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FROM THE DEPARTMENT HEAD

We survived — and sometimes surviving is a major win and this year was one of those times.

On the downside our student enrollment did drop from 664 in fall 2019 to 618 in fall 2020, with 77% of the reduction in the freshman class. But fortunately this was much better than the dire predictions of last summer.

For bright spots in the numbers, 2020-2021 saw another large graduating class with more than 110 new CS graduates, as well as 12 Ph.D. and 15 M.S. graduates. Our freshman-to-sophomore retention rate held steady at 88.6%, while our four-year graduation rate has risen to 46.6% from 13% only four years ago. This is a huge improvement and a testament to the hard work and dedication of our faculty and advisors.
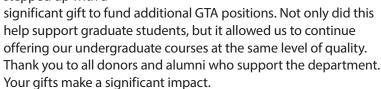
We added instructor Emily Alfs-Votipka, one of our Ph.D. students, as a new teaching faculty member. She is involved with developing and teaching computational core courses, but will also step into the classroom next year with our introductory class, CIS 115.

Despite any obstacles, our faculty and students continued to make outstanding progress, some of which we've documented in these pages. You'll get to meet Ratan Lal, Pavithra Prabhakar's Ph.D. student, who graduated this spring and won the first department Distinguished Graduate Research Award. You'll read about how Pascal Hitzler and his post-doc, Cogan Shimizu, helped to launch an online database on the history of slavery. And you'll learn about the major research grant successes of our faculty as well as those who were named as new research and teaching scholars.

After alarming predictions about the financial impact of COVID on the state of Kansas and the university in particular, I am happy to report things did not turn out as badly as initially thought. One area particularly concerning going into last fall was the 50% reduction in our budget for graduate teaching assistantships, or GTAs. GTAs are critically important to delivering a high-quality education, and loss of associated stipends and tuition waivers would have brought great financial hardship to several of our graduate students.

Thankfully K-State engineering alumnus Nick Chong, head of Global Support and Services at Zoom Video Communications, stepped up with a significant gift to fund additional GTA positions. Not only did this help support graduate students, but it allowed us to continue offering our undergraduate courses at the same level of quality. Thank you to all donors and alumni who support the department. Your gifts make a significant impact.

Yes, this year was interesting for K-State computer science. However, I was extremely pleased with how faculty, staff and students came together to overcome each and every obstacle. I truly believe this whole COVID experience has made us stronger and better prepared to face the challenges and opportunities of tomorrow.

And as always, it's a great day to be a K-State computer scientist!

Scott DeLoach
Department head and professor

CS@K-STATE

ABOVE: STUDENTS WORK TOGETHER ON AI AND DATA SCIENCE LAB PROJECT.
ON THE COVER: WILLIE THE WILDCAT VISITS WITH STUDENTS IN CS LAB.

A FOCUS ON SAFETY AND SECURITY

In three joint efforts, computer science professors Robby and John Hatcliff have been awarded more than $1 million dollars for U.S. Department of Defense-related projects.

Tool development for Defense Advanced Research Projects Agency

Two Kansas State University professors of computer science have been awarded $231,000 for a two-year period by the U.S. Department of Defense – Defense Advanced Research Projects Agency for development of tools that will assure the safety and security of mission-critical software.

The project, "Software Implementation from Rigorous Formal Usable Requirements (SIRFUR)," which includes funds for an optional third year and an anticipated award of up to $693,000, will be led by Robby, professor and Don and Linda Glaser – Carl and Mary Ice Keystone research scholar, with co-investigator John Hatcliff, university distinguished professor and Lucas-Rathbone professor in engineering.

The SIRFUR tools will be used to specify and verify behavioral properties of Department of Defense system implementations. While application of other logic-based techniques requires highly paid experts with specialized doctoral degrees, SIRFUR has a unique approach that emphasizes usability. It integrates automated deduction techniques in a non-obtrusive way in widely used software development tools so that typical industry engineers have the benefits of automated logic-based verification while still using tools and processes familiar to them.

Read more at **bit.ly/ToolsforSafety**.

ROBBY

Building safety-critical systems for use in military operations

Two Kansas State University professors of computer science have been awarded just over $400,000 for two years by the U.S. Department of Defense – Army for development of techniques in building safety-critical systems used in military operations.

The project, "Grand Unified Modeling of Behavioral Operators (GUMBO) SBIR Phase 2" funded under the Adventium Enterprises LLC program, will be led by John Hatcliff, university distinguished professor and Lucas-Rathbone professor in engineering, with co-investigator, Robby, professor and Don and Linda Glaser – Carl and Mary Ice Keystone research scholar.

"The behavior description notation is easy for developers to use and understand, but is based on advanced logics that can be

JOHN HATCLIFF

automatically processed by computer verification tools," Hatcliff said. "When components obtained from different suppliers are integrated into a system, these verification tools can prove that important behaviors of each component work correctly with those of other components and that key functionality of the overall system is achieved."

This behavior specification and verification framework incorporates the Architecture Analysis and Design Language — a modeling language incorporated into multiple uses by the Army, including its Future Vertical Lift program. Future Vertical Lift, a plan to develop a family of military helicopters for the U.S. Armed Forces, involves sharing common hardware such as sensors, avionics, engines and countermeasures for five different sizes of aircraft under development.

Read more at **bit.ly/SafetyCriticalSystems**.

International team works to strengthen DOD systems against cyberattacks

Computer science professors, Robby and John Hatcliff, are part of an international team selected for the capstone phase, or phase three, of the DARPA Cyber-Assured Systems Engineering, or CASE, program.

Robby, professor and Don and Linda Glaser – Carl and Mary Ice Keystone research scholar, and Hatcliff, university distinguished professor and Lucas-Rathbone professor in engineering, and the team led by Collins Aerospace, which includes Adventium Labs, Data61 — Australia's leading digital research network — and the University of Kansas, will partner in the contract extension that fully realizes the pairs' $950,000 Collins' subcontract with Adventium Labs for the August 2018 – April 2021 period of performance.K-State's share in this funding is $375,000.

In addition, Collins Aerospace has continued to support Robby and Hatcliff's sabbatical work by awarding an additional $550,000 for the period of August 2020 – February 2022. This new award includes partial funds for research associates and graduate research assistants to support work on the DARPA CASE Phase 3 projects.

The DARPA CASE program aims to develop system modeling, analysis, code generation and verification techniques that will help engineers harden critical systems, including Department of Defense systems, against cyberattacks. In DARPA CASE Phase 3, code generation, analysis and verification tools built by the K-State team will be used to develop cyber-resilient mission control software for an experimental version of an in-use military aircraft platform.

Read more at **bit.ly/StrengtheningDoDSystems**.

CS INITIATIVE

Expanding programming offerings to small colleges, high schools

An initiative at K-State could soon bring university computer programming courses to high schools and small colleges across the state, providing students with an in-demand job skill.

K-State's Computational Core Initiative, offered by the computer science department in the Carl R. Ice College of Engineering, is a set of programming courses designed to provide students of any major with the fundamental knowledge to utilize programming in a variety of situations. The courses focus less on programming theory, so advanced mathematics classes such as calculus are not required — college algebra is sufficient.

"Programming is the skillset that makes students stand out in the 21st century job market," said Scott DeLoach, professor and department head of computer science. "The use of computers to solve problems is a key part of the modern, technology-driven workplace."

While the initiative's original goal was to integrate computer science classes into other degree programs offered at K-State — which has happened with a certificate program offering a new integrated computer science degree — the initiative's vision has expanded.

Through the Computational Core Initiative's Academic Partners Program, K-State computer science courses saw enrollment success at Manhattan Christian College this past spring, with upcoming plans to offer the courses to more small colleges regionally.

The Computation Core Initiative is multifaceted in that it uses the same basic courses to make computer science available to non-computer science majors online, on campus and throughout the region at smaller colleges lacking resources or expertise to offer their own classes in this area.

At the high school level, the initiative's Cyber Pipeline program was piloted at Manhattan High School in fall 2020 with 18 students enrolled in the first course through a hybrid setup. The students learned online but also had a teacher in their classroom to help with questions. Enrollment for the spring semester was 12 students, all attending class in person.

Cyber Land-Grant University

Cyber 4H & Cyber Pipeline

CS, Applied CS, Cybersecurity, CS Tech

Teacher Education

Certificates/Degree Completion, Micro Credentials

Research & Investment

Teachers — Agents

Elementary Students

Middle School Students

High School Students

College/Tech Students

Adults *New Jobs Advancements Keeping Current*

Industry

> "The use of computers to solve problems is a key part of the modern, technology-driven workplace."
> —SCOTT DELOACH

Both Manhattan High School and Basehor-Linwood High School in Leavenworth County have signed onto the program for the 2021-2022 school year.

"Our vision is for computer science to be taught in all high schools in Kansas at no cost to the students," DeLoach said. "Right now we are projecting a $100 cost to school districts for each student in a yearlong course. In the coming years we are expecting even more high schools across the state will be on board, with possibly even a Missouri high school now that K-State is offering in-state tuition to Missouri residents."

Prospective high school teachers and administrators can find more information at **bit.ly/Cyber-Pipeline**.

DeLoach has plans to expand the initiative's outreach even further.

"We basically want to provide a set of highly modular educational components that can be integrated into computer-related education from middle school through college, and even adult education," he said.

DeLoach cited for top university honor

Scott DeLoach, professor and head of computer science, is the recipient of the 2021 Kansas State University Presidential Award for Outstanding Department Head.

DeLoach has worked to boost the department's enrollment, expand its undergraduate and graduate academic programs, increase scholarship funding, strengthen diversity and inclusion efforts, and improve facilities and infrastructure.

Under his leadership, department enrollment has increased nearly 30%, including a nearly 6% increase in multicultural student enrollment. CS doctoral graduates have increased more than 50% in the last five years and a new scholars program has provided more than $100,000 in scholarships. New academic initiatives include the ability to earn both a bachelor's degree in computer science and an MBA in five years, cybersecurity and entrepreneurship options for students, and launch of a certificate in computer science as well as creation of an online master's degree.

DeLoach has added 10 new faculty, converted three instructors into teaching assistant professors, created professional advisor positions and increased the budget for staff development. Refereed publications by faculty and graduate students have increased 100% in the last five years, while research expenditures are up by approximately 20%. He has also led efforts to improve CS laboratories and install the latest instructional hardware and software.

Enslaved | Peoples of the Historical Slave Trade

CS team continues design effort for online database

Pascal Hitzler, professor and Lloyd T. Smith creativity in engineering chair in the computer science department at Kansas State University, and his postdoc, Cogan Shimizu, will continue in their subcontracted role of ontology design for the online database Enslaved.org, which has been awarded a grant expansion.

Michigan State University recently shared the new $1.4 million expansion that will run through March 2023 and extend the reach of the project. This will be done by refining the infrastructure; publishing more datasets and narrative stories; introducing new features for visualizations; driving sustainability; strengthening a commitment to the inclusion of underrepresented voices in humanities scholarship; and continuing partnerships with scholars, heritage and cultural organizations, and the public.

The database collects archives and entries documenting the lives of those who were enslaved, owned slaves or participated in slave trading. The K-State team was in charge of developing the model for the database, which dictates how the data is organized and how Wikipedia-style browsing of the historical records is enabled.

"Enslaved: Peoples of the Historical Slave Trade" at Enslaved.org was launched Dec. 1, 2020, and is sponsored by The Andrew W. Mellon Foundation. Matrix: The Center for Digital Humanities and Social Sciences, and the history department, both at Michigan State University; the University of Maryland; and multiple other scholars at various institutions plan to overcome the challenges of databases with five objectives for the site:

- **The people** — focuses on recognition and identification
- **Linked open data** — facilitates federated searching and browsing across all linked project data and supports preservation of current and future slave data projects
- **Best practices and workflow** — not yet agreed upon by scholars due to the rapid pace of online database projects
- **Scholarly recognition** — ensures quality of data
- **Preservation and sustainability**

More information about the project can be found at **enslaved. org/about**.

ASSOCIATE PROFESSOR AWARDED GRANTS FROM NASA AND NSF

Pavithra Prabhakar, professor in computer science, will focus her research on intelligent and robust aircraft, as well as artificial intelligence-based controllers.

NSF research on artificial intelligence-based cyber-physical systems

Pavithra Prabhakar, professor and Peggy and Gary Edwards chair in engineering in the computer science department at K-State, has been awarded $450,000 from the National Science Foundation to work on artificial intelligence-based controllers in the three-year project, "Scalable Formal Verification of ANN Controlled Cyber-Physical Systems."

Artificial intelligence-based controllers, increasingly used for modern-day cyber-physical and autonomous systems such as driverless cars, are called on to perform sophisticated functions and operate in highly dynamic environments. Use of such controllers in driverless cars is highly safety-critical, where the vehicle is expected to not only stay in the correct lane but avoid collisions with other vehicles and pedestrians crossings roadways under varying lighting conditions.

Prabhakar's research will provide correctness guarantees of artificial intelligence-based controllers using foundational mathematical analysis techniques known as formal methods. The project will develop algorithms that can analyze these systems by drastically reducing network size and representing them with a novel data structure.

Read more at **bit.ly/PavithraNSF**.

NASA project for design of intelligent aerospace control systems

With an immediate need for intelligent and robust aircraft controllers resilient to mid-air disturbances such as wind, turbulence and sensor noise, NASA has provided a $750,000 grant to a team of Kansas researchers for development of certified, artificial intelligence-based controllers for aerospace systems.

Pavithra Prabhakar, professor and Peggy and Gary Edwards chair in engineering in the computer science department, will take the lead at Kansas State University on the project "Evolving and Certifiable Autopilot for Unmanned Aerial Systems, Phase II."

Collaborators on the NASA-supported research are Willem Anemaat, president of the DARcorporation, an aeronautical engineering firm in Lawrence; and Shawn Keshmiri and Heechul Yun, faculty members at the University of Kansas. The team will develop machine learning-based controllers to improve the performance of traditional controllers in fixed-wing, unmanned aerial systems by adapting to stimuli in the environment.

Read more at **bit.ly/PavithraNASA**.

FACULTY AWARDS

Four faculty members from computer science have joined the prestigious ranks of those holding named positions in the Carl R. Ice College of Engineering.

Nathan Bean
Instructor/advisor
Richard B. and Mary Jo Myers Cornerstone Teaching Scholar

Nathan Bean has 10 years of experience in the software development industry creating full-stack web applications for Envisage Consulting and Wellspring Web Design. His primary area of research is at the intersections of education and computing, especially use of computers, simulations and games as learning tools. Bean has developed a number of courses for the computer science department including *Introduction to Computer Science, Foundations of Game Programming, Game Engine Design and Web Interface Design.*

Julie Thornton
Instructor/advisor
David and Lynda Dawson – Carl and Mary Ice Cornerstone Teaching Scholar

Julie Thornton received bachelor's degrees in computer science and mathematics from Kansas State University in 2003. In 2005 she completed a master's degree in computer science, also from K-State.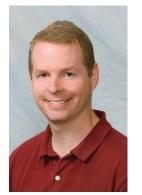 Thornton is not currently active in research, but as an undergraduate and graduate student, she was part of the Knowledge Discovery in Databases group in the department of computer science. With this group she helped develop BNJ, an open-source software development toolkit for research in probabilistic learning and inference using Bayesian networks. Her master's thesis was on edge-deletion algorithms for Bayesian network inference.

Robby
Professor
Don and Linda Glaser – Carl and Mary Ice Keystone Research Scholar

Robby joined the department of computer science at Kansas State University as an assistant professor in 2004. He works in the general area of formal methods, software engineering and programming languages, with a focus on specification and verification techniques for high-assurance, high-integrity software systems. He has worked on user-friendly formal languages for describing software correctness properties and algorithms that provide orders-of-magnitude cost reductions for assuring complex software, while significantly increasing confidence and trustworthiness of such assurance techniques.

Dan Andresen
Professor
Michelle Munson-Serban Simu Keystone Research Scholar

Dan Andresen is a professor of computer science and director of the Institute for Computational Research. His research in distributed systems ranges from sensor networks monitoring bovine health levels to high-performance computing systems. His work often intersects with his role as director of the Institute for Computational Research in Engineering and Science, which oversees the campus research HPC cluster, Beocat, and strives to build a cyberinfrastructure foundation to allow K-State to successfully compete at the national level. Andresen's research partnerships extend beyond computer science to civil engineering, biology, agriculture, biochemistry, physics and geography, and beyond K-State to Nebraska, Oklahoma, Missouri and Arkansas.

GRADUATE STUDENT SPOTLIGHT

Computer science doctoral candidate Ratan Lal has been recognized with two awards related to his research efforts.

Lal was one of two recipients in the Carl R. Ice College of Engineering of the Gattani Outstanding Graduate Student Award for graduate students who have demonstrated excellence in research in engineering and/or made significant impact to the graduate student population.

The award, established by alumnus Sanjay Gattani, civil engineering M.S. '87 and Ph.D. '93, supports Kansas State University, the Carl R. Ice College of Engineering and graduate students, recognizing outstanding contributions in research and graduate education. Recipients receive a certificate and cash award of $1,000.

Lal also received his third csrankings.org recognition, earning him the Distinguished Graduate Research Award for the paper "Formally Verified Switching Logic for Recoverability of Aircraft Controller," written in collaboration with his advising professor in computer science, Pavithra Prabhakar.

The work was accepted for the CAV 2021 33rd International Conference on Computer-Aided Verification where Lal will be formally recognized and receive a $2,000 scholarship.

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