SUMMARY OF THE PROPOSAL FOR THE E. & J. GALLO SCHOOL OF MANAGEMENT

We envision a new **Ernest & Julio Gallo School of Management**, incorporating both academic and professional degree programs, that supports and promotes the integrated research, teaching, and service missions of social and natural scientists, engineers, and practitioners in areas of (a) management and science of complex coupled socio-technical and coupled human-natural systems; and (b) behavior, management, and governance of individuals, firms, institutions, and economies in a world of rapidly evolving technologies, populations, and global environment. A key to sustainable, vibrant, and empathic civilization lies in an integrated understanding and management of individual and collective human behavior, the natural environment, and socio-technological innovation, considering physical, cognitive, economic, and social processes, and accounting for complex interactions and dynamics in private, public, and non-governmental contexts.

The proposed Gallo School has six aspirational goals:

Establishing-World Renowned Research and Training Tomorrow's Leaders in Studies of Cognition, Economics, Politics, Management, and Sustainability: To be world leaders in scholarship and application of knowledge in disciplinary and interdisciplinary studies of business, cognitive science, economics, ethics of technology, environmental sustainability, management, politics, public policy, and computational, empirical, quantitative, and qualitative social sciences.

Advancing Social, Behavioral, and Economic Knowledge for Human Welfare: To advance knowledge of the behavior and performance of individuals and groups in integrated social-political-economic systems and to inform the design and practices of businesses, organizations and governments in local, regional, national and international markets and societies. Related underpinnings include complex physical, biological, social, and natural systems; the design and use of incentives and policy; and the functioning and failures of markets; all in view of social and economic outcomes broadly defined to include human satisfaction, diversity and equality in health, education and wealth, health of natural environments and their relationship to both human progress and ecosystem function.

Generating Opportunities in the Study and Teaching of Complex Systems Science, Engineering, Politics, and Management: To generate opportunities for interdisciplinary collaboration across the fields of decision science, engineering, and management of complex human-centered systems. This means creating support for the development of new theories and methods aimed at understanding, shaping, and improving the outcomes that emerge from interactions among people, technology, institutions, and the natural world across multiple scales. This requires incorporating cognitive and behavioral science, economics and social science, philosophical and ethical analysis, environmental and sustainability science, design science and engineering, data science and analytics, and management science and practice.

Educating Future Leaders and Training a Modern Workforce: To prepare the future workforce and future leadership of California to tackle grand challenges by combining traditional approaches to science, engineering, and management education with practice-based educational programs at the undergraduate, graduate and professional levels. Our programs aim to incorporate complex systems thinking, data analytics, technological skills, ethical analysis, and a triple-bottom-line (people, planet, and profit) perspective throughout the curriculum so our diverse graduates will be able to work effectively today and will be able to create what is needed to lead effectively tomorrow. Related educational priorities include the advancement of historically oppressed and marginalized groups within California and the Central Valley, and training students in politics and ethics so they are socially responsible.

Driving Prosperity and Sustainable Development in the Central Valley and California: To drive local and regional growth and development sustainably through novel educational programs and development of knowledge, tools, and resources that promote entrepreneurship and innovation. To do this, we will focus on complex human-centered economic, technological, and environmental systems. Applicable to local and regional needs, our programs aim to enable state and local investment to multiply across existing and new social and economic opportunities in the Central Valley, creating an approach that can serve as a model for driving sustainable growth and development in historically oppressed and marginalized areas around the world.

Promoting Social Justice, Environmental Justice, and Equity Locally and Globally: To address complex social, environmental, economic, and technological challenges, such as climate change, food insecurity, wealth inequality, wildfire, drought, artificial intelligence, workforce automation, privacy, and more. In this, we take an approach centered on complex systems as well as social and environmental justice perspectives, demonstrating a commitment to supporting and improving the conditions of vulnerable and marginalized populations locally, regionally, and globally.

BENEFITS

We see a number of specific benefits to establishing the proposed Gallo School:

Establish thought leadership on grand challenge problems. By taking advantage of interdisciplinary alignment and convergence of disciplines, we can realize UC Merced's potential as an innovator in complex systems research and management.

Prepare students for rewarding careers addressing socially relevant problems. By providing training and tools to manage problems in complex and dynamic nonlinear systems, and by establishing high-demand programs at undergraduate, graduate, and professional levels, we will be in a strong position to prepare our students to address challenging societal problems in diverse issue areas, contributing to society while developing capacity to take advantage of changing opportunities in a complex and difficult to predict job market.

Promote human wellbeing in social, economic, physical, and environmental realms. We aim to improve human welfare and environmental quality in our community through

research, teaching, and practice, building knowledge and capacity for sustainably managing coupled complex systems globally.

Expand resources and opportunities campus wide. By leveraging unused gift funds for faculty, student, and campus use, we will open new opportunities for philanthropy and industry partnerships on campus and generate additional cash-flow for the campus.

SYNERGY AND ALIGNMENT

The proposed new Gallo School aims to explain and improve the management of both society and the Earth. It will combine scholarship and teaching in science and engineering that addresses complex processes of individual human and natural systems with scholarship and teaching in understanding behavior, design, and performance of political-economic-technological systems – while considering practical implications for businesses, groups, and governments in markets and society. Work in the new School will build knowledge of physical, cognitive, economic, political, and natural systems in an effort to advance human satisfaction, diversity, and equality while promoting sustainability of the Earth's natural resources and ecosystem function.

Four existing departments have collaboratively articulated this new shared vision and mission: Cognitive and Information Sciences (CIS), Economics and Business Management (EBM), and Political Science (POLI) in the School of Social Sciences, Humanities, and Arts (SSHA), and Management of Complex Systems (MCS) in the School of Engineering (SoE). The four groups propose collectively to meet challenges for research, teaching and learning, filling gaps in knowledge related to

- understanding complex human behavior and decision-making in individual, interactive, organizational, institutional, technological, natural, and market settings;
- understanding complex interactions and barriers between natural processes and human-designed or human-influenced systems;
- designing complex systems in both the public and private realm that sustainably and efficiently couple people, technologies, and natural processes; and
- managing complex real-world systems to put theory into practice and improve human and natural conditions locally and globally.

All four groups rely on similar methods, including observation, experimentation, conceptual models and qualitative analytics, large-scale data analytics, and computational modeling and simulation. Aligning these departments represents the seeds of an innovative integration of perspectives that focus on theories, methods, and applications related to management, information, cognition, economics, politics, and coupled-human natural systems.

CIS. The CIS faculty focus on the interdisciplinary study of human behavior and cognition. In its short history, CIS has established an international reputation as a world leader in studies at the intersection of communication, dynamics, and complex systems, as well as in the computational modeling of cognitive processes. The CIS Department currently houses 10 ladder-rank faculty members with expertise in artificial intelligence,

experimental psychology, communication, and neuroscience.[1] This group oversees six educational programs: world-class Ph.D. and M.S. programs in Cognitive and Information Sciences (34 students in Fall 2021), both B.S. and B.A. programs in Cognitive Science (177 majors), an undergraduate minor in Cognitive Science (64 students). Cognitive Science majors have gone on to top graduate programs and excellent jobs at leading technology companies. CIS postdocs and Ph.D. graduates have been offered tenure-track faculty positions and prestigious postdoctoral positions, as well as positions at companies that work at the intersection of human cognition, data science, and technology.

EBM. The EBM faculty focus on the behavior and management of individuals, organizations and institutions in the economy, considering broad social objectives to advance welfare, sustainable environments and improved health. The ladder-rank faculty have published in top general interest and field journals within the Economics profession, already placing the nascent department in the top 7% of world economics departments.[2] EBM has developed two undergraduate programs. Between the two, EBM delivers the third largest undergraduate program on campus (by number of graduates), graduating roughly one-seventh of UC Merced's undergraduates (a higher proportion than at most major universities) and serving more than 700 majors. The two undergraduate programs are Economics B.A. and B.S. (91 majors) and Management and Business Economics B.S. (714 majors). An Economics Ph.D. program began in Fall 2021 (10 students).

MCS. The MCS faculty focus on adaptive management of complex human behavior and complex coupled human-technological and human-natural systems, including for-profit and not-for-profit organizations and public and private enterprises and public lands. Faculty have a range of social-science, natural-science and engineering expertise, and are recognized across diverse fields. MCS is aligned with the graduate group in Management of Innovation, Sustainability, and Technology (MIST). MCS has one minor program, Management Analytics and Decision Making (MAD), and expects to have several undergraduate major within the next five years. MIST is offering the campus' first professional master's program, Master of Management (M.M.). It also has two academic graduate programs, M.S. and Ph.D. in Management of Complex Systems. The MCS department has 12 core ladder-rank faculty members. Arrangements of people, organizations, information, technology, and the natural world, operating together for common purposes, constitute the sort of complex adaptive systems that MCS/MIST faculty aim to understand and shape. Many MCS faculty also participate in the Environmental Systems graduate group, which also takes a cross-disciplinary approach to Earth systems sciences.

POLI. The POLI faculty study governments, public policies, political processes, political systems, and political behavior. The Department currently has 15 ladder-rank faculty FTEs (with 3 open lines). They oversee three programs: a highly regarded Political Science PhD program (ranked 63rd in the nation by the US News and World Report) with 22 students as of fall 2021, a B.A. program in Political Science (with 339 majors), and an undergraduate minor in Political Science (with 51 students). The

[1] Pending Philosophy faculty forming a new department in SSHA.

[2] According to https://ideas.repec.org/top/top.inst.all.html

Department is working toward establishing a new minor in Data Analytics and Policy Evaluation. Every graduate of the Political Science PhD program has gone on to a PhD level placement including tenure track positions at research universities, teaching universities, and community colleges, as well as data science positions in industry.

Co-locating research and education on complex physical, cognitive, human and natural processes with economic modeling and research on behavior and outcomes in firms, markets, politics and the economy at large promises unique and innovative research opportunities for both individual disciplines and across disciplines. Some work focuses principally on the "upstream" (fundamentals of physical, cognitive and natural processes, including properties of brain function, communication, and natural systems) whereas other work focuses principally on the "downstream" (behavior of individuals, groups, firms, and governments in economic and natural worlds). A unique feature of the Gallo School vision is the combination of these in one school that promises intellectual and learning synergies for advancing knowledge and teaching at the intersection of upstream science and downstream research and practice.

There are many promising synergies for advancing new paradigms and approaches to related research and teaching in areas of management and science of complex coupled human-centered systems, and behavior, management, and governance of individuals, firms, institutions, and economies.

There are several benefits to aligning these four departments in a new School, including:

Common Tools. There is a growing set of general tools for investigating complex human and natural systems, offering innovative new concepts, mathematical modeling formalisms, computational methods, and approaches to data analytics. Data science and analytics is an overarching paradigm that uses scientific methods, algorithms, and statistics to extract insights from structured and unstructured data. Some examples relevant to the Gallo school include: (a) standardized metrics for measuring progress towards sustainable development goals (by the United Nations); (b) scalable and dispersible remote sensing capabilities producing reams of environmental science data; (c) highly annotated metadata (e.g., patents and publications) for studying innovation at different levels of aggregation (e.g., people, teams, institutions, globe); (d) high-frequency market data to study financial systems; (e) behavioral-socio-economic data captured in human internet activity; (f) modeling the micro-foundations of political insurgency; and (g) analyzing the effect of electoral rules on individual voter behavior

Understanding Problems. Deep research problems lie at the intersection of management, cognitive science, economics, politics, and the earth systems. As the relationships between humans and natural systems grow increasingly complex, and as ever more information about such relationships is generated, there is a need for more awareness, skills, and systems-oriented thinking to manage the coupling of data, information, people, and the Earth's resources in a sustainable and ethical manner, using for instance, incentives and appropriate institutional arrangements. This systems approach falls squarely at the nexus of CIS, EBM, MCS, and POLI.

Developing Solutions. Management, cognitive science, politics, and economics apply results of scholarship to the design of practical and productive systems that leverage the strengths of human cognition and human institutions while guarding against weaknesses

of the same, for instance, in the context of sustainability and the future of work and automation. Applied work can range from cognitive engineering of user experiences with computers to shaping the visual and linguistic context of risk communication to crafting of organizational structures and policies to adaptively manage natural resources or to implement incentive systems for positive human outcomes. Whereas applications benefit from experimental work and theory, management, cognitive science, economics, politics, and environmental sciences share a deep respect for case studies of real systems to guide fundamental research. This common interest in designing real-world applications leads to a common need for infrastructure to support partnerships with companies, government agencies, and other institutions. Such partnerships both facilitate research and offer valuable opportunities for education and professional training.

Shared Pedagogical Approaches. There are a variety of points of intersection in the educational curricula of management, cognitive science, economics, politics, and Earth and environmental sciences and engineering. There are common concepts and skills – such as the mathematics of complexity, big data analytics, computational modeling of complex dynamical systems, and applied ethics, among other areas – that could be taught effectively in a coordinated fashion, giving rise to efficiencies in teaching and unique interdisciplinary educational experiences. For instance, management students will benefit from easy access to coursework on the scientific study of human cognition, and since many cognitive science graduates pursue careers involving leadership positions outside of the academy, management skills will likely be seen as useful augmentations to their scientific training. Related teaching priorities include the education of business and intellectual leaders with a preeminent objective to advance under-represented groups of California and the Central Valley in private and public sectors of the economy.

Given a shared vision and the many benefits of establishing close ties among the four academic groups in this proposal, we believe there is a compelling rationale to establish a new Gallo School at UC Merced to advance both the campus' aspirations for preeminence in research and its interdisciplinary mission and identity, particularly in the intersecting domains of management, economics, cognitive science, economic and environmental sustainability, and human health. The new Gallo School envisioned here does so by sculpting an institution that embraces the complexities of real-world interactions among people, technologies, and the natural environment.

NEED FOR THE PROPOSED SCHOOL

University of California campuses serve the public as producers and repositories of formal, institutional, and instructional knowledge. Thus, in a manner that is central to its mission, UC Merced acts as an emerging hub within the larger knowledge economy. The organizational structure of the campus currently reflects conventional epistemological pillars, with intellectual efforts divided among three schools: Social Sciences, Humanities, and Arts; Engineering; and Natural Sciences. We propose to add a school dedicated to the study of the behavior, management, and governance of complex coupled human-technology and human-natural systems.

BUILDING ON ACADEMIC STRENGTHS

From an organizational perspective, convergence in research and education will be supported through strategic alignment of four existing departments to be collocated within the Gallo School, namely Cognitive and Information Sciences, Economics and Business Management, and Political Science, all from the School of Social Sciences, Humanities and Arts[3] and Management of Complex Systems from the School of Engineering. The migration of full departments into a new school, rather than sub-groups and select individuals, will maintain the organizational integrity of these departments. Consequently, it is anticipated that the reconfiguration costs at the departmental administration level will be relatively low, with minimal interruption of department-level research and educational program development.

These four departments already provide the campus with intellectual leadership in an array of academic disciplines and emerging interdisciplinary fields. The faculty provide expertise in diverse, but related, research areas, including behavioral complexity, learning and memory, communication and language, coordinated action, embodied cognition, science of science, data science, knowledge management, philosophy of mind, ethics, security and privacy, entrepreneurship, business management, behavioral economics, environmental economics, forest and natural lands management, climate change solutions, water security, service science, political behavior and cognition, political institutions and political economy, as well as international relations among others. These areas range across social sciences, natural sciences, engineering, and management disciplines. Because each department draws on a different mix of disciplinary roots, the proposed school will, by construction, feature diverse competencies and perspectives coming together around a shared vision centered upon the complex dynamics of coupled human, social, technological, and environmental systems. The conceptual connections emerging as the result of both explicit alignment and proximity-mediated diffusion will further support campus values embracing interdisciplinarity and promoting diversity.

Bringing these successful departments together under a shared vision and a shared organizational infrastructure will generate new intellectual pathways by training future leaders with powerful conceptual frameworks and critical thinking skills, honed for addressing so-called “wicked problems” just over the horizon.

The development of an explicitly open epistemological culture – resembling what can be found at progressive Institutes for Advanced Study, like those in Princeton and Santa Fe – will also foster cross-disciplinary career paths across the three existing schools,[4] thereby capitalizing on existing knowledge- and skill-based human capital on campus. In this way, by increasing the number of cross-disciplinary pathways to success, early career researchers will receive institutional support when taking advantage of opportunities for intellectual exploration and career matching, which are distinct advantages of agglomerated innovation systems.[5] This will help UC Merced capitalize on the skilled workforce that it is able to develop locally and attract from elsewhere.

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[3] Although the Department of Cognitive and Information Sciences is currently associated with the social sciences on campus, this field can often be found within a School of Natural Sciences, such as at Princeton University.

[4] Cognitive Science as a discipline is also heavily rooted in the Natural Sciences.

[5] Interview with Enrico Moretti, by David A. Price. Econ Focus, Federal Reserve Bank of Richmond, Q1 2019. https://www.richmondfed.org/publications/research/econ_focus/2019/q1/interview

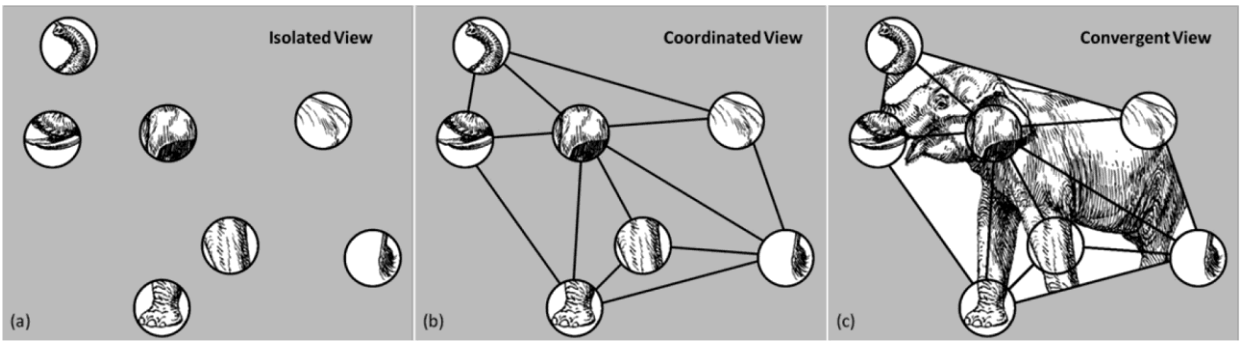

FIGURE 1. CONVERGENT PERSPECTIVES.
THIS SCHEMATIC ILLUSTRATES THE ADVANTAGE OF COMPREHENSIVE 'CONVERGENT' VIEWPOINTS OVER THE MORE TRADITIONAL VIEWPOINTS DERIVING FROM ISOLATED AND WEAKLY COORDINATED CONFIGURATIONS. REPRINTED WITH PERMISSION FROM LINKOV, I., WOOD, M. AND BATES, M. (2014). SCIENTIFIC CONVERGENCE: DEALING WITH THE ELEPHANT IN THE ROOM. ENVIRONMENTAL SCIENCE & TECHNOLOGY, 48(18), P.10539. COPYRIGHT 2014, AMERICAN CHEMICAL SOCIETY.

This possibility for convergent research and collaboration also aligns with the long-term vision of U.S. research funding agencies. In particular, the National Science Foundation (NSF) supports fundamental and applied research on human behavior pertaining to grand societal challenges.[6] In 2016, the NSF included "Growing Convergence Research" as one of 10 "Big Ideas" that would shape its future funding agenda.[7] Two of the principal characteristics identified by the NSF for Convergence Research are "research driven by a specific and compelling problem" and "deep integration across disciplines". Indeed, research focusing on developing a better understanding of human-centered complex systems is at the core of the goals and values identified by each department:

> **CIS** focuses on how cognition and intelligent behaviors emerge in systems of variable size and structure, ranging from individuals to groups of individuals, including artificial agents; applied to compelling problems in social cognition, human dimensions of information technologies, artificial intelligence ethics, and individual and collective decision making under uncertainty.
>
> **EBM** focuses on empirical microeconomic analysis using advanced econometric techniques to identify causal effects and economic mechanisms, with the goal of guiding effective policy design and efficient resource allocation; applied to compelling problems in health, environment, income and savings, innovation, migration and education.
>
> **MCS** focuses on how to reconcile sustainability-oriented decision making and management of complex coupled human-technological-natural systems within the constraints imposed by holistic "people, planet, and profit" values; applied to compelling problems in service system innovation, climate change, land and natural resource management, and information systems.
>
> **POLI** focuses on the ways in which institutions, cognition, and behavior shape and constrain politics systems. It entails the scientific study of power, governments, public

[6] National Academies of Sciences, Engineering, and Medicine, 2017. The value of social, behavioral, and economic sciences to national priorities: A report for the National Science Foundation. National Academies Press.

[7] NSF Program: Growing Convergence Research. https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505637

opinion, and public policy both in the United States and throughout the world; applied to compelling problems in residential segregation, war, human rights, voting behavior, judicial decision making, service provision, and political representation.

Colocation will accelerate the development of common cross-cutting research agendas and facilitate team assembly for extramural funding opportunities with explicit multi-disciplinary criteria (see Figure 2). Creating internal fellowship or research awards from endowed funds for high-impact and cross-cutting projects may also accelerate convergence research and help build a cross-disciplinary research culture.

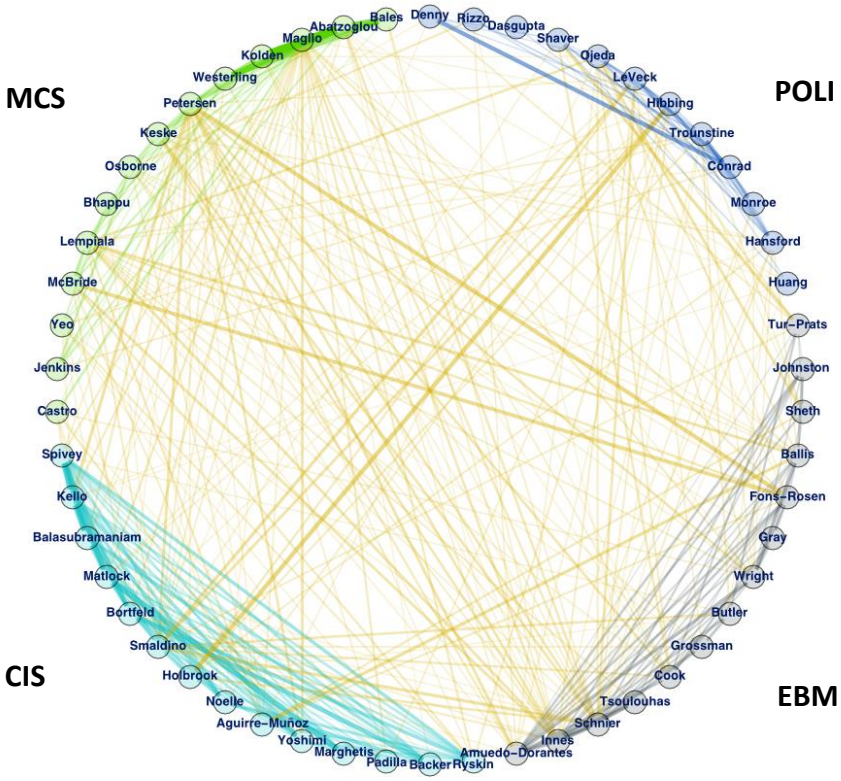

FIGURE 2. CROSS-DEPARTMENT RESEARCH ALIGNMENT.
VISUALIZATION OF THE FACULTY-FACULTY SIMILARITY MATRIX FOR THE THREE PROPOSED GALLO SCHOOL DEPARTMENTS (FACULTY ARE SORTED WITHIN DEPARTMENT CLUSTERS ACCORDING TO TOTAL NUMBER OF WEB-OF-SCIENCE PUBLICATION RECORDS TO REDUCE LIKELIHOOD OF THE STRONGEST LINKS OCCURRING BETWEEN DIRECT NEIGHBORS IN THE LAYOUT). LINK THICKNESS IS PROPORTIONAL TO KEYWORD CO-OCCURRENCE. STRONG LINKS CROSSING THE CENTER OF THE NETWORK INDICATE EXISTING CROSS-DEPARTMENT SYNERGY.

CONVERGENCE OF EDUCATIONAL PROGRAMS

At its inception, the Gallo School of Management will offer four PhD programs – one in Economics, one in Management of Complex Systems, one in Cognitive and Information Sciences, and one in Political Science. In addition to these existing programs, the proposed Gallo School provides the opportunity to exploit overlap in faculty research interests in new and innovative ways. Integrating research on complex physical, cognitive, human and natural processes with economics modeling and research on behavior and outcomes in firms, markets,

cultures and the economy at large promises unique research opportunities both within and across disciplines. In this way, the Gallo School promotes the research, teaching, and service missions of social and natural scientists, engineers, and practitioners in areas of management and science of complex coupled human-technological and human-environmental systems and of behavior, management, and governance of individuals, firms, institutions, and economies.

Overall, building the Gallo School on two existing internationally renowned Ph.D. programs (CIS and POLI) and two nascent programs with the potential to rapidly gain recognition in their well-defined niches (MCS and Economics), coupled with the potential to create new programs and to tackle important societal issues from the considerable potential research overlap across the constituent faculty, should place the proposed Gallo School of Management on a trajectory to rapidly achieve a reputation for producing UC quality research and education.

CURRENT ACADEMIC PROGRAMS

As described, the proposed Gallo School includes four existing departments (CIS, EBM, POLI, and MCS) and associated graduate groups (CIS, Economics, MIST, POLI respectively), incorporating the educational programs that these already offer or that have already been approved. In total, six majors, five minors, and nine graduate programs will shift operations to the proposed Gallo School (see Table 1).

TABLE 1. CURRENT ACADEMIC PROGRAMS

Department/Graduate Group	Undergraduate Programs	Graduate Programs
CIS/CIS	B.S./B.A./Minor in Cognitive Science	Ph.D./M.S. in Cognitive and Information Sciences
EBM/Economics	B.S./B.A./Minor in Economics B.S./Minor in Management and Business Economics	Ph.D./M.A. in Economics
MCS/MIST	Minor in Management Analytics and Decision-making	Ph.D./M.S. in Management of Complex Systems M.M., Master of Management
POLI/POLI	B.A./Minor in Political Science	Ph.D./M.A. in Political Science

PROPOSED ACADEMIC PROGRAMS

Data Science and Analytics

It is clear that the world is in the midst of a "big data" revolution – and the demand for highly trained computational and data scientists is growing at an astounding rate. To fully realize the promise of "big data" to foster innovation – improving management of critical challenges in environmental sustainability, human health, living standards, national security and much more – it is not enough to just increase computing power and data storage capacities. We must increase skills related to data, information, decision making and their application to management. Data sets are increasing in complexity just as fast as they are increasing in size. Relationships among variables are often nonlinear and context-dependent, and useful information must be culled from virtually limitless sources of data. Decisions often must be made under conditions of time pressure and uncertainty, and systems must constantly adapt to new data and changing conditions and management objectives. Data scientists bridge the gap between data and computation on the one hand, and information and decisions on the other. Big data is creating job opportunities in

many fields related to computer science and math: The Bureau of Labor Statistics projects employment of computer and information scientists will grow 16% from 2018-2028, more than three times faster the national growth rate for all occupations.[8] But the impact of the data science revolution and the opportunities it creates will also be realized in careers far afield from computer and information sciences alone.

Recent research and technological advances are changing how we conceptualize and interact with data science. From viruses and amoebae to swarms and human brains, scientists are making rapid advances into the data sciences that allow us to uncover the mechanisms and principles that underlie an increasingly remarkable range of natural phenomena. At the same time, data science is becoming just as pervasive in driving technological change. From devices and software that anticipate consumer behaviors, to robots and algorithms that autonomously seek out information in real and virtual spaces, data science is fast becoming an integral part of modern life. And data science is increasingly used by social scientists to understand the statistical and causal regularities that drive emergent phenomena in economic and social systems, leading to new insights into the impacts of policies and events.

Application Areas

Both theoretical and practical advances are likely to emerge from academia and will complement important technological advances in data science that arise from industry. Indeed, the big data revolution, along with the imminent age of robotics, is likely to drive major technological innovations and advances. Many such advances will be peripheral to this proposal, e.g. in software and hardware needed to process vast amounts of data and allow robots to operate robustly for extended periods and in various environments. However, advances also will be needed to build systems that can collect, manage, and act upon information to manage complex systems for beneficial goals, and stimulating these advances will be a core objective of our data science programs. For instance, companies will need systems that adapt to and predict the needs and specifications of users and clients, or that can intelligently filter and highlight data that are autonomously identified as high priority. Other companies will need systems that interact with the physical world in semi- or fully autonomous modes to manage transport or sensor systems, for example, or search large environments that are too dangerous or expensive for humans or manage processes that are hazardous to humans. In the policy realm, the analysis of large datasets will allow policymakers to harness new methods of causal inference to understand the key determinants and scalar dependencies of policy outcomes. These examples demonstrate the need for applied scientists with broad perspectives who can perceive opportunities and problems, and formulate strategies and solutions, that require synthetic knowledge of data science.

Toward Program Proposals

Data science is a common thread running through the three departments of the proposed Gallo School. We plan to establish Data Science and Analytics degree programs in the proposed Gallo School that will provide a valuable training environment for individuals seeking work in the data economy. The Data Science degree programs will equip students to draw sound conclusions from data in context, using knowledge of machine learning, statistical inference, computational processes, geographic information systems, data management strategies, domain knowledge, ethics, and theory. Students will learn to carry out analyses of data through the full cycle of investigative processes in scientific and managerial contexts. They will gain a deep appreciation

[8] See https://www.bls.gov/ooh/computer-and-information-technology/computer-and-information-research-scientists.htm#tab-1

of the human, social, and institutional structures and practices that shape technical work around computing and data, as well as an understanding of how data, data analytics, machine learning, artificial intelligence, and computing permeate and shape our individual and social lives. Specifically, we will propose B.S. and M.S. programs in Data Science and Analytics, to start with the proposed Gallo School in AY 2023-2024. These programs will be proposed in the next year through established processes of existing departments, groups, and schools, and they will move to the proposed Gallo School when it opens. Note that the proposed Gallo School faculty have agreed that these new programs should be established and incorporated into the new school.

Data Science and Analytics B.S.

The bachelor's degree will combine mathematical and ethical foundations with data science foundations and computational training in analytics, modeling, decision-making, and application areas. It will draw on lower division and upper division courses from CIS, MCS, EBM, and POLI. It will also incorporate lower division and upper division courses from other campus programs, such as Applied Math and Computer Science and Engineering. A number of new courses, for instance, in foundations and methods of data science, will be required; some of these may serve multiple majors (including those managed by CIS and EBM) and some may provide new teaching opportunities for MCS faculty. The bachelor's degree will also include a capstone activity, such as an internship or research project.

Data Science and Analytics M.S.

The masters is envisioned to be a one-year (two semesters plus one summer) self-supporting graduate degree program. Student tuition will be set around $40,000, at the low end of comparable self-supporting programs at UC, including Berkeley ($70,000), Irvine ($50,000), and UCSD ($40,000).[9] Coursework will include an introduction to data science and data science methods courses, as well as courses in statistics and computational modeling, with electives possibly drawn from other graduate programs, including Electrical Engineering and Computer Science, Applied Math, CIS, Economics, MIST, and more. The program will also include a capstone activity in the summer, either as an internship or a research practicum.

FUTURE ACADEMIC PROGRAMS

We see opportunities to create a number of additional academic and professional degree programs in the Gallo school over the next 10 years. For example, we may combine our faculty's interests in complex systems, sustainability, and management to create an undergraduate minor and bachelor's degree in this area, and we may create a number of possible self-supporting programs at the master's level as well, depending on future resources and other conditions. Note that none of these programs are in our immediate plan and may be considered formally by the Gallo School faculty at a later time.

Undergraduate Programs

Minor in Sustainability and Society

A minor program in Sustainability and Society would incorporate courses related to natural resource management, climate solutions, parks and protected areas management, as well policy and related areas. This program would draw primarily on courses and faculty in MCS and would

[9] Data available at https://www.ucop.edu/institutional-research-academic-planning/content-analysis/academic-planning/attachment_a_description_and_summary_table-51619.pdf

also include courses and faculty from CIS and EBM, for instance, with elective courses on ethics and resource economics. The minor would be available to students from all majors and preliminary analysis of undergraduate program emphases and campus learning community themes suggests this would be both a highly relevant and sought-after minor with complimentary curriculum to that of established majors.

B.S. in Systems, Sustainability, and Management

A major program in Systems, Sustainability, and Management would incorporate courses from the existing MAD minor and future Data Science and Analytics major and future Systems and Sustainability minor, applying "systems thinking" to human-environment concerns and human-technology concerns, particularly in the context of sustainability in complex real-world systems. The program will also leverage resources already available on campus, such as project support with access to geographic information systems analysis and visualization tools at the Spatial Analysis and Research Center (SpARC). Graduates would be good candidates for jobs in many areas, including sustainability officers, environmental consultants, systems analysts, and managers which are high-demand, high-paying jobs,[10] and they would also be good candidates for graduate school in human factors, environmental systems, management, and more.

Graduate Programs

Master of Professional Accountancy (Self Supporting)

Demand for accountants remain strong.[11] Locally, California State University campuses in the Central Valley incorporate accounting as tracks in their M.B.A. programs. CSU Sacramento along with UC campuses at Davis, Irvine, Riverside, and San Diego have implemented standalone masters programs in accounting, which provide required training for individuals seeking to pass the CPA exam. We will explore approaches to providing professional training in accounting through a self-supporting professional master's program in the Gallo School.

Master of Parks and Lands Management (Self Supporting)

Building on the success of our *National Parks Institute Executive Leadership Seminar*,[12] we will explore the opportunity to create a professional masters degree program in the area of parks and lands management, serving public sector and private sector demand in this area.[13] Existing connections that will contribute to the curriculum delivery and program learning outcomes for students including the proximity of Yosemite National Park and Sequoia and Kings Canyon National Parks to the UC Merced campus as natural learning laboratories to learn from practitioners about the complexities of parks management, such as, wildland fire response, visitor use and transportation planning, and park financial administration. Furthermore, an ongoing collaboration between the University Library and each park's archives has led to the digitization of archival resources related to lands management that will enable virtual (remote) learning on applied topics, such as, superintendent reports, fire records, organizational charts, annual budgets, and engineering and infrastructure plans.

[10] See for example, https://www.bls.gov/ooh/business-and-financial/management-analysts.htm

[11] See https://www.bls.gov/ooh/business-and-financial/accountants-and-auditors.htm

[12] For more on the National Parks Institute, see the next section and https://parkleadership.ucmerced.edu/

[13] See for example, https://www.bls.gov/ooh/life-physical-and-social-science/urban-and-regional-planners.htm

Master of Engineering Management (Self Supporting)

Given steady demand for engineering management skills across a range of engineering disciplines, including Mechanical, Environmental, Materials, and Bio Engineering,[14] we envision creating a practical core of management education with emphases aligned with several specific engineering disciplines. For example, a Master of Engineering Management with emphasis in Environmental Engineering would augment environmental engineering skills with practical management skills, putting graduates in a perfect position for jobs in the design or supervision of the design of systems, processes, or equipment for control, management, or remediation of natural resources, or work with environmental scientists, planners, engineers, or other specialists to address environmental problems, in-demand, high-paying jobs.[15] Such a program would cater to students with specific engineering backgrounds, combining management courses (offered through the proposed Gallo School) with engineering courses (offered through the School of Engineering) in a one-year self-supporting program.

FILLING GAPS AT UC MERCED AND IN THE CENTRAL VALLEY

The city of Merced and its region are burdened by hardships relating to poverty; a dominant agricultural industry that provides limited demand for a skilled technical workforce and consequently lower levels of integration within the innovation economy; and associated negative externalities manifest in the social cost of high-intensity wildfire, poor air quality, unsustainable groundwater use, degraded lands, industrial and agricultural pollution, and heat stress – among others. To address these issues, there is an unmet need for an organizational platform upon which relevant human-systems oriented problems can be brought to the fore. The proposed school will address this need for a central repository of human, social and intellectual capital charged with targeting the region's very real problems.

Building upon the successful completion of the Merced 2020 building project,[16] the proposed school can thus contribute to these next phases of integration and growth. These phases will take place both internally to the campus, as well as externally, by virtue of the skilled workforce trained at UC Merced. This workforce is integral to developing the region's lacking knowledge economy[17] that will provide greater opportunities for social and economic mobility within the Central Valley. For example, with faculty expertise in entrepreneurship, economics, organizational management and finance, the proposed school will be in a position to develop professional degree programs producing administrators with the modern skillset that is in demand, certainly on campus, but also broadly across IT-oriented organizations.

Many of the Merced region's issues are multi-faceted, requiring an integrated understanding of the underlying behavioral, institutional, technological, legal and environmental factors. In many ways, Merced and the Central Valley will benefit from research focusing on complex systems problems: It lies at the center of California and at the center of so many challenges facing society

[14] See https://www.bls.gov/ooh/management/architectural-and-engineering-managers.htm

[15] See https://www.onetonline.org/link/summary/17-2081.00

[16] Campus's Economic Impact on State Nears $3 Billion: https://news.ucmerced.edu/news/2017/campus-economic-impact-state-nears-3-billion; https://www.universityofcalifornia.edu/news/economic-impact-uc-merced-rises-26b

[17] For example, based on official US government data collected by the *Data USA* platform, the employment occupations that are overly represented in Merced CA relative to other similar metropolitan statistical areas are *Farming, Fishing, & Forestry*, *Personal Care & Service*, and *Material Moving* occupations: https://datausa.io/profile/geo/merced-ca-metro-area

today, from financial inequities, health disparities, and climate change including drought and wildfire. Addressing such issues requires a systems-oriented approach based upon complementary mixed methods, that is, both qualitative and quantitative analysis. A relevant example of a graduate program addressing this type of holistic training is the Master of Management program, which provides students valuable experience working on integrative team projects centered around real-world issues. The program is designed to prepare graduates for the hard constraints encountered by sustainability-minded professionals charged with balancing people and planet bottom lines with the more traditional bottom line of financial profit. This "triple-bottom-line" paradigm requires students to understand how interacting systems give rise to challenges that lack clear solutions. One goal of the proposed school is to extend this educational framework into new undergraduate programs.

The four departments are already equipped with faculty in the relevant expertise domains needed to develop new undergraduate educational programs around the challenges of decision making in the face of uncertainty within highly constrained human-oriented systems. To further fill the void of undergraduate education centered around systems problem solving, the proposed school will develop a new major in Data Science and Analytics, which is currently lacking formal educational programs despite being thematically represented across campus in various forms. These undergraduate programs will be designed to provide breadth across both soft "people" skills and hard "technical" skills, both of which are increasingly moderated by technology and critical to developing the nation's knowledge-based economy.[18]

The proposed Gallo School of Management lies at the intersection of converging disciplines with the capacity to substantively tackle deep research problems in management, cognitive science, economics, politics, and the natural environment – problems related to the complex systems of everyday life. The capability to address such problems is not directly addressed by any other school within the UC system or the region. Moreover, the Central Valley currently lacks a world-class research-focused school of management. Though several schools in the region offer M.B.A.'s, no school in the region offers a Ph.D. in business, management or related areas. In filling this gap and offering several distinct Ph.D. programs at its outset, the proposed Gallo School of Management will advance the UC system's mission of providing research education to currently underserved populations and regions of the state of California.

[18] National Research Council, 2001. Building a workforce for the information economy. National Academies Press; National Academies of Sciences, Engineering, and Medicine, 2017. Building America's skilled technical workforce. National Academies Press.