2019–2020
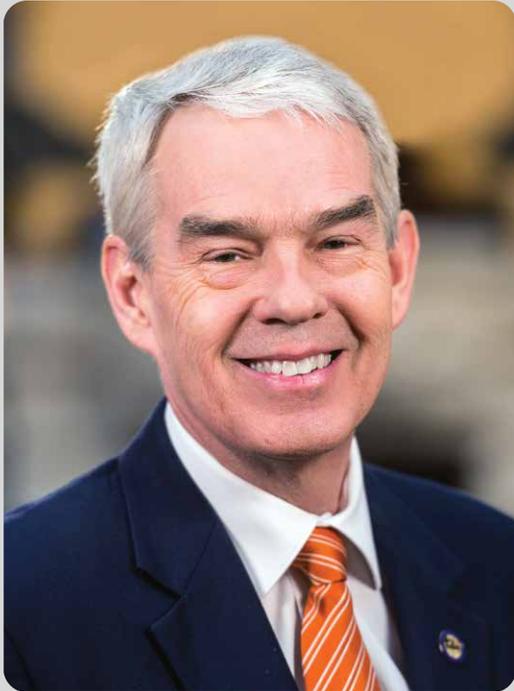
research report

Ohio Supercomputer Center

An **OH·TECH** Consortium Member

"As a leader in Ohio's knowledge economy, the Ohio Supercomputer Center empowers faculty and students and enables new research and business opportunities. From biosciences to advanced materials, OSC's powerful high performance computing serves an incredible range of disciplines that are critical to moving Ohio forward. This year, OSC's flexibility enabled it to immediately support dozens of researchers as they pivoted to the COVID-19 crisis and helped shape Ohio's strategic response."

— Randy Gardner, Chancellor,
Ohio Department of Higher Education

Photo: Chancellor Randy Gardner directs ODHE and oversees the strategic initiatives of OH-TECH and its member organizations in support of the state's technology infrastructure needs.

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Ohio Supercomputer Center

By centralizing Ohio's supercomputing services at the Ohio Supercomputer Center (OSC), the state's higher education and industry communities gain cutting-edge capabilities at unmatchable value. OSC delivers flexible, secure and reliable computational power and comprehensive client support at a fraction of the cost of similar commercial services or smaller standalone systems. Ohio's academic and industrial communities alike benefit from OSC's affordable, on-demand supercomputing that enables groundbreaking research and innovation throughout the state.

Governed by the Chancellor of the Ohio Department of Higher Education (ODHE), the Ohio Technology Consortium (OH-TECH) serves as the technology and information division of ODHE. The consortium comprises a suite of widely respected member organizations collectively unsurpassed in any other state: OSC, OARnet and OhioLINK. The consortium drives efficiencies through common services provided to member organizations through the Shared Infrastructure and Consortia Services divisions.

osc.edu

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■ Area of Science

Natural Sciences

Engineering and Technology

Medical and Health Sciences

Agricultural and Veterinary Sciences

Social Sciences

Humanities and the Arts

▲ InnovateOhio Sectors

Aerospace

Agribusiness

Automotive

Aviation

Energy/Chemical

Invention/Discovery*

Manufacturing

InnovateOhio—the DeWine Administration's commitment to leading an aggressive, innovative path towards a better and stronger Ohio—has outlined these traditional areas of innovation strength throughout the state's history.

*(*Invention/Discovery describes InnovateOhio's Edison category.)*

Director's Letter

In the last year, COVID-19 has changed every aspect of daily life, but technology's rapid evolution has been altering the world as we know it for much longer. Fortunately, as new challenges and opportunities emerge, the capabilities of the Ohio Supercomputer Center (OSC) continue to expand.

This year, the COVID-19 crisis has brought to the forefront what OSC has been doing since its inception: accelerating innovation, research and learning for higher education and industry in Ohio and beyond.

We helped limit disruption by providing virtual computer labs for 1,847 students in 75 courses at 14 Ohio universities. OSC also hosted specialized research software for faculty and graduate researchers who were unable to use their campus workstations after the shift to remote work.

OSC continues to provide no-cost priority access and support for COVID-19-related projects all over Ohio, ranging from Case Western Medical School to the Ohio Department of Health. Notably, Dr. Amy Acton's 'flatten the curve' charts utilized data processed on OSC's systems.

Despite this year's unique challenges, OSC continued to evolve and build upon a 30-year tradition of high technology in the service of higher education.

In October 2020, we said goodbye to our venerable Ruby cluster after 157,226,305 core hours in its 5.5-year lifespan. We also completed a $4.3 million expansion of the Pitzer Cluster, adding nearly 400 nodes and 20,000 cores to bring the system to more than 650 nodes and almost 30,000 cores in total. Combined, Pitzer and Owens now provide peak computing performance of 5.5 petaflops. In June 2020, we added 8.6 petabytes of IBM Elastic Storage Server technology, bringing us to 14 petabytes of secure, reliable research data storage.

We are also expanding access to high performance computing (HPC) at OSC and beyond. We are continually improving the MyOSC client portal and have shifted our training and research support online to make access as easy and safe as possible. Soon, we will launch version 2.0 of our NSF-funded, open-source software Open OnDemand, a user-friendly, web-based front end already in use at hundreds of supercomputer facilities around the world.

Ultimately, our work is intended to make a difference. Since 2015, more than 1,990 peer-reviewed publications across dozens of scientific fields have cited OSC, similar to leading academic computing centers worldwide.

To all our clients: thank you for trusting us as a partner as we all strive to make an impact. If you aren't yet a client but think your work could benefit from secure and reliable HPC and storage, we would love to hear from you!

David Hudak, Ph.D.

David Hudak, Ph.D.
Executive Director

2019–20 Highlights

Systems Deployment

Working within the bounds of COVID-19 safety precautions, OSC deployed two major upgrades in 2019–20. First, we tripled our high performance storage with the addition of 8.6 petabytes of IBM Elastic Storage Server capacity. Then, the Pitzer Cluster gained nearly 20,000 cores across 400 nodes, bringing the system to more than 30,000 cores and 650 nodes altogether and a theoretical peak performance of 3.9 petaflops.

COVID-19 Response

As both an employer and a service provider, OSC responded to the coronavirus pandemic on two fronts. OSC staff shifted to a work-from-home scenario without missing a beat thanks to previously deployed remote work infrastructure. On the client side, OSC made its resources available at no cost to researchers studying COVID-19 and provisioned free classroom access for educators across the state to help enhance the remote student learning experience.

Client Profiles

OSC empowers the innovations and discoveries of Ohio students, faculty, scientists, engineers and clinicians, leading to new products, services and breakthroughs in a vast array of disciplines. By partnering with businesses and educating Ohio's workforce, OSC also helps move the needle ahead in economic development. In 2019–20, OSC served 4,833 clients, a 300% increase over 2016–17.

Academic

Students and faculty need access to powerful computational tools without becoming IT experts. OSC supports all types of institutions—public and private, large and small—across a broad range of disciplines and degree programs. These include historically computing-intensive fields such as materials engineering and mathematics, and areas of growth including horticulture and crop sciences, architecture, anthropology, political science and more. Since 2015, researchers have cited OSC in 1,994 peer-reviewed articles.

As classes and research moved online this past spring, the Center provided priority access for dozens of faculty working on COVID-19-related research and virtual computer labs to support hundreds of students lacking physical lab access due to in-person teaching restrictions. In 2019–20, OSC supported higher education in 75 courses at 14 Ohio universities, impacting more than 1,847 students, a 200% increase compared to 2016–17.

OSC's educational value extends to high school and middle school students through its Summer Institute and Young Women's Summer Institute programs. Alumni of these intensive experiences have gone on to pursue advanced degrees and work for some of the biggest tech companies as a direct result of their exposure to computational science at OSC.

Commercial and Non-Profit

OSC's resources are available to business, government, health care, and non-profit organizations throughout Ohio and the world. Proprietors, managers, engineers, industrial designers, IT professionals, data scientists and more are learning about the "HPC in the cloud" advantages available to them through OSC. In all, more than 100 industry and non-profit organizations accessed OSC's resources in 2019–20.

Through OSC's AweSim industrial outreach initiative, staff members at the Center work with a team of engineering service providers who are experts in a variety of computer-aided engineering disciplines. With the Center's assistance, businesses of all sizes and across a variety of industries can use HPC for virtual product design, testing simulations and data-intensive projects.

The Center's capabilities extend outside Ohio, such as Liqun Zhang's coronavirus research at Tennessee Tech (page 17), and outside the U.S., such as Andrew Paluch introducing students in Brazil to supercomputing (page 15) and D2H's performance engineering in the UK (page 12).

30 Ohio Universities

41 Companies
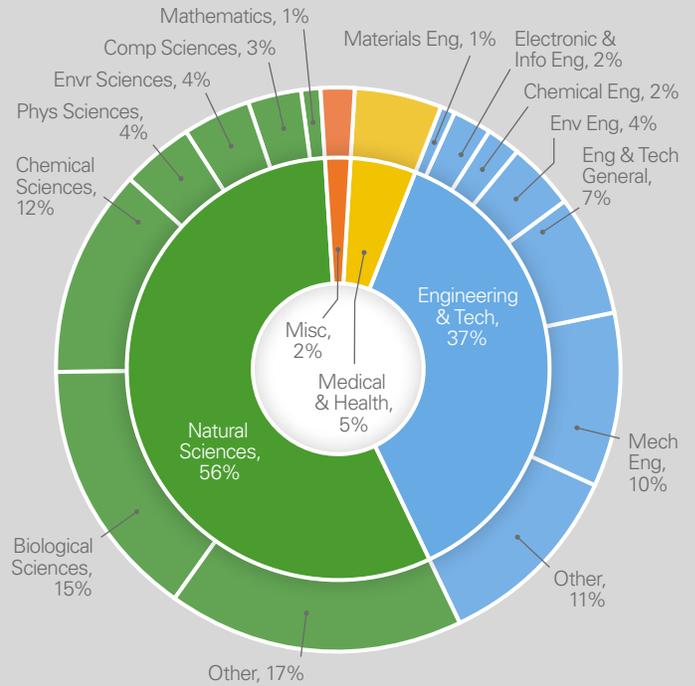
4,833 Clients

75 Higher Ed Courses

15 Training Opportunities

304 Trainees
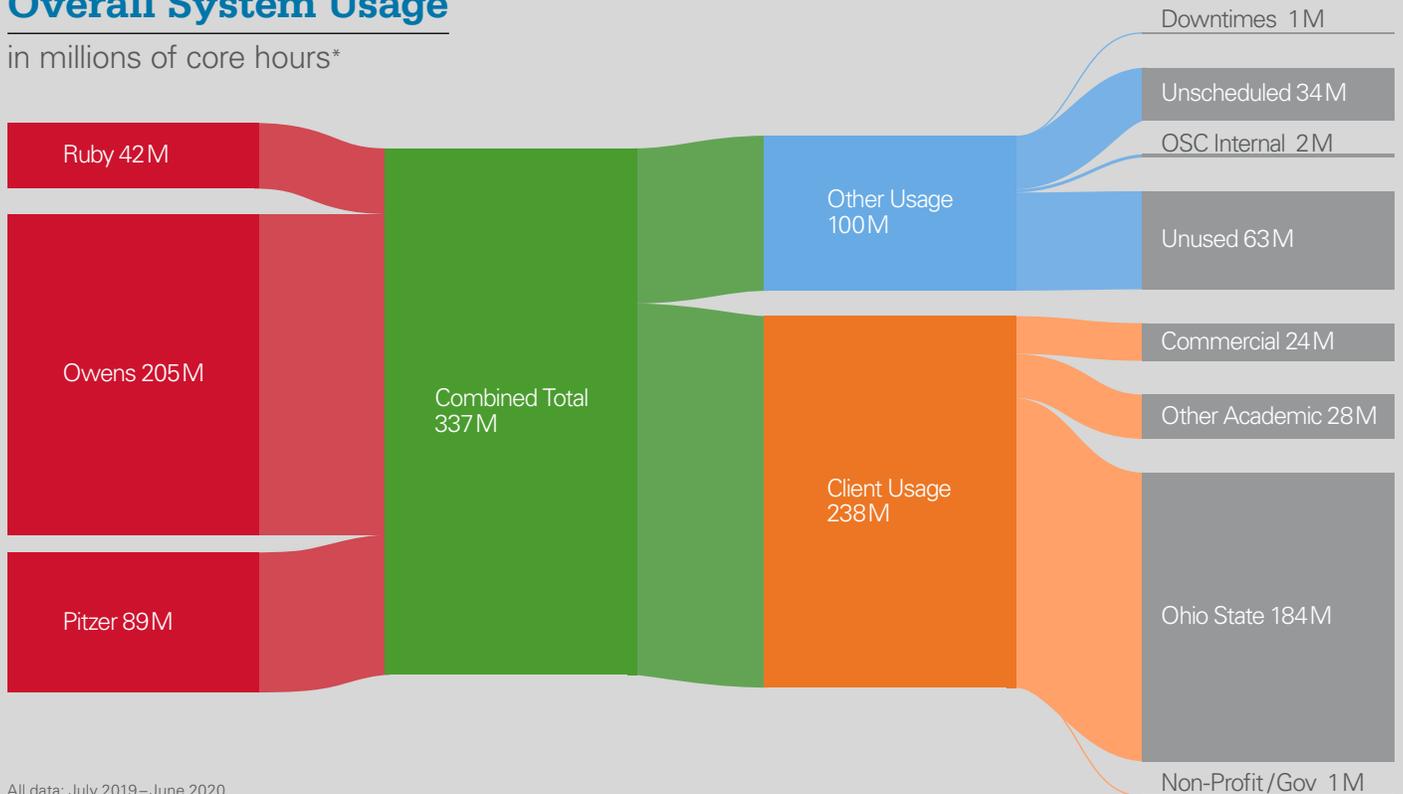
Higher Ed Institutions Using OSC

U. of Toledo
Bowling Green State U.
Oberlin College
Cleveland State U.
Case Western Reserve U.
Brunswick High School
Kent State U.
U. of Akron
Youngstown State U.
Stark State College
U. of Mount Union
College of Wooster
Bluffton U.
Kenyon College
Ohio Wesleyan U.
Urbana U.
Denison U.
Wittenberg U.
Ohio State U.
Muskingum U.
Zane State College
U. of Dayton
Wright State U.
Cedarville U.
Central State University
Air Force Inst. of Tech.
Miami U.
Xavier U.
U. of Cincinnati
Ohio U.

Usage by Field of Science

Mathematics, 1%
Comp Sciences, 3%
Envr Sciences, 4%
Phys Sciences, 4%
Chemical Sciences, 12%
Materials Eng, 1%
Electronic & Info Eng, 2%
Chemical Eng, 2%
Env Eng, 4%
Eng & Tech General, 7%
Engineering & Tech, 37%
Misc, 2%
Medical & Health, 5%
Natural Sciences, 56%
Mech Eng, 10%
Biological Sciences, 15%
Other, 11%
Other, 17%

Overall System Usage

in millions of core hours*

Ruby 42 M
Owens 205 M
Pitzer 89 M
Combined Total 337 M
Other Usage 100 M
Client Usage 238 M
Downtimes 1 M
Unscheduled 34 M
OSC Internal 2 M
Unused 63 M
Commercial 24 M
Other Academic 28 M
Ohio State 184 M
Non-Profit / Gov 1 M

All data: July 2019 – June 2020

Responding to COVID-19

The Ohio Supercomputer Center (OSC) moved quickly to protect its staff and assist the state as the coronavirus pandemic began to impact the United States. As a resource for the public good, OSC recognized its role in crisis response and immediately offered its computational capabilities and expert support for any COVID-19-related activities.

"If you're a researcher and you're doing something that's COVID-related and you need priority access or special software, we're going to jump you to the front of the line and get you onto the system faster than ever," said Alan Chalker, Ph.D., director of strategic programs for OSC.

Assistance for Students and Faculty

OSC provided academic continuity during the shift to remote learning by opening virtual computer labs at class.osc.edu. These digital facilities supported hundreds of students lacking physical access to computer labs due to COVID-19.

Support for COVID-19 Research

Due to the extraordinary circumstances, OSC provided no-cost priority access to its clusters, storage, training and expert staff for all COVID-19-focused researchers. Through November 2020, coronavirus researchers completed more than 60,000 jobs, totaling more than 10 million core

Governor Mike DeWine @GovMikeDeWine

Universities are critical resources in the fight against #COVID19. Experts at @OhioState, with resources from @osc, created a COVID-19 monitoring tool for central Ohio schools: ow.ly/YEtZ50CjPIu #InThisTogetherOhio #StaySafeOhio

Ohio State experts create COVID-19 surveillance tool for schools
A kindergartner develops a sore throat, so he visits the school nurse. A teacher and two students at the middle school next door call in sick with fevers. Across ...
🔗 news.osu.edu

hours. Learn more about how OSC's Wilbur Ouma coordinated these efforts in "Research Collaboration" on page 22.

These projects range from the creation of the "flattening the curve" models utilized during Governor Mike DeWine's press conferences (page 9) to investigation of possible treatments (page 17) and the effect of the pandemic on political rhetoric (page 11).

OSC also hosts the COVID-19 Analytics and Targeted

Surveillance System (CATS) used by more than 40 local school systems to track cases in their districts. Created by The Ohio State University's Ayaz Hyder, the dashboard was recognized by Governor DeWine as a critical tool. Read more at go.osu.edu/catsdb.

Protections for OSC Staff

OSC staff shifted to remote work at the same time as its fiscal agent, Ohio State. When staff head into the office at 1224 Kinnear Rd. or to the State of Ohio Computer Center where the clusters are physically located, they follow the safety protocols of both the state and university, including temperature and symptom checks, mask wearing, social distancing and frequent hand washing and sanitizing.

Changes to OSC Programs

The Spring 2020 Statewide Users Group meeting was cancelled due to the unfolding COVID-19 situation and the Fall 2020 event was shifted to a virtual platform (more on page 18). The Summer Institute and Young Women's Summer Institute were cancelled in 2020, with hopes to resume in 2021 as the situation allows.

Data Consolidation

Carstens centralizes diffuse species data

■ NATURAL SCIENCES

Serving as a professor and vice chair of the Department of Evolution, Ecology, and Organismal Biology at The Ohio State University, Bryan Carstens has the privilege to share his passion for biology and genetics with students and fellow researchers. After years in the field, Carstens began to notice that imperative data sets containing information used for genetic research were often difficult to centrally locate. For example, if a researcher was studying a species of turtles, data about where the turtle samples were collected from may end up in a separate database than that of their DNA sequence.

"It makes sense that you would organize databases based on similarities. If it's a database for measurements of morphology, then that might be entirely different than a database for the genetic data," Carstens said. "But what it does is it makes it really challenging for other people to reuse that data."

Two challenges present themselves with this way of documenting data: researchers are hindered when performing large data analyses, and researchers and students lack easily accessible data about various species they may be studying or interested in throughout their careers.

To remedy this, Carstens has teamed up with Radford University and the Ohio Supercomputer Center (OSC) to build connections between different databases and package them in a way that allows for easy analysis and access using an analytical software such as the R programming language.

"Without OSC, I wouldn't be able to do the work or my lab wouldn't be able to do the work that we do. By the time we're done with this project, we'll have a database that has thousands of species' worth of data on it and then a set of different analyses that can be easily done without being a programmer," Carstens said. "We'll use Shiny R to make it very modular and to make it very intuitive and something you can do from a web browser. And so, by doing this, we're

providing the kind of resource that hopefully will get lots of people excited about biology."

This project has been deemed the "Phylogatr," a contraction of the words phylogeographic data aggregator. Phylogeographic refers to the study of historical processes that led to geographic distribution amongst individuals, particularly in light of genetics. Additionally, this project is unique due to the fact that OSC employees are directly involved. Eric Franz, Shameema Oottikkal, Trey Dockendorf and Samir Mansour have all been involved, taking code written and tweaking it to extract the desired data.

The information that is being centralized consists of data that has been paid for and collected by the National Science Foundation over the last 40 to 50 years. This data is pivotal in both the research and academic realms. For students particularly, this development will lessen the time it takes to collect data and will allow them to research species that are of interest to them personally.

"Hopefully next summer or the following summer, we will release it to the public. The exciting thing is we're working with high school teachers from a local high school and we're hoping to tie it into the Ohio State curriculum for secondary education," Carstens said. "This allows lots of kids throughout the state to really use the supercomputer to do super cool analyses that they're designing on species that they're excited about." •

Project Lead: Bryan Carstens, Ph.D., The Ohio State University
Research Title: Phylogatr Project
Funding Source: The National Science Foundation
Website: carstenslab.osu.edu

Photo credit: The Ohio State University College of Arts and Sciences

Increasing Accessibility

Supporting UC and expanding HPC usage

■ ENGINEERING AND TECHNOLOGY

Even as supercomputing becomes increasingly common in the research landscape, it can still be intimidating for new users. Jane Combs, associate director of research computing services at the University of Cincinnati, made it her goal to demystify and expand supercomputing at the university and educate faculty, staff and students on campus about how those resources can be used in a variety of areas with the Ohio Supercomputer Center's (OSC) help.

When Combs met Brian Guilfoos, OSC's high performance computing (HPC) client services manager, OSC quickly began offering instructional workshops on campus to bring together University of Cincinnati (UC) researchers who utilized OSC services. After implementing consistent workshops and training, Combs saw a large increase in OSC usage and a movement for additional HPC capacity on campus.

"We were funded to have our own computing cluster," Combs said. "We designed our cluster to be architecturally the same as the Ohio Supercomputer Center's so that we could easily transition our users to these new resources."

In 2018, Combs worked with the OSC team and began using Open OnDemand, an NSF-funded open-source HPC portal developed by OSC. Running entirely in a web browser, the user-friendly portal allows researchers to remain focused on their field of expertise rather than the practice of supercomputing. As a result, use of the cluster has expanded to include faculty from fields as diverse as computational fluid dynamics and music.

"I'm sure we have people that wouldn't otherwise be using the cluster that now are because they're just using the basics of Open OnDemand," said Kurt Roberts, information technology manager at UC. "It's different because it's in a web browser. It lowers the barrier of entry for some people. That's where I see one of the biggest benefits of Open OnDemand."

The benefits extend beyond faculty. According to Combs, the platform has been integrated into multiple classes at UC, where students gain exposure to high performance computing without the need to install software on their personal computers.

"With the broad community that uses Open OnDemand, it's nice for us to train students to have tools that are used across the country, because when they graduate, they may be able to find a job because of their experience with Open OnDemand," Combs said. "I think Open OnDemand makes a really nice entry for students learning what HPC is about." •

Project Lead: Jane Combs, University of Cincinnati
Website: research.uc.edu/arc

Ohio Supercomputer Center

Pandemic Modeling

COVID-19 projection models equip Ohioans

■ MEDICAL AND HEALTH SCIENCES ▲ INVENTION/DISCOVERY

As citizens around the world first caught wind about the COVID-19 virus, almost no one predicted that it would become an international pandemic with such far-reaching effects. Wasiur KhudaBukhsh, a president's postdoctoral scholar at the Mathematical Biosciences Institute at The Ohio State University, was no exception.

"I was in Marseilles, France in February this year and there was a conference about infectious diseases. We were discussing all sorts of methodology, state of the art techniques, and we also discussed COVID-19. But back then, it was considered to be an epidemic in the Wuhan province in China. It was not yet a pandemic," KhudaBukhsh said.

Soon after KhudaBukhsh returned from France, many parts of the United States entered into a lockdown due to the rapid spread of the virus. This led a team of researchers, headed up by Joseph Tien of Ohio State, to begin modeling the spread of the virus within the state of Ohio. After reaching out to the Ohio Department of Health to determine how the team could help state agencies make data-informed decisions and come up with public health interventions regarding the virus, they soon realized that the volume of data they were dealing with would require the use of a supercomputer.

Tien noticed the special announcement on the Ohio Supercomputer Center's (OSC) website stating that researchers involved in COVID-19 research projects would be given priority, unbilled access to computational and storage resources. After a proposal was submitted and quickly approved, the team was able to get to work.

"I was responsible for generating statewide predictions of new cases of COVID-19," KhudaBukhsh said. "There was no fixed methodology in place because this pandemic is so different from any other in history because people are changing their behavior. There was lockdown and then all sorts of other things. Even if you look at the curve from a scientific standpoint, it's very different from other things. So, we were running those computations all the time."

Models produced by KhudaBukhsh's team were featured on the press conferences conducted by Governor Mike DeWine and former Director of the Ohio Department of Health Dr. Amy Acton. As time progressed, the research questions surrounding the virus changed to focus on how to best advise the state on safe reopening practices after the initial lockdown period and then how to handle a second surge of the virus.

"OSC has been instrumental. Without OSC, we couldn't have done what we did. And going forward, although our research questions are changing and the demands from our state partners are changing, we're still doing a lot of different kinds of modeling for COVID-19," KhudaBukhsh said. "We want to make sure our conclusions are scientifically robust, regardless of the methodology." •

Project Lead: Joseph Tien, Ph.D., The Ohio State University
Research Title: Predicting COVID-19 Cases and Subsequent Hospital Burden in Ohio
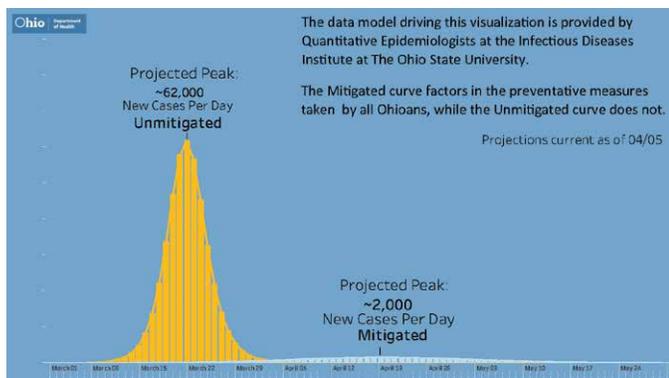**Website:** idi.osu.edu/assets/pdfs/covid_response_white_paper.pdf

Figure: Projection models such as these were used at Governor Mike DeWine's daily press conferences early in the pandemic.

Classroom Computing

Introducing students to R software via Open OnDemand

■ ENGINEERING AND TECHNOLOGY

Walking into a lecture hall of over 200 students can be daunting for a young undergraduate, especially when that class is centered around conducting statistical analyses of biological data. Laura Kubatko, a professor at The Ohio State University, teaches Statistics for the Life Sciences and is well aware of the apprehension that students feel.

Kubatko's class serves as many students' first real experience with statistical computing, including how to make statistical graphs, perform statistical analyses and utilize the appropriate software. To create a streamlined and cohesive learning environment, Kubatko began to search for something she could utilize with a large group of students on their university-issued iPads that would provide them all with the same online computing environment.

Kubatko was introduced to the Ohio Supercomputer Center's (OSC) Open OnDemand resource by a computing administrator within her department. Open OnDemand allows users to access high performance computing (HPC) resources via a web browser on their device. This gives students the opportunity to access R on their iPads and enables instructors to control the interface and what students see when they log in.

"When they log in to the OnDemand server through OSC on their iPads, they all see exactly the same thing. We can write laboratory exercises and write hints for homework problems and this helps them have a standardized environment and know what to expect when they use the tool," Kubatko said.

Additionally, without the need for software installation, students are able to access the R program from their iPad wherever they are and in turn are not confined to working in an on-campus computer lab.

Having control over the learning environment has allowed Kubatko to conduct practice exercises in larger groups, eliminating discrepancies that can arise in the computing environment when there are multiple sessions of the same course with different teaching assistants. While each student works independently, Kubatko is able to take their results and display them in real-time to the whole class through the interface.

Kubatko noted that the utilization of OSC resources is something that excites students. She believes that the sooner students are introduced to HPC and R software, the less daunting it will be as they continue progressing toward their career.

"What's great about it is that it brings a widely used tool for statistical analysis of biological data to every student, basically for free, and lets them experiment with it," Kubatko said. "We've had a really good response overall. We've gotten a bunch of emails from students that talk about how in the lab where they are doing their research everyone uses R and now, they understand what they're talking about."•

Project Lead: Laura Kubatko, Ph.D.,
The Ohio State University
Website: www.asc.ohio-state.edu/kubatko.2

Photo: Laura Kubatko teaches one of her statistics courses using Open OnDemand.

Ohio Supercomputer Center

COVID-19 Polarization

Analyzing political division surrounding a pandemic

■ SOCIAL SCIENCES

A Points represent accuracy rate in the given week for each fold of cross-validation

B Absolute difference in words used by party

Figure (L): As time went on, the researchers' predictions became more accurate, suggesting increased polarization over time.
Figure (R): Key words in tweets were tracked and noted if they were used more by one party.

An election year in the United States is marked by incisive campaign ads, heated debates and get-out-the-vote messaging. The bombast of the 2020 presidential election was further amplified by the heavily politicized COVID-19 pandemic. With the help of the Ohio Supercomputer Center (OSC), The Ohio State University's Skyler Cranmer used Twitter data to examine the extent of this partisan polarization.

Cranmer, the Carter Phillips and Sue Henry Associate Professor of Political Science in Ohio State's College of Arts and Sciences, specializes in political methodology and the development of new statistical methods for network analyses. As COVID-19 became the main topic of conversation in the United States, Cranmer and four of his colleagues were interested to see if the topic had become politically polarized, especially among politicians on Twitter.

"Political science has documented the fact that people tend to take cues from political elites and modify their behavior accordingly" Cranmer said. "While this hasn't been specifically studied with COVID-19, there is a whole literature to suggest this is happening.

"In this case, it is important, because if your partisans are sending cues to not wear a mask, not place a lot of emphasis on washing your hands or social distancing, then you as an individual are less likely to adopt those behaviors. And the earlier in the crisis this happens, the earlier those attitudes are formed and are harder to unform."

Cranmer and his team collected tweets from members of the House of Representatives and the Senate, beginning with the arrival of COVID-19 in the United States. While collecting the data was straightforward, the text analysis was computationally intensive, so Cranmer turned to OSC and its vast analytical capabilities for help.
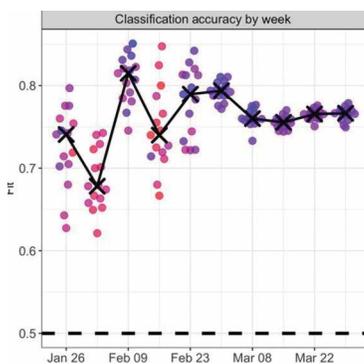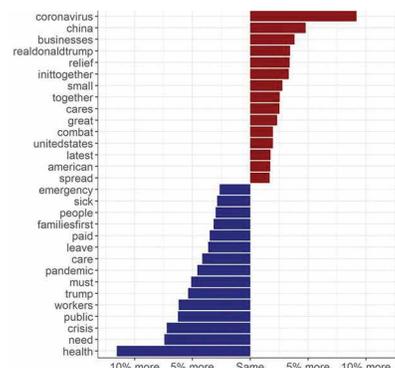
"The first interesting thing we found was that polarization occurred very, very quickly," Cranmer said. "There were also substantial differences in the word choices that were used by different parties. Democrats were framing the issue in terms of things like health and safety, aid to workers, direct aid to citizens, whereas Republicans tended to frame the issue in terms of a battle, so more militaristic language, to have greater calls for national unity and to blame China specifically."

Using models developed through his analysis on the OSC clusters, Cranmer can now predict with more than 75% accuracy whether a Republican or Democrat sent a particular tweet based solely on its text and date. This predicitive rate was used as a measure for how divided Congress was: if a tweet could be attributed to the correct party based on the text of the tweet, then the parties are relatively divided. Cranmer credits OSC for helping to enable these results.
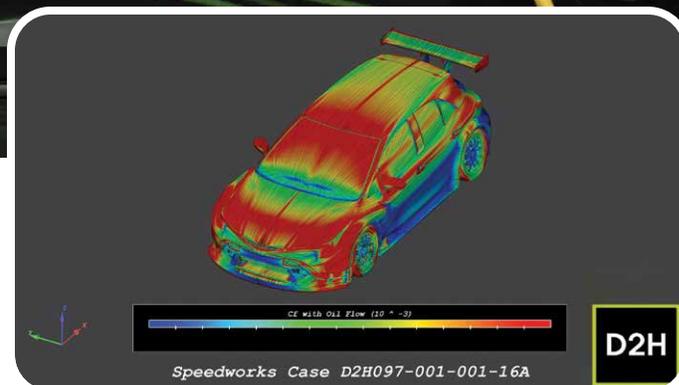
"OSC was incredibly responsive, certainly in our case. They were very quick to get our special account created, and we were able to get this research pushed through really quickly. Computing was definitely not bottlenecked here, even though it had the potential to be." •

Speedworks Case D2H097-001-001-16A

Fluid Dynamics

D2H maximizes efficiency in automotive engineering

■ ENGINEERING AND TECHNOLOGY

▲ AUTOMOTIVE

"Between the flexibility OSC gives us and our drive for workflow efficiency and speed, we're changing the map. The accuracy, speed and value we deliver is changing the way that people think about CFD."

— Darren Davies, D2H CEO

Efficiency and accuracy are everything in motorsports. Finely tuned engineering workflows must operate on demanding timelines and reliably deliver aerodynamically optimized vehicles. Automotive and industrial company D2H Advanced Technologies relies on the Ohio Supercomputer Center's (OSC) on-demand high performance computing (HPC) for maximum efficiency in both process and product.

With offices in both the UK and the USA, D2H operates in motorsports including NASCAR, high-performance sports including cycling and skeleton bobsleigh, as well as industrial technology, and automotive and electric vehicles. Among the firm's technical specialties is computational fluid dynamics (CFD), used to model how fluids behave when they are moving through and around objects. This modeling provides engineers with crucial data, such as how air flows around a vehicle.

The accuracy and speed of solutions produced by D2H rival any engineering firm in the industry, according to CEO Darren Davies.

"Every millimeter cell around the car, we get the pressure, the velocity, vorticity, all of these parameters we need to tell what's going on so that we can then go and make changes to the car," Davies said. "Our models are an order of magnitude larger

Ohio Supercomputer Center
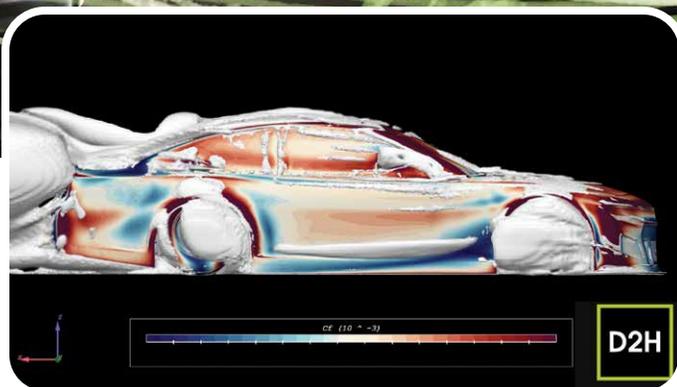
Figures: D2H's computational fluid dynamics simulations generate data that guides engineers as they improve the aerodynamic profiles of vehicles such as the race cars pictured in these visualizations.

and more refined—amongst the most complicated and most detailed CFD models that anybody runs, commercial or industrial."

These complex analyses reduce the need for expensive and time-consuming wind tunnel tests, as one skeptical manufacturer found out recently.

"They had already tested a vehicle in the wind tunnel," Davies said. "The planning and execution of the tests took months, and I would estimate that it cost them between $30,000 and $40,000. They gave us the same problem in CFD on OSC and we turned it around within a few days at a cost in the low single-figure thousands of dollars, proving that CFD testing would have been much faster and better value, without detracting at all from the accuracy of the results."

When preparations began in 2019 for a new D2H office in Winston-Salem, North Carolina, newly hired engineer and University of Dayton post-graduate Seth Morris suggested checking out OSC. After looking at the available resources, D2H decided to utilize OSC as a backup provider, but the Center's performance and reliability quickly changed the plan.

"Over the last year, OSC has stretched ahead, and comfortably so," Davies said. "The true on-demand service with low wait times is unique. We don't have that anywhere else. And that's what keeps OSC ahead

of everyone else right now. The prices are great, the service is great and OSC keeps it all up to date."

Mark Jackson, operations manager for D2H, feels the same way.

"We've been pushing to reduce all of our runtimes and make everything more efficient and then sometimes [with OSC's competitors] we're waiting in the queue longer than the jobs are taking," Jackson said. "We haven't been getting that with OSC."

The Center's recent Pitzer cluster expansion, which added dozens of GPU nodes and nearly tripled the total number of cores, has unlocked even more value. D2H has reduced the number of cores it uses by 5% without any increase in runtimes, translating directly to lower costs.

"It's still good for us to have two providers," Davies said. "But right now, OSC is the stronger proposition and is our 'go to' provider of HPC resources" •

Project Lead: Darren Davies
Research Title: D2H Advanced Technologies
Website: d2h-group.com

Enhancing Analysis

Supercomputing boosts Wooster genetics lab

■ AGRICULTURAL AND VETERINARY SCIENCES

The Ohio State University Molecular and Cellular Imaging Center (MCIC) serves as a shared technology laboratory to facilitate research in microscopy, genomics and bioinformatics. Since its founding in 2000, the center has grown into a data-intensive operation that has thrived in partnership the Ohio Supercomputer Center (OSC).

As the MCIC expanded over the years, the center acquired Illumina, a high-throughput genetic sequencing (HTS) system to identify the order of nucleotides in a DNA segment. Sequencing often proves to be invaluable in genetic work: DNA abnormalities can be indicators of disease and other areas of concern. The incorporation of HTS methods allowed the center to dramatically improve its efficiency, up to sequencing an entire genome at once.

Tea Meulia, MCIC director and adjunct associate professor of plant pathology, realized the volumes of data generated and processed by HTS required more computational power than she had at her disposal. She turned to OSC to take the MCIC's computing operations to a new level.

"As this new instrument was acquiring terabytes of data at once, we needed support for storing and analyzing data, and OSC provided us with the infrastructure for short-term storage of the sequencing runs to perform the analysis," Meulia said. "Throughout the years our needs have changed, but we have been consistently using OSC infrastructure in one way or another."

Over the past several years, Meulia has worked to migrate all analyses at MCIC from local servers to OSC. This infrastructure now supports ongoing work across the Ohio Agricultural Research and Development Center, part of Ohio State's College of Food, Agricultural, and Environmental Sciences (CFAES).

Photo: A researcher and a student utilize the Molecular and Cellular Imaging Center (MCIC) in Wooster, Ohio.

"CFAES research encompasses the improvement of agricultural food production and quality and maintaining agrosecurity, study of the environment and ecosystems and the development of advanced energy technologies and bio-based products," Meulia said. "Our bioinformatics laboratory has the opportunity to work on very diverse projects with faculty. In this past year we have been involved in several [projects] utilizing OSC resources."

For example, the MCIC's bioinformatics group has helped Anne Dorrance, Ph.D., study the development of disease resistance in soybeans. Dorrance, associate dean and director for Ohio State's Wooster campus and associate director for the Ohio Agricultural Experiment Station, has assembled and annotated several soybean genomes using OSC resources. Resistance markers can then be identified and introduced into germplasm—plant material from which new individuals can be cultivated—and then grown successfully with added disease resistance.

"OSC has provided the computational infrastructure to perform analyses that otherwise would not be possible, as they cannot be done on personal computers, or would require a substantial investment in computing and personnel to maintain it," Meulia said. "OSC also allows for easy sharing of data with faculty and collaborators." •

Project Lead: Tea Meulia, Ph.D., The Ohio State University
Website: plantpath.osu.edu/our-people/tea-meulia

Computing Abroad

Paluch brings supercomputing experience to Brazil

■ ENGINEERING AND TECHNOLOGY

▲ ENERGY/CHEMICAL

The Ohio Supercomputer Center (OSC) may be located in the Buckeye state, but its power reaches across the globe. Andrew Paluch, associate professor of chemical, paper, and biomedical engineering at Miami University, took OSC's computational power all the way to Brazil to introduce students to high performance computing (HPC).

After coming to Miami University in 2013, Paluch established a relationship with Luciano Costa, an associate professor of physical chemistry at the Fluminense Federal University located in Niterói, Brazil. Through working on research projects together, Paluch learned of the CAPES-Print program, which brought in American researchers to introduce their research ideas and connect Brazilian researchers with international colleagues.

"I was asked to give a workshop on performing free energy calculations," Paluch said. "I had an idea of what the university was like and the resources that are available there. They are nothing like we have here."

Paluch had access to a computer lab comprised of 30 workstations but not enough computing power to give students hands-on lessons in supercomputing. Becoming anxious, Paluch reached out to OSC and received a classroom allocation so students could access the OSC clusters virtually. He then built the workshop course on OSC OnDemand, the Center's deployment of the open-source HPC portal Open OnDemand, and set up the participants' OSC accounts.

"It just made it seamless in terms of getting things set up from a software perspective," Paluch said. "Only a small number of students in the class were
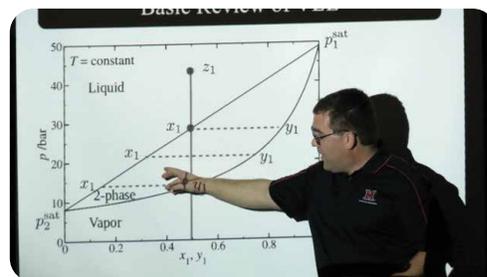
actually computational people. A lot of them were there just to see what it was all about, best practices, how to perform calculations and things of that nature. I didn't know what the workstations were going to be like In Brazil, and so just knowing exactly what I was getting into with Open OnDemand was invaluable."

While his workshop in Brazil was attended by students in graduate school or above, supercomputer exposure can be equally beneficial for students like his undergraduates at Miami. Paluch noted that introducing students to these resources provides opportunities in a range of subjects while allowing them to learn the basics of supercomputing and other tools for their future careers.

In addition to the ways that OSC has been helpful domestically and internationally, he also credits the Center for helping him achieve tenure and integrate into the HPC community.

"When I came to Miami, I remember investigating resources available and coming across OSC," Paluch said. "During my first semester, I joined the allocations committee and developed a support system through OSC. OSC has supported all my work since I started. And that's why I say that my promotion and tenure is in a big part thanks to support from OSC." •

Project Lead: Andrew Paluch, Ph.D., Miami University
Title: Calculation and Application of Solvation Free Energies Using Modern Computational Tools
Website: miamioh.edu/cec/academics/departments/cpb/about/faculty-staff/paluch/index.html

Photo: Andrew Paluch teaching his free energy calculation workshop in Brazil.

Breaking Barriers

Nahar aids female Muslim scientists with supercomputing

■ NATURAL SCIENCES

Sultana Nahar knew from an early age that she had a love for science, particularly astronomy. After moving from her native Bangladesh to the United States and earning her Ph.D. at Wayne State University, Nahar began working at The Ohio State University in 1990. As a research professor in astronomy, Nahar studies astrophysical atomic processes by utilizing the Ohio Supercomputer Center (OSC) in her data-intensive research.

While assisting a Ph.D. student at Beni Suef University in Egypt in 2008, Nahar was asked by the student's advisor if she would be interested in traveling to Egypt to deliver a keynote address at the Modern Trends in Physics Research international conference.

"It was the first Islamic country I went to for a conference," Nahar said. "When I went there, I was surprised that there were very few female scientists, but they are all eager to do research."

Following her presentation, Nahar was approached by a female Sudanese scientist who expressed gratitude for the address. Conversing with her, Nahar soon realized that many more female scientists lacked the outside support and collaboration needed to take their research to the next level. Moved by the experience, she pondered how she might help.

In April 2010, Nahar founded the International Society of Muslim Women in Science (ISMWS), an organization engaged in supporting Muslim women participating in scientific research around the world. The society currently has over 500 members from 31 countries.

One means of support the organization provides to these researchers is exposure to crucial research tools, such as high performance computing (HPC). Through ISMWS, Nahar has been able to partner with researchers and conduct research-based computational workshops around the world on projects using OSC resources.

"For example, my Turkish collaborator is an ISMWS member. She and another collaborator were able to use OSC with me and they just published a paper," Nahar said. "These kinds of collaborations are being carried out quite a bit, actually, and are still going on."

ISMWS has expanded to include a student chapter at Ohio State to support students as they start their research careers in college. Nahar hopes this organization will empower Muslim women to uphold their values while simultaneously pursuing scientific disciplines with the support of advanced research technologies like HPC. •

Project Lead: Sultana Nahar, Ph.D.,
The Ohio State University
Website: astronomy.ohio-state.edu/~nahar

Photo: The certificate ceremony for the Women in STEM Roadshow workshop hosted by Nahar in Patna, India.

COVID-19 Drug Research

Zhang tests defensins' potential in COVID-19 treatment

■ MEDICAL AND HEALTH SCIENCES

▲ INVENTION/DISCOVERY

Photo: Liqun Zhang's lab group pictured on Tennessee Tech University's campus.; Figure: Pictured are simulations Zhang's lab has generated in their research of human beta defensins and how they bind to the receptor binding domain on the spike protein of COVID-19.

Liqun Zhang, assistant professor in the department of chemical engineering at Tennessee Tech University, has spent most of her academic career researching human beta defensins. Defensins are small proteins, categorized as host defense or antimicrobial peptides, that serve as part of the human immune response and help in defense against infections. Zhang's lab has spent the last five years studying beta defensins' ability to kill viruses and bacteria.

As the COVID-19 virus became widespread in the United States early in 2020, Zhang questioned how the virus would correlate with her study of beta defensins. She reached out to her former colleagues at Case Western Reserve University, where Zhang was a postdoctoral research associate, and began to run preliminary simulations in her lab. Zhang quickly realized the increasing volume of work would require additional resources, such as high performance computing (HPC), to complete.

During her time at Case Western Reserve, Zhang was introduced to the Ohio Supercomputer Center (OSC). Zhang recognized that its capabilities and COVID-19 provisions would be a perfect match for the caliber of research she was hoping to complete. After teaming up with the Center and receiving a grant from Case Western Reserve for her research project, Zhang and her team began running molecular dynamics simulations to study possible roles beta defensins could play in combating the coronavirus.

"Without the subsidized resources from OSC on our COVID-19 project, we wouldn't have been able to do as much. We wouldn't have been so efficient," Zhang said.

Because of the preliminary findings that Zhang's lab has completed, her team has applied for several more grants to continue to work on designing beta defensin-based peptides that could be used in drugs to fight the coronavirus.
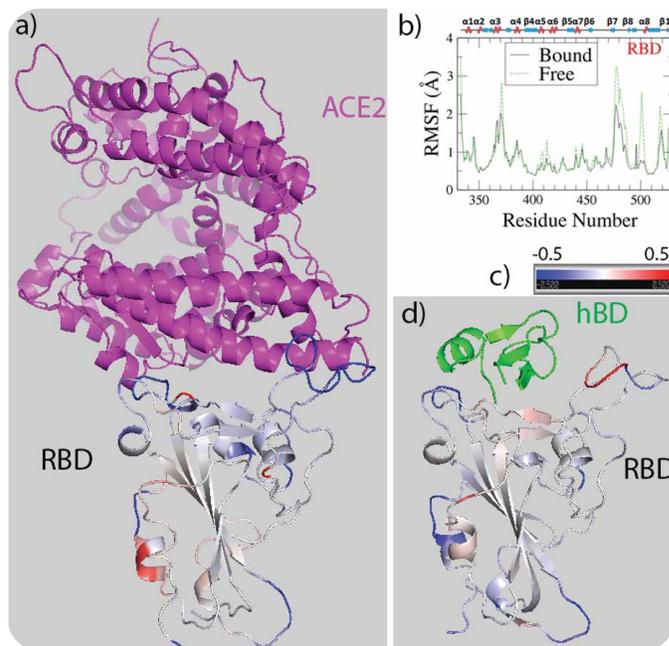
"Because defensin is secreted from the human immune system, if we were to use it in a drug for COVID-19 it would not cause as many side effects and would be more compatible with the human body," Zhang said. •

Project Lead: Liqun Zhang, Ph.D., Tennessee Tech University
Title: Novel Endogenous Beta Defensin Based Therapeutics to Treat COVID-19 Patients
Funding Source: Case Western Reserve University and Tennessee Tech University
Website: tntech.edu/directory/engineering/faculty/liqun-zhang.php

Statewide Users Group

Photo: IBM's Raj Krishnamurthy, delivered the Fall 2019 SUG keynote address, entitled "Challenges and Opportunities: Convergence of HPC, Big Data and Machine Learning."

As the nature of research continues to evolve and increase in complexity, it is vital that investigators have access to tools and resources that are up to the task. Faculty and commercial researchers throughout the state turn to the Ohio Supercomputer Center (OSC) for its high performance computing (HPC) hardware and expertise to take their research to the next level.

The Statewide Users Group (SUG) conference on October 21, 2019, brought together OSC users to share their experiences, offer feedback and hear from OSC leaders about the progress and direction of the Center.

Held in person at OSC, the conference featured keynote speaker Raj Krishnamurthy, a senior technical staff member at IBM, detailing the convergence of HPC, big data and machine learning. Attendees had the opportunity to tour the State of Ohio Computer Center (SOCC) or attend one of three informative breakout sessions covering various topics on HPC usage.

OSC Executive Director David Hudak discussed the Center's progress and performance before the conference closed with the flash talk and poster competition. Featuring 10 talks and 19 posters, the final

session provided participants the opportunity to share their ongoing research that utilizes OSC resources. The first-place winners of both competitions received complimentary computing time on OSC systems.

The spring SUG conference, originally scheduled for April 2020, was cancelled as a result of COVID-19, with plans to move the fall event online in order to protect the health of both attendees and staff.

SUG Conference Winners

Fall 2019 Flash Talks

Each flash talk participant had six to eight minutes to walk through their presentation. Coming in first place was The Ohio State University's Lifeng Jin for his presentation "Large Scale Simulations of Language Acquisition."

Taking second place was Joseph Smith, also of Ohio State, for his presentation titled "Optimizing Laser-Plasma Interactions with Evolutionary Algorithms and Particle-in-Cell Simulations."

Fall 2019 Posters

Out of the 19 posters submitted, Ohio State's Danielle Parsons won first place with her poster titled "Predicting Cryptic Diversity within Class Mammalia."

In second place was Sanket Walujkar of Ohio State with a poster titled "Non-Equilibrium Molecular Dynamics Simulations of TMC1, an Inner-Ear Transduction Channel Candidate."

Photo top: Rajendra Thapa of Ohio University presents his poster on his research titled "Applications of inversion with diffraction data to study complex systems."

Photo center (from left to right): Joseph Smith, OSU; Lifeng Jin, OSU; Brian Guilfoos, OSC; Danielle Parsons, OSU; Sanket Walujkar, OSU.

Photo bottom: Sanket Walujkar of Ohio State delivers his flash talk titled "Non-equilibrium molecular dynamics simulations of TMC1, an inner-ear transduction channel candidate."

Education and Training

Education

Research that utilizes the Ohio Supercomputer Center's (OSC) resources spans a variety of disciplines, including medicine, business, computer science, economics, engineering, chemistry, mathematics and physics. For students at numerous institutions, these research programs play an integral role in their education. Poster and flash-talk competitions held at OSC twice yearly provide students and faculty the opportunity to present their work and hone their abilities in science communication.

Summer Youth Programs

OSC has hosted the annual Summer Institute (SI) since 1989 and the Young Women's Summer Institute (YWSI) since 2000. These programs encourage Ohio high school students and middle school girls to engage with high performance computing (HPC) and STEM education through first-hand experience.

SI is a two-week residential summer program for high school students entering their sophomore, junior or senior years. Participants learn programming languages, parallel processing techniques and visualization toolkits. YWSI is a weeklong program for middle school girls centered on developing computing, math, science and engineering skills through hands-on projects. OSC made the difficult decision to cancel SI and YWSI in 2020 to ensure the safety of students and staff and is currently exploring the safest approach for these programs in the upcoming year.

Virtual Computer Labs

OSC staff regularly make classroom accounts available to assist faculty and student researchers as they utilize HPC in their courses. In 2019–20, more than 1,800 students from 14 different Ohio universities gained hands-on experience with supercomputing in at least 75 courses.

During the COVID-19 pandemic, many classes went to a remote format, putting up a barrier to completing work in the lab environment. OSC responded by providing access to its cloud computing resources at no charge to numerous classes to ensure students can access lab environments from home. For example, Kent State University utilized OSC's virtual computer labs in several courses to provide students with a uniform lab experience during the fall 2020 semester.

Workshops

To promote the continued adoption of HPC, OSC staff members offer workshops, one-on-one classes, web-based training and consulting services to users and potential users. Topics covered include getting started using OSC, containers for research computing and performance tuning. This year, these trainings and workshops moved to a remote setting, a development that has expanded access to these resources. Fifteen training opportunities were offered with over 300 participants in attendance.

Photo left: Students outside at the Summer Institute; Photo center: Students pose in the State of Ohio Computer Center; Photo right: Students use OSC OnDemand in a lecture.

User Services

Office Hours

For answers to specific questions about research done on Ohio Supercomputer Center (OSC) systems or for advice on simply getting started, clients can speak directly with OSC experts.

In-person consultations have shifted to a virtual environment until further notice. Visit osc.edu/events to see the full schedule of office hours and sign up for a time.

Consulting

As professionals in high performance computing (HPC) and software engineering, OSC's staff has deep expertise in developing and deploying software that runs efficiently on large-scale cluster computing platforms. They are available to advise on advanced debugging or code optimization.

Technical Support

OSC also provides clients with training support in the form of an online FAQ, a web-based knowledge base and a remote help desk. Staffed by members of OSC's HPC Client Services group, OSC Help features Level-1 basic support and Level-2 advanced support Monday through Friday, 9 a.m. to 5 p.m. These services can provide onboarding for new users, deliver system status updates and help clients resolve

Photo: OSC Client Engineer Wilbur Ouma, Ph.D., adapted his HPC training programs for a virtual environment and coordinated resources for COVID-19-related research.

issues such as debugging, software installation and workflow improvements. OSC Help is available by email at oschelp@osu.edu or by phone at 1-800-686-6472. Follow @HPCNotices on Twitter to get real-time system status updates directly from OSC.

Research Collaboration

Staff members at OSC often collaborate with researchers around the state on various research and education projects. This year, OSC's experts acted quickly to support investigators studying COVID-19.

OSC Client Engineer Wilbur Ouma, Ph.D., coordinated all COVID-19 projects at OSC to ensure that requests for computational access, storage, and technical assistance were provided in a timely manner. Notably, he coordinated a multidisciplinary team from OSC and Ohio State's College of Public Health that developed COVID-19 epidemiological simulation and modeling dashboards used by state and county health officials. Additionally, Ouma provided onboarding training that enabled new OSC users to start using the resources as soon as possible.

Software & Research Collaboration

The Ohio Supercomputer Center (OSC) staff has experience with several computing languages, programming models, numerical libraries and development tools for parallel/threaded computing and data analysis. They are available for consulting or collaboration and are happy to help tackle client coding problems or reduce the runtime for analyses.

The Scientific Applications group at OSC helps to optimize and scale codes for academic research groups. Examples include the following:

- Develop scalable and high-performance communication mechanisms for HPC and AI applications, led by Dhabaleswar Panda, Ph.D., professor and distinguished scholar of computer science at The Ohio State University

- Automate high-resolution terrain generation, led by Ian Howat, Ph.D., director of the Byrd Polar & Climate Research Center at Ohio State

- Provide strategic, high-fidelity computational aerodynamics capabilities for the United States Air Force Research Laboratory, led by Datta Gaitonde, Ph.D., Ohio Research Scholar and John Glenn Chair of the Department of Mechanical and Aerospace Engineering at Ohio State

- Optimize and extend data analysis software for building and selecting models to predict soil properties, led by Scott Demyan, Ph.D., School of Environment and Natural Resources at Ohio State

To enable an increasing number of user communities to productively carry out their research, the Center maintains a broad assortment of applications, including more than 200 different software packages. About 20 of these are licensed packages. The OSC website features getting started guides for most of the software supported.

OSC staff members update and test these software packages regularly. To see the complete list of software, please visit our website.

Top Apps

By CPU Hours

VASP
LAMMPS
WRF
OpenFOAM
Amber
QChem
CP2K
Python/Jupyter

By Number of Users

R/Rstudio
Python/Jupyter
Gaussian
SAMtools Matlab
LAMMPS
Bowtie

Top App Areas

By CPU Hours

Molecular Dynamics
Quantum Chemistry
Computational Fluid Dynamics
Data Analytics

By Number of Users

Data Analytics
Quantum Chemistry
Molecular Dynamics
Bioinformatics

Gateways Development

The expert gateways development team at the Ohio Supercomputer Center (OSC) helps clients create custom web interfaces to simplify the use of high performance computing (HPC) resources, allowing data to be the main focus. Simplifying workflows allows users to dive into finding solutions and making breakthroughs in their research.

OSC OnDemand

ondemand.osc.edu

OSC OnDemand is a web-based portal that equips users with seamless, flexible access to HPC computing and storage services at OSC. Users can upload and download files, as well as create, edit, submit and monitor jobs.

"Lack of a web-interface in HPC led to the perception that HPC work was lagging behind in ease of use. Scientists and engineers would rather spend their time advancing their disciplines than learn HPC. Many students have always used web-based graphical user interfaces (GUIs) and are not interested in spending time learning about file systems, directories, and command line entries," said Alan Chalker, Ph.D., director of OSC Strategic Programs. "Developing an easy-to-use web-based interface is lowering the barrier to entry so that students, commercial clients, and government researchers have access to OSC supercomputer cluster systems."

In 2015, OSC was awarded a National Science Foundation grant (NSF #1534949) to develop an open-source version of the application that could be shared with other HPC facilities. The 1.0 version of Open OnDemand launched in 2017.

Open OnDemand

openondemand.org

A 2019 follow-up project award, Open OnDemand 2.0 (NSF #1835725), has enhanced resource utilization visibility and extended to more resource types and institutions. Other new developments include web portal enhancements, integration of the XD Metrics OnDemand tool (XDMoD) developed at the University of Buffalo's Center for Computational Research, portal extension to provide methods of access for other science domains and improvements to the scaling of the system.

The Open OnDemand portal has already been successfully downloaded by more than 200 HPC facilities around the world, including at least 135 located in the United States.

MyOSC

my.osc.edu

The MyOSC client portal serves as OSC's accounting and account management infrastructure. With MyOSC, clients can self-sign up for accounts, manage user access to research projects, report funding and publications relevant to their use of OSC services, annotate jobs and run custom reports on usage.

In July of this year, OSC deployed a new version of MyOSC. Notable changes include elimination of the grant application process for Ohio faculty researchers, introduction of project budgets, an "org fiscal ID" field for use by institutions, and the introduction of credit functionality. Additionally, Resource Units and allocations were eliminated. OSC set subsidized prices for all services and added annual per-faculty credits to offset fees incurred. New administrative workflows were also added to ensure universities have the ability to approve and set budget limits on resource usage to prevent unexpected charges.

Each project in my.osc.edu now features an automated budget balance, updated daily, that will indicate the remaining dollar balance of a project's budget. Users can now run reports for custom time frames to determine charges for corresponding jobs. Certain types of clients also have the ability to set unlimited budgets if need be.

233 M+
Cluster CPU Core
Hours
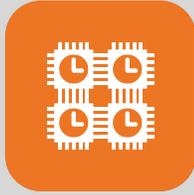
4.5 M+
Huge-Memory
Core Hours

1.5M+
GPU Hours

200+
Software
Packages

87%
Average System
Utilization

99.7%
Availability*

Hardware Services

Cluster Computing

A leader in high performance computing and networking, the Ohio Supercomputer Center (OSC) serves as a vital resource for Ohio's researchers. With flexible and scalable clusters rivaling those found at National Science Foundation centers and other national labs, OSC supercomputers provide a peak computing performance of 5.5 petaflops.

Dedicated to growth, OSC deployed a $4.3 million expansion to the Pitzer cluster over the summer. This grew the cluster to more than 650 nodes and almost 30,000 cores in total. New features include the installation of Xeon Cascade Lake processor-based nodes, engineered to handle large data sets and enable real-time transactions as well as provide high-performance inference and vision for AI workloads.

In October, the Center decommissioned the Ruby Cluster. The $1.5 million system was built in 2014 and ran more than 2 million jobs over six years. The cluster was named after Ruby Dee, a Cleveland-born actress, author and civil rights advocate. During its use, the Ruby Cluster accelerated research ranging from mechanical and aerospace engineering, protein structure predictions, computational fluid dynamics and more.

Research Data Storage

OSC partnered with IBM in 2019 to expand the center's high performance computing (HPC) storage capacity by 8.6 petabytes for a total file-storage capacity of about 14 petabytes over several file systems. Engineers are working to develop a remote data backup site for the home and project directories at a location geographically distant from the Center to ensure data security and availability.

OSC also offers HPC clients more than 10 petabytes of backup tape storage, plus the potential for another 10 petabytes through the purchase and installation of additional tapes.

OSC's Protected Data Service (PDS) is designed to address the most common security control requirements encountered by researchers while also reducing the workload on individual PIs and research teams to satisfy these requirements. OSC currently supports protected data types including International Traffic in Arms Regulations (ITAR), Export Administration Regulations (EAR), Health Insurance Portability and Accountability Act of 1996 (HIPAA), personally identifiable information (PII) and proprietary data.

*includes planned outages

75%
of Jobs Started
Within 30 minutes

5.7 PB
Stored on Disk

3.4 PB
Data Transferred

65%
Average Storage
Utilization

Supercomputers

Students, faculty, scientists, engineers and clinicians depend on these Ohio Supercomputer Center systems:

Owens Cluster

- Date: 2016
- Cost: $7 million
- Theoretical Performance: ~1.6 PF
- Nodes: 824
- CPU Cores: 23,392 Intel Broadwell
- RAM: ~120 TB
- GPUs: 160 NVIDIA Pascal P100

Pitzer Cluster

- Date: 2018
- Cost: $3.4 million
- Theoretical Performance: ~1.3 PF
- Nodes: 260
- CPU Cores: 10,560 Intel Skylake
- RAM: ~70.6 TB
- GPUs: 64 NVIDIA Volta V100

Pitzer Cluster Expansion

- Date: 2020
- Cost: $4.3 million
- Theoretical Performance: ~2.6 PF
- Nodes: 398
- CPU Cores: 19,104 Intel Cascade Lakes
- RAM: ~93.7 TB
- GPUs: 102 NVIDIA Volta V100

Total:

- Cost: $14.7 million
- Theoretical Performance: ~5.5 PF
- Nodes: 1,482
- CPU Cores: 53,056
- RAM: ~284 TB
- GPUs: 326

"OSC is a critical partner in advancing Ohio's knowledge economy. Kimberly Murnieks, director of the Ohio Office of Budget & Management, described the Center as one of several "projects of statewide benefit" in testimony to the Ohio House and Senate finance committees. She highlighted the Center's $7.2 million 2021 capital bill appropriation, which OSC will use to upgrade hardware and further increase security over the next two years."

— David Hudak, OSC Executive Director

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oh-tech.org/blog

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osc.edu

Ohio Supercomputer Center
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of the Ohio Department of Higher Education.

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