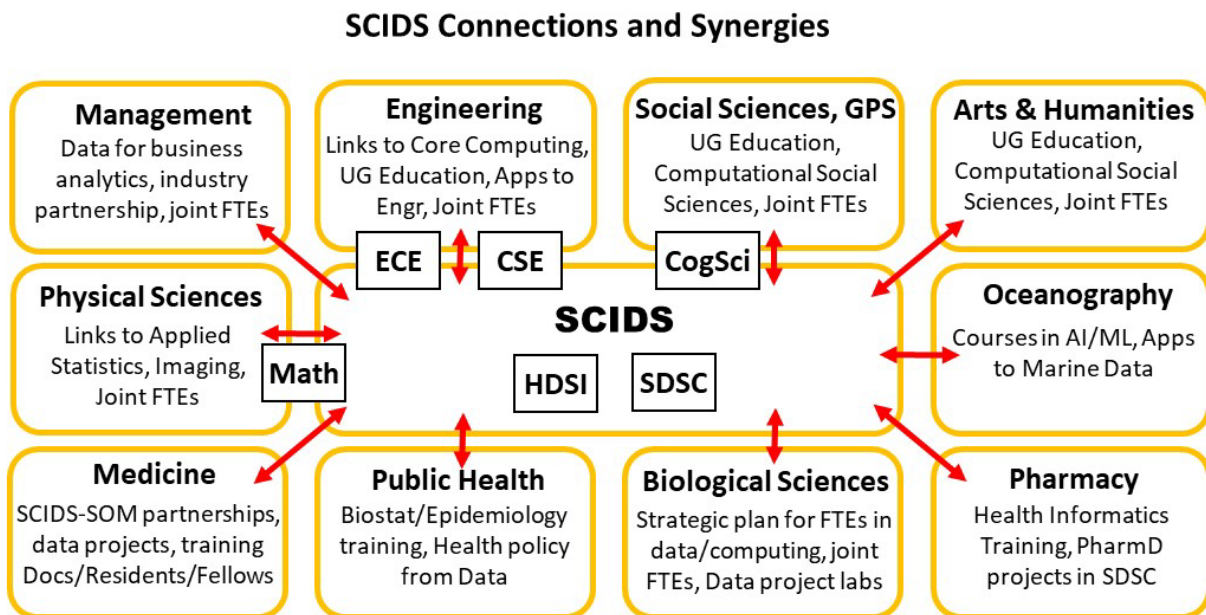
Economics; Environment, Resource Management & Society; Evolution & Biodiversity; Geospatial Information & Technology; Human & Population Health; Human Behavior & Psychology; Human Biology; Inequalities in Society; Linguistic Sciences; Molecular Biology & Genomics; Neurosciences; Organizations & the Economy; Philosophical Foundations: Evidence & Inference; Physical Foundations: Minds, Morals, & Machines; Physical Science Analytics; Quantitative Social Science; Robotics; Science, Technology & Society; Social Welfare, Health, & Poverty; Social Policy & Law; Sustainable Development & Engineering; and Urban Science.

across scientific and technological frontiers by transforming data into knowledge and finding solutions to society’s greatest challenges. As UC Berkeley professor and Nobel Laureate Saul Perlmutter described:

“It is pretty clear that almost every field today needs data-savvy researchers. It has become something as basic as driving a car in our intellectual work. Data science—and the new division—offers the university community unusual opportunities to bridge what can otherwise be disparate disciplines. It’s exciting to see the social scientists, the humanities scholars, the natural scientists, and the computational and statistical scholars all in the same conversation, with novel collaborations beginning to address previously intractable and fascinating questions.”⁵

These connections can be seen through UC San Diego’s proposed School of Computing, Information, and Data Science (SCIDS) that will leverage the existing San Diego Supercomputer Center (SDCC) and the newly established Halıcıoğlu Data Science Institute (HDSI) and create synergies among existing divisions and Schools across the campus.

Figure 3: UC San Diego proposed School of Computing, Information, and Data Science (SCIDS) connections and synergies



The growth in data science programs is occurring across all segments of higher education in California. In recognition of this trend, UC Berkeley became a founding partner and host of the California Alliance for Data Science Education (CADSE). As Jennifer Chayes, UC Berkeley’s

⁵ Berkeley inaugurates Division of Data Science and Information, connecting teaching and research from all corners of campus, UC Berkeley News, November 1, 2018. <https://news.berkeley.edu/2018/11/01/berkeley-inaugurates-division-of-data-science-and-information-connecting-teaching-and-research-from-all-corners-of-campus/>

Associate Provost for the Division of Computing, Data Science, and Society and Dean of the School of Information described:

“Increasing access to data science as a career option for all students is key to making data science a more diverse and inclusive field. We welcome partnership with members of the California Alliance for Data Science Education in sharing resources and curriculum and supporting data science teaching across the state.”⁶

CADSE is an intersegmental group with UC, CSU, and CCC institutions that focused on creating a California-wide effort for data science education. CASDE is focusing on:

- Data science pedagogy and training instructors
- Providing cloud-computing education infrastructure
- Streamlining data science articulation for students transferring to UC and CSU from community colleges including ensuring there are incentives for CCCs to create data science courses

Over the last five years, CASDE hosted national and statewide workshops on data science education with participants from all three segments and the California Department of Education. The 2022 National Workshop on Data Science Education included sessions on fundamentals courses (e.g., UC Berkeley’s Data 8), data science undergraduate programs, building capacity for student-driven data science communities, human context and ethics in data science education, technology partnerships, and inclusion and data science. CASDE has also produced instructor internship programs in partnership with Microsoft.

Some of CASDE’s early success stories include creating a data science academic resource kit with open-source resources for teaching data science. UC Berkeley has also helped hundreds of colleges and universities (e.g., De Anza College, Antelope Valley College, Santa Barbara City College, West Valley College, City College of San Francisco) adopt Data 8 modules into their curricula. In addition, the National Science Foundation has awarded several Harnessing Data Revolution Data Science Corp grants for:

- UC Riverside, CSU San Bernardino, Riverside City College, Moreno Valley College, Norco College, and San Bernardino Valley College to establish a Data Science Career Pathway in the Inland Empire to create shared coursework, seamless pathways, and a summer fellowship program
- UC Santa Barbara, Cal Poly San Luis Obispo, CSU San Bernardino, and Santa Barbara City College to create a Central Coast Data Science Partnership that will establish pathways for data science training through coursework and real-world projects
- UC Irvine, CSU Fullerton, and Cypress College to launch the California Data Experience Transformation (CADET) program to recruit 120 data science scholars to develop a cross-disciplinary curricular, research, and career preparation program in data science

⁶ California Alliance for Data Education (CADSE) website: <https://data.berkeley.edu/californiaalliance>

that creates a paradigm for applying data science training from academia into the real world through close partnership with industry, government, and nonprofit organizations.

CONCLUSION

The University of California is at the forefront of innovation and scholarly creative activity because it hires excellent faculty and supports them. That research informs the educational experience of UC graduate and undergraduate students, but it also helps disciplines evolve and stay on the cutting edge of discovery. Academic programs evolve and new programs are created as a result of new discovery. It is a complex process, but some of the examples discussed in this item show that the University and its academic programs are not static—they can and do evolve with the changing needs of the academy and the need for the academy to address the challenges facing society. The new curricula and programs that result from UC research are shared with and result in collaborations with the other segments of California higher education including the CSU and the community colleges.

KEY TO ACRONYMS

APC	Academic Planning Council
CADET	California Data Experience Transformation
CADSE	California Alliance for Data Science Education
CCC	California Community College
CSU	California State University
HDSI	Halicioğlu Data Science Institute
SCIDS	School of Computing, Information, and Data Science
SDSC	San Diego Supercomputer Center
UC	University of California
UCOP	UC Office of the President