Computational Mathematics, Science and Engineering

Current Status: The Department of Computational Mathematics, Science and Engineering (CMSE), https://cmse.msu.edu, is in its 6th year at Michigan State University. The department was founded to create a home for people who focus on the science of algorithms across all STEM fields. CMSE strives to foster a create and dynamic research environment to lead the development of both Data Science and Scientific Computing across much of STEM. CMSE is at the triple point of domain science, theory and computation, as it applies to state-of-the-art algorithms and there use in understanding the world around us. The department consists of 36 faculty across 12 traditional STEM disciplines. 26 of 36 where hired over the first 5 years of CMSE. 20 of the faculty focus on data science and 16 faculty focus on scientific computing, with many faculty looking at the overlap between the two areas. By design, 33 of the 36 faculty have joint appointments with one of 12 traditional

departments hear at MSU. For Assistant professors, this is either a 30-70 or 70-30 split, so that the faculty have a clear tenure home. Counting all the fractional appointments, the department has 21 full time equivalent faculty. The department has 5 staff members and 2 continuing specialists, which could be thought of as tenure like teaching faculty, and 1 fixed term teaching faculty member.
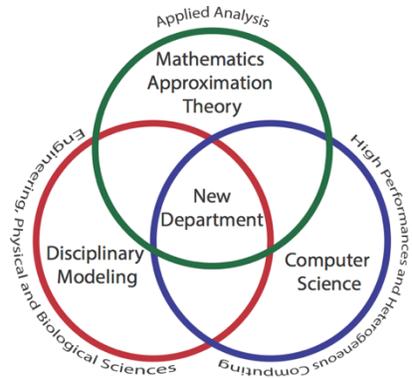
The department has three main research thrusts: theory of algorithms; computational and data informed physical science; computational and data informed biological science. Within these areas, the department has real strengths in: foundational theory of machine learning and scientific computing; peta and exo scale computing as it pertains to fundamental physics; data informed physics and engineering; scalable and innovative machine learning algorithms in genomics research; and inverse problems in geoscience and imaging. Related to these research efforts, the department has over $14M per year in external grants associated with its 36 faculty. Currently there are 20+ post docs funded by external grants in CMSE.

The educational mission of CMSE is to educate people in how to work in this data-driven and computational informed environment. A major goal is to foster critical thinking around issues of method development, data reliability, inherent bias in data and resulting models, robustness of algorithms, etc. To achieve our goals, in 2016 CMSE launched a PhD in Computational Mathematics, Science and Engineering, which has both data science and scientific computing tracks, as well as a dual PhD option with any STEM field. CMSE currently has 53 PhD students and 45 dual PhDs. We also launched two graduate certificates, one certificate on computational modeling and the other certificate on high performance computing, and a minor in CMSE in 2016. We currently have 140 students in the CMSE minor. We have graduated 14 PhD/Dual PhD, 4 Masters, 34 have received the certificate in Computational Modeling and 13 have received the certificate in high performance computing. In 2016, CMSE joint with the MSU institute for cyber enabled research won an REU award for undergraduate summer research experiences in computational and data driven science. The program was just renewed. In 2017 CMSE, in collaboration with the biological sciences, started an innovative one month one credit bio-informatics training program to meet the needs of biology PhD students at MSU. In 2018, related to this effort in bio-informatics training, CMSE together with MSU's Plant biology department, won an NSF NRT training grant in data driven plant biology. In 2019, CMSE launched our new Bachelors of Data Science and a minor in Data Science. After one year, our B.S. in data science has grown to 90 majors and we now have 72 declared minors in data science. In the spring term of 2021, together with Computer Science and Statistics, we are launching an M.S. in data science targeted at anyone who has a B.S. in a

STEM field. The B.S. in data science and the M.S. in data science consists of an entirely new curriculum designed from the ground up. Courses are taught in a flipped environment designed to foster critical thinking.

Background, Challenges and Solutions: The department arose from a community of 17 faculty working across two colleges seeking to create an environment where key aspects of computational science, such as releasing open source code and collaborative research across disciplines, were valued as much as papers. The goal was to create a DoE stile research environment centered on challenging science problems. The department is supported by university funds which were directed to making hires in CMSE. Key issues we have had to address include: buy in from across two colleges; Tenure evaluation across two colleges; launching a data science degree when many units wanted to claim data science as their property; the issue of parity and representation among our students. The cross college issue was complicated in that we need to make clear to other departments that CMSE was developing a new curriculum that complemented, not overtook, existing coursework. In regards to tenure, issues of communication are critical. On a theoretical level, this involved developing MOUs (memoranda of understanding) establishing best practices for hiring and evaluating faculty with joint appointments to ensure that faculty receive consistent messages and support across units. On a practical level, the evaluation results are presented at a joint meeting involving the chairs from each unit with the faculty and administrators worked together to address differences in culture and expectations for tenure across colleges. While we have worked through some of the difficulties and established a better process that is less stressful for the candidates, we continue to explore improvements. In particular, we work to set common expectations, use common language, and present material in ways that allow both colleges to identify metrics they value in the faculty evaluation package.

We also worked on developing a B.S. and M.S. Data Science degree, done deliberately and with the cooperation of multiple stake holders over a 3 year period. Year one established a joint committee to decide curricula and establish best practices. The inclusion of stake holders early on allowed each department to feel ownership of some part of data science. In year three CMSE launched a B.S. in Data Science with the last parts of the degree establishing a minor in an area the students want to apply data science. Computer Science launched a B.S. in computational data science utilizing all the B.S. Data Science courses, but ends with an additional 28 credits of computer science. Statistics launched the M.S. in data science, but it consists of three graduate certificates, one from Computer Science, one from CMSE and one from Statistics. In the end, the expansive timeline gave everyone space to talk about and work through finding common ground. Finally, while our B.S. is off to great start, it is very unbalanced in terms of gender and representation. While we are only a year in, we now see that we need to much more actively recruit women and minorities into the data science degree and that is the work ahead of us.

CMSE is off to a great start. While Diversity, Equity and Inclusion have always been part of the hiring process, we realize that we have an opportunity to address equality in the majors we produce and hence pipeline issues if we work on this now. To make sure we can properly recruit into data science, CMSE has launched a Diversity, Equity and Inclusion committee that is designed to work with both the college of Natural Science DEI and College of Engineering DEI committees. It is meant to identify key issues, raise cultural awareness and engage with all CMSE committees. We seek parity in data science, and these efforts are being put in place why the department is still young and has time to adapt. The DEI committee involves faculty, continuing specialists, graduate students and post docs and came out of a CMSE strategic planning exercise we ran in academic year 2019-2020. We will keep you posted on our efforts.