

ANNUAL REPORT



2020

LETTER FROM LEADERSHIP

It is our pleasure to highlight the achievements of the Laboratory for Innovation Science at Harvard (LISH) for the last 18 months. The lab had unprecedented growth and accomplishment, with the publication of 28 articles, papers, and cases, the development of three courses, execution of four practitioner-focused events, hosting of 19 new visitors, placement of two RAs in prestigious PhD programs, faculty placements for three postdoctoral LISH researchers, and the addition of HBS Professor Marco Iansiti as Co-Director of the lab.

The success of the lab can be attributed to the multidisciplinary team and the unique dual-purpose approach the lab takes in conducting research. While rooted in social science, an interdisciplinary team of researchers collaborate with industry and academic partners to explore questions across domains, such as healthcare, computer science, finance, and aerospace. Together, researchers conduct rigorous field experiments while simultaneously extracting key insights to drive organizational operations.

This past year, our work in open innovation and artificial intelligence in healthcare reached an important milestone with the publication of the "Use of Crowd Innovation to Develop an Artificial-Based Solution for Radiation Therapy Targeting" in *JAMA Oncology*. The paper found that on-demand crowdsourcing methods can be used to rapidly prototype artificial intelligence algorithms that can replicate the results of an expert radiation oncologist in targeting lung tumors, while reducing associated time costs by 75% – 96.8%.

LISH staff and researchers continued to push the boundaries on pedagogy development, addressing technology commercialization, artificial intelligence, and crowdsourcing in online and in-classroom settings. In Spring 2019, we debuted the *Launching Breakthrough Technologies* massive open online course (MOOC), a first for the lab, which allows students to explore how entrepreneurs match promising technology with customer needs to launch a successful new business. A revised version of the course, launched in April 2020, currently has over 45,000 participants enrolled.

We continue to advance understanding and research on knowledge sharing and production with a special focus on academic science. This year, we developed a study on the long-term outcomes of serendipitous encounters between scientists based on a field experiment we ran with Harvard Catalyst in 2012. We sought to understand how these "chance" encounters led to knowledge transfer and diffusion among 15,817 scientist pairs at Harvard. Findings from this experiment have been published as a working paper "Engineering Serendipity: The Role of Cognitive Similarity in Knowledge Sharing and Knowledge Production."

Like many of those impacted by the global pandemic, LISH researchers looked to make a difference in not only understanding the wide-ranging effects of COVID-19, but also worked in partnership with research and industry leaders, such as the Broad Institute and Topcoder to contribute to the development of treatments for the disease. Together, researchers ran a crowdsourcing contest leveraging a unique data set developed by the Broad Institute's Connectivity Map group to explore and answer questions related to potential treatments to COVID-19. The contest is a continuation of a partnership with the Connectivity Map Group who, for the past five years have provided a wealth of data and insights for non-domain experts to develop algorithms for more accurate predictions and pathways to produce better drug discovery in the "wet" labs. A key publication in 2020, "Advancing Computational Biology and Bioinformatics Research Through Open Innovation Competitions" highlights the results of these contests and presents the decision process and competition design considerations that lead to these successful outcomes.

As we celebrate our achievements from the past year, we look forward to continuing to build on our successes in the years ahead. The next year should prove to be one of the most ambitious yet, as LISH will deepen its research in foundational areas, such as open innovation and science of science, and continue to expand in recent areas of focus such as open source software and artificial intelligence.

Sincerely,



Karim R. Lakhani
Faculty Co-director
& Founder



Jin H. Paik
Program Director,
Senior Researcher

JULY 2020



Well, in many ways, the core task of any innovator, any entrepreneur, any commercializer, is to solve problems.

**KARIM LAKHANI,
LISH FOUNDER & FACULTY CO-DIRECTOR**

HISTORY

The Laboratory for Innovation Science at Harvard has its origins in the Harvard-NASA Tournament Lab and the Crowd Innovation Lab. Under the leadership of Professor Karim R. Lakhani, who specializes in distributed innovation and crowdsourcing at the Harvard Business School, the NASA Tournament Lab at Harvard University—established in 2009 as a joint initiative between NASA, Harvard Business School, and the Institute for Quantitative Social Science—was commissioned to design and field competitions or tournaments that create the best computer codes and data analytics solutions for NASA and other federal government agencies.



2009

Harvard NASA Tournament Lab established at IQSS



2010

Research cooperation with Harvard Catalyst at the Harvard Medical School



2011

Helped establish US Government Center for Excellence in Collaborative Innovation



2012

NASA Tournament Lab Renamed Crowd Innovation Lab



2016

Crowd Innovation Lab Completes Over 700 Challenges & Pioneers Field Experiments for Innovation



2017

Laboratory for Innovation Science at Harvard Established

With the creation of the lab, our researchers were able to conduct experiments into the optimal design parameters for innovation competitions of this type, facilitating the use of these tournaments within the public and private sectors. The foundation of the NASA Tournament Lab was a response to the growing value of crowdsourcing as a professional tool for technology procurement. It also reflected the efforts by NASA, recognized and supported by the U.S. government, to try new and innovative approaches to real-world software and algorithmic challenges. The mission of the lab was to cover both operation and exploration approaches to crowdsourcing.

By 2010, the Lab had expanded its crowdsourcing research and developed connections with Dr. Eva Guinan at Harvard Medical School and Harvard Catalyst, partnering with her on healthcare innovation research. In reflection of work beyond its partnership with NASA, the Lab was renamed the Crowd Innovation Lab (CIL) in 2012. CIL continued to support the development and conduct research around hundreds of innovation challenges.

The lab continued to expand its research agenda—taking on projects in patient innovation, data science, science of science, and more. In 2017, the Laboratory for Innovation Science at Harvard (LISH) was officially established as a Harvard-wide research program led by faculty co-directors Karim Lakhani, Harvard Business School; Eva Guinan, Harvard Medical School; and David Parkes, Harvard School of Engineering and Applied Sciences; with support from the Institute for Quantitative Social Science. And in 2019, Marco Iansiti, Harvard Business School joined as co-director. LISH's mission is to spur the development of a science of innovation through a systematic program of solving real-world innovation challenges while simultaneously conducting rigorous scientific research and analysis. With our partners in both academia and industry, LISH conducts research on innovation within six areas of application: Crowdsourcing & Open Innovation, Data Science & AI Development, Science of Science, Technology Commercialization, Business of Sports, and Networks.

CURRENT & PAST FUNDERS



PARTNERS



LAB STAFF, STUDENTS, & VISITORS



ZACH ALERTE



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NINA COHODES



TIM DESTEFANO



PATRICK FERGUSON



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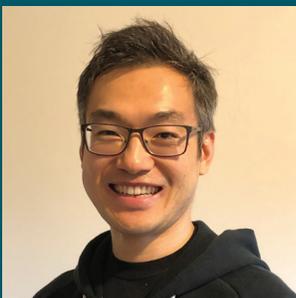
ALEXANDRA KESICK



JACQUELINE LANE



HANNAH MAYER



HIROTAKA MIURA



STEVEN RANDAZZO



SHREYAS SEKAR



THOMAZ TEODOROVICZ

“

What makes LISH a unique place to work? It's our people. Yes, we have the best and the brightest, but so much more! We have thinkers and doers. We have people who can design the most elaborate studies and find ways to execute them to drive real-world impact. Each person at the lab, from the founder to our research associates have all made valuable contributions to the workplace and the culture. It's rare to find such encouraging colleagues who want to help each other succeed!

We've been bold this year in launching many new projects and finishing some great ones! We are one step closer to having a collaborative community of virtual researchers that can study the

latest developments in technology, healthcare, and management.

Now—more than ever—we need to study innovation and partner with leading thinkers to get us through this changing world.

JIN H. PAIK



JAMES DANA



ALESSANDRA JACIMOVIC



MIKE MENIETTI



JIN H. PAIK



WEI YANG THAM



EHSAN VALAVI



LUCA VENDRAMINELLI



RUIHAN WANG

CROWDSOURCING & OPEN INNOVATION

Open innovation harnesses the principles of discovering new ideas and solutions through a distributed network of individuals to tackle the most critical problems in business, technology, and society. Unlike closed innovation, knowledge is often shared from outside traditional organizational boundaries.

through open innovation competitions” highlights the results of these contests and presents the decision process and competition design considerations that lead to these successful outcomes.

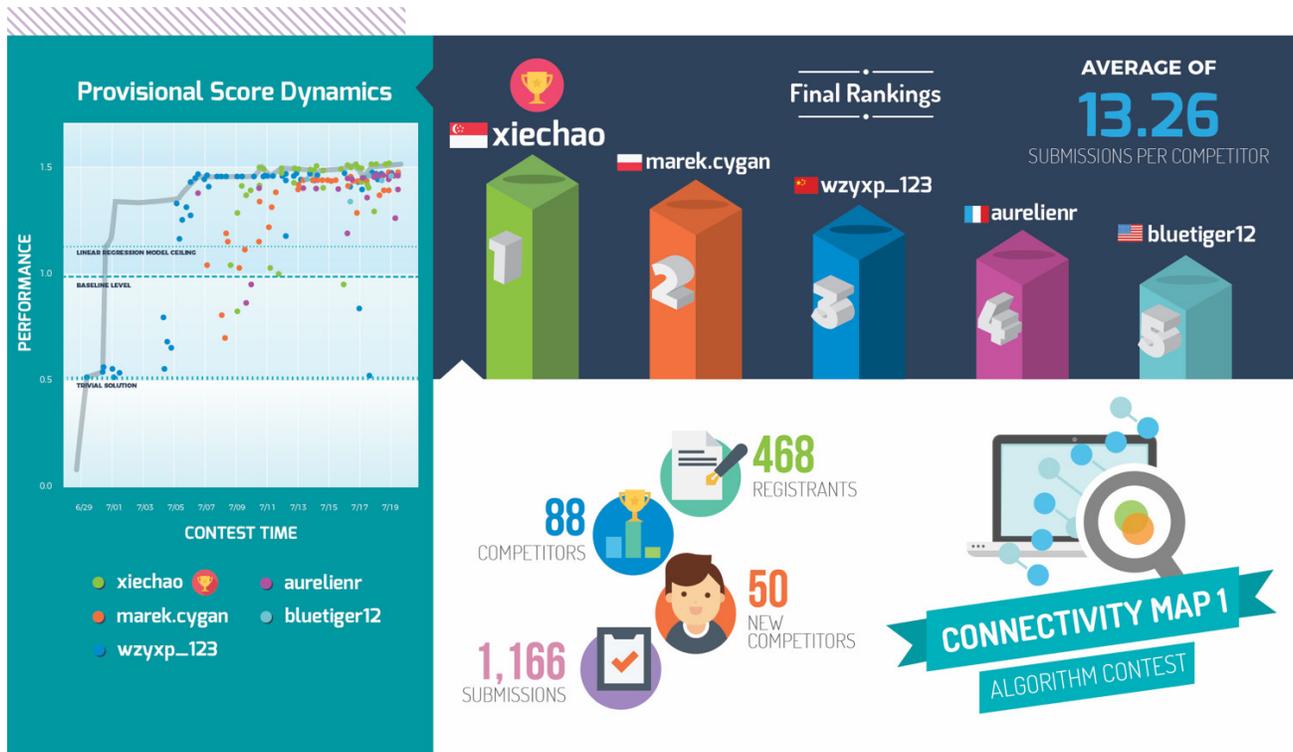
Computational Biology Challenges

LISH and the Broad Institute have partnered together for the past five years to run contests in computational biology. In particular, researchers at the Broad Institute’s Connectivity Map (CMap) Group group have provided a wealth of data and insights for non-domain experts to develop algorithms for more accurate predictions and pathways to produce better drug discovery in the “wet” labs. A key publication in 2020, “Advancing computational biology and bioinformatics research

Improving Deconvolution Methods in Biology

LISH and the CMap Group executed the D-Peak Challenge in early 2019 to develop new computational methods to address a recurring problem in biomedical research: the ability to identify biomarkers (measurable substances that are indicative of a disease). Attracting 294 competitors from 20 countries, the contest was hosted on the Topcoder crowdsourcing platform and gave contestants access to a novel dataset. The contest solutions resulted in a variety of machine learning approaches, such as convolutional neural networks

The winners and results of the first Connectivity Map Challenge.



and random forests, to more traditional approaches like Gaussian Mixtures and k-means. The top nine solutions were faster and more accurate than the benchmark and have application beyond gene expression.

NASA International Space Station RFID Localization Challenge

It may be hard to believe, but astronauts often lose track of items on the International Space Station (ISS). RFID-Enabled Autonomous Logistics Management (REALM) experiments have involved a number of different project phases and approaches aimed at improving and optimizing item storage on the ISS. This challenge was aimed at improving the algorithm for the RFID tracking system. The contest offered a combined prize purse of \$25,500 and ran for five weeks. During that time, 139 competitors registered and 25 submitted solutions. The winner of the contest developed a model that exceeded NASA benchmarks by 28%. In the real world conditions experienced on the ISS, this level of performance increase corresponds to astronauts searching through approximately half as much volume in order to locate a lost item than they would using the original algorithm.

Employee incentives on NASA's internal crowdsourcing platform NASA@work

With support from LISH and UCLA's Jana Gallus, HBS doctoral student Oliva Jung conducted a field experiment with NASA (N=11,192) to study managerial and peer-based recognition as incentives. Incentivizing

employee engagement with crowd-based innovation mechanisms can be difficult as it often requires a culture shift and extracurricular work effort. Our analysis shows that managerial recognition positively impacts engagement with the crowdsourcing platform NASA@work. Follow-up interviews suggest that (1) managerial recognition works through signaling the platform's legitimacy in a context of uncertainty and offering managerial attention and appreciation; and (2) recognition interacts with workers' job proximity to the organization's mission and can be particularly motivating for workers with distant job functions.



There are so many different approaches one might pursue in an effort to improve the accuracy of the location algorithms, however, these approaches require resources, and like most organizations, our resources are limited. So, we are very excited about the diverse set of approaches that can be rapidly evaluated for this challenging problem through crowdsourcing.

**PATRICK FINK,
REALM (RFID LOGISTICS) PRINCIPAL
INVESTIGATOR, CHIEF TECHNOLOGIST, WIRELESS
& COMMUNICATION SYSTEMS**



Manager's Tools for Scaling and Sustaining Open Innovation

Open innovation (OI) has been written about at scale by the academic community; however, adoption has largely been limited to pilot activities. "Sustaining and Scaling Open Innovation," investigates the core strategies used by NASA to scale and sustain a center of excellence that facilitates OI projects for the federal government. "Overcoming cultural resistance to open source innovation," identifies how leaders can make the transition more productive and less traumatic for incumbents. It provides language and tested methods to help senior leaders use innovative technologies to build on their core even as they explore new business models. Researchers at LISH cover managerial lessons and counterfactual costs for running contests benchmarked against 2 projects run by NASA and the US Department of Energy in "Innovation Contests as a High Tech Procurement Tool."

Freelancer.com Multimedia Case

Even though up to a quarter of US jobs can be done remotely the adoption of gig-economy solutions has been limited, especially in large enterprises. Curious about this gap between potential and practice, LISH created a case study to examine what a broader shift to freelancing and open innovation means for corporations, as well as individual workers. This multimedia case study follows Freelancer.com's decision to tailor their labor-on-demand solutions to enterprise clients, incorporating video interviews with Matt Barrie (CEO, Freelancer.com)

and other key players to bring the business context to life. Both *Managing the Future of Work* (a second-year MBA course) and *Launching New Ventures* (an Executive Education course) taught this case during the Spring 2020 semester to explore the complexities of bringing the gig-economy into the corporate world.

Innovation Science Guide

In an effort to catalyze information and knowledge sharing with those in industry and academia, the LISH launched the Innovation Science Guide, an online crowdsourced repository of white papers, presentations, and videos for content related to LISH's areas of application. Firms and individuals can submit resources to the platform for publishing. The repository hosts 70+ resources with a focus on crowdsourcing, including reports from organizations like Unanimous.ai, which explored the use of swarm intelligence to the IQ of teams, and RWTH Aachen University in Germany, which explored the market of open innovation accelerators (OIA). In addition to crowdsourcing-focused resources, the Innovation Science Guide hosts content related to innovation policy, artificial intelligence, startups and technology transfer.

In addition to resource publishing and sharing, the platform hosts one of the largest databases of crowdsourcing platforms. The Crowdsourcing Platform Finder is a tool designed to help users find the right crowdsourcing platform based on a user's needs.



[At Freelancer it's] really about setting out the right business processes to optimize and minimize the hiring risk and optimize the return you get.

**SARAH TANG,
VICE PRESIDENT OF ENTERPRISE
AT FREELANCER.COM**



Just because a project is extremely widely used, does not necessarily mean that it is extremely well supported.... That's one of the other things we have been trying to identify—not only what are the most widely used open source components and packages [in the private sector], but also how well supported and maintained those packages are.

FRANK NAGLE ON SECURITY LEDGER PODCAST
FEBRUARY 24, 2020

The user answers a series of questions and is then recommended crowdsourcing platforms that meet the user's identified criteria. While initially seeded by LISH, the Innovation Science Guide focus is to be populated, cultivated and shared by the crowd.

Core Infrastructure Initiative

Free and Open Source Software (FOSS) has become a critical part of the modern economy. It has been estimated that FOSS constitutes 80-95% of any given piece of modern software, and software is an increasingly vital resource in nearly all industries. Therefore, LISH has partnered with the Linux Foundation to conduct a census to identify and measure how widely FOSS is deployed within private and public organizations. This census provides a more complete picture of FOSS usage by analyzing private sector usage data provided by partner Software Composition Analysis (SCA) companies. Currently underway, the census project aims to identify the most commonly used free and open source software components, examine them for potential vulnerabilities, and then use this information to prioritize investments and resources to support the security and health of the FOSS ecosystem.

Crowd Online Course

In collaboration with HarvardX and Harvard Business School Online, LISH began development of an online course focused on open innovation. The course will provide learners with a foundational understanding of open innovation and crowdsourcing, a strategy that uncovers and connects problem holders to problem solvers regardless of employment status and physical location, with a focus on key implementation questions related to three types of open innovation: contests, collaborative communities, and gig platforms/labor markets.



CHRIS STANTON is Marvin Bower Associate Professor of Business Administration in the Entrepreneurial Management Unit at Harvard Business School. An applied economist, Professor Stanton directs his research at how technology is changing the management of work, particularly through the fragmentation of work and the rise of the gig economy. He has partnered with LISH to design and implement experiments with several major enterprises interested in deploying online platforms to change how work is allocated. Additionally, he recently co-authored the multimedia case study on Freelancer Ltd., one of the largest digital labor platforms, and debuted it in the second-year MBA course *Managing the Future of Work*.

DATA SCIENCE & AI DEVELOPMENT

LISH's research aims to help practitioners help understand advances in data science and AI. Along with developing AI-based projects through the crowd, LISH is paving the way for practitioners to gain insights into the value of data collection, the power of data analysis, and the importance of understanding machine predictions in creating value for firms.

AI in Enterprise Series

This fall, LISH launched a new *AI in Enterprise* series in partnership with HBS Digital Initiative, Harvard Data Science Initiative, and the Harvard School of Engineering and Applied Sciences (SEAS). In contrast to other talks on AI which focus heavily on start-ups and investment, this invitation-only series provides key insights on how enterprise firms are thinking critically and strategically about AI integration. During the first day-long event in November, attendees learned from some of the most experienced leaders in AI and finance—including Marty Chavez (Goldman Sachs), Scott Zoldi (FICO), and Sameena Shah (JP Morgan Chase).

Drawing on the lab's extensive experience running programs that develop algorithm and AI-based solutions with partners across industries—as well as subject

matter expertise from Harvard Business School faculty and partners—the event provided a uniquely enterprise-focused forum for understanding artificial intelligence for over forty practitioners in attendance.

The *AI in Enterprise* series focuses on the strategic and operational decisions that executives and senior decision makers face as they lead corporations through AI adoption and integrations. Instead of simply presenting updates on the latest technological advancements or providing general overviews, these talks provide insights from business leaders on the practical aspects of preparing for and persevering through the organizational transformations that AI and machine learning can fuel. Participants also benefit from the unique opportunity to meet and learn from their peers—in similar, as well as diverse industries.

In light of the unprecedented events of the early months of 2020, LISH continued the *AI in Enterprise* series with monthly online web conferences. Adding an ongoing community component through the creation of an online Slack discussion channel, the series incorporates even more peer-learning for attendees.

FOR A PEEK INTO THE *AI IN ENTERPRISE* EVENT FROM NOVEMBER 2019, CHECK OUT THE HIGHLIGHT REEL:

lish.harvard.edu/ai-enterprise

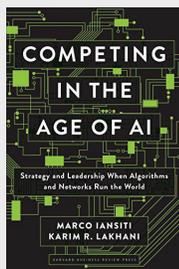


The attention around AI tends to focus on the latest technologies, but the firms that are thriving have harnessed the subtle, inherent power of AI to break down traditional operational constraints, capture new value, and accelerate growth and innovation.

MARCO IANSITI,
LISH FACULTY CO-DIRECTOR



Book & Tour



LISH faculty co-directors Marco Iansiti and Karim Lakhani kicked off 2020 with the release of their new book, *Competing in the Age of AI: Strategy and Leadership with Algorithms and Networks Run the World*, followed by an international speaking tour stopping in London, Paris, and Munich. From Airbnb to

Ant Financial, Microsoft to Amazon, the book's research shows how AI-driven processes are vastly more scalable than traditional processes, allow massive scope increase, enable companies to straddle industry boundaries, and create powerful opportunities for learning—to drive ever more accurate, complex, and sophisticated predictions.

AI Survey

Led by Timothy DeStefano, LISH is running a large scale survey on the nature of AI use by enterprises. In particular, the survey will shed light on the degree of AI adoption and the extent to which complementary investments, organizational change and management practices are conducive to using this technology. The data collected from the survey will be used in econometric analysis and will guide future research by the lab, including case studies and field experiments.

Algorithms for Radiation Therapy

In partnership with a team of researchers from the Dana-Farber Cancer Institute, Brigham and Women's Hospital, and Harvard Catalyst, LISH ran a three-phase, ten-week prize-based crowdsourcing contest on Topcoder, a crowdsourcing platform for developers, designers and data scientists, to develop an AI-based solution to address the critical and resource intensive task of tumor segmentation. Requiring substantial subspecialty training, and performed by a radiation oncologist, tumor segmentation is a key informant in the development of a patient's radiation therapy plan. And yet, the process suffers from significant interobserver variance, and showed opportunity to be made more precise. In total 45 solutions were submitted by 34 contestants through three phases of crowdsourcing contests. Solutions were then scored by comparing volumetric segmentation produced by each algorithm on a given patient's CT scan against the expert segmentation. A higher score reflected an automated segmentation for a given patient's entire tumor that has a high level of both relative and absolute overlap with the expert segmentation. Researchers identified multiple AI solutions that replicated the accuracy of an expert radiation oncologist in targeting lung tumors and performed the task more rapidly than the benchmark solution. While contest solutions reduce the time costs associated with tumor segmentation, without losing any of the accuracy associated with a physician, potential effects of adoption of such a tool include freeing time for clinicians to spend more time with patients and addressing the larger skilled oncology workforce crisis experienced by under-resourced healthcare systems worldwide. Findings of the study, "Use of Crowd Innovation to Develop an Artificial Intelligence-Based Solution for Radiation Therapy Targeting", were published in *JAMA Oncology* in April 2019.



We are trying to identify where crowdsourcing can contribute to addressing healthcare problems. That includes carefully examining whether and why the approach works to determine optimal practices for maximal impact.

**EVA GUINAN,
LISH FACULTY CO-DIRECTOR**

DATA SCIENCE TEAM



HIROTAKA MIURA is a Research Associate at Harvard Business School with a primary focus on supporting research conducted by Professor Chiara Farronato. His expertise includes applying both traditional econometric and modern machine learning methods on high-dimensional datasets in parallel computing environments. In recent years, he has applied his skills to estimate the effects of U.S. occupational licensing stringency on consumer outcomes, modeling the relationship between recency of review and search ranking of New York City restaurants, and exploring congestion in online matching markets for freelance labor. In the fall, Hiro will be transitioning to the Information Technology Group at MIT Sloan to commence his PhD studies. His future research agenda includes developing new ways of measuring group consciousness, a proxy for collective intelligence.



HAYLEE HAM is a data scientist at the LISH with a primary focus on supporting research conducted by Professor Rem Koning. Her current focus is on quantifying the impact of digital tools and data on entrepreneurship, firm growth, and competition. Haylee holds a master's degree in computational social science from the University of Chicago and a bachelor's degree in economics from Brigham Young University. Her research interests include machine learning, natural language processing, and using computational approaches to address social issues.



I enjoy the atmosphere of LISH. Working with talented people with diverse backgrounds inspires lots of new ideas and thoughts every day. I can always explore new dimensions here.

RUIHAN WANG



The lab provides each of us with the freedom to pursue our intellectual interests. I have the opportunity to see guest speakers, attend seminars, and go to workshops that expose me to new ideas and opportunities to collaborate.

HIRO MIURA



RUIHAN WANG is a data scientist at LISH. He received his master's degree in Information Science from University of Michigan and a bachelor's degree in E-Commerce Engineering from Beijing University of Posts and Telecommunications. He focuses on using innovative data-driven methods to explore real-world problems. His interests include various data science techniques, such as data manipulation, machine learning and natural language processing.

SCIENCE OF SCIENCE

LISH is interested in understanding the science of science, and aims to understand how labs operate, what makes them productive or efficient, and what are the drivers, behaviors, and motivations behind innovative work.

Science of Science Observatory

With support from the Alfred P. Sloan Foundation, LISH researchers are studying questions related to the (1) micro-organization of scientific production, at the individual, laboratory, departmental, and community levels and (2) impact on the economy and society. In the first wave of the project, graduate student fellows interviewed principal investigators and their staff across several different fields on issues in the organization of scientific labs, including:

- how work is structured and managed;
- knowledge and information sharing within and across labs and disciplines;
- competition, norms, and collaboration among scientists;
- funding and allocation of resources across sciences; and
- translation and commercialization of knowledge.

In light of the COVID-19 pandemic, LISH launched a survey on the effects of the coronavirus pandemic and related social distancing policies on scientists and their research. This large-scale survey attempts to identify the types of scientists that are more or less affected in areas such as their overall work time, allocation to different tasks, and future outputs. Results from this survey, "Unequal effects of the COVID-19 pandemic on scientists," were published in July 2020 in *Nature Human Behavior*. LISH has partnered with academic institutions and associations to help inform them on how the pandemic is affecting their faculty and members and hope the results will help them create policy to best support science during and after this difficult time.

FUTURE OUTLOOK

The next phase of the project is the development of a longitudinal panel survey of U.S. academic scientists in order to create new facts about the determinants of scientific productivity and a venue for sharing data on, and experiments in cooperation with, the U.S. scientific workforce.



JERRY & MARIE THURSBY

are Visiting Scholars at LISH. After retiring from the Georgia Institute of Technology, Professors Thursby have remained active economics of innovation researchers. They have been close collaborators on the lab's Science of Science Observatory, in particular on the interviews of scientists and the design of the longitudinal survey to create new facts about the determinants of scientific productivity.



KYLE MYERS is an Assistant Professor of Business

Administration at Harvard Business School. His research lies at the intersections of science, health care, and the commercialization process. Myers has been a key member of the Science of Science team at LISH, leading the development of the COVID-19 scientist survey as well as the longitudinal survey.



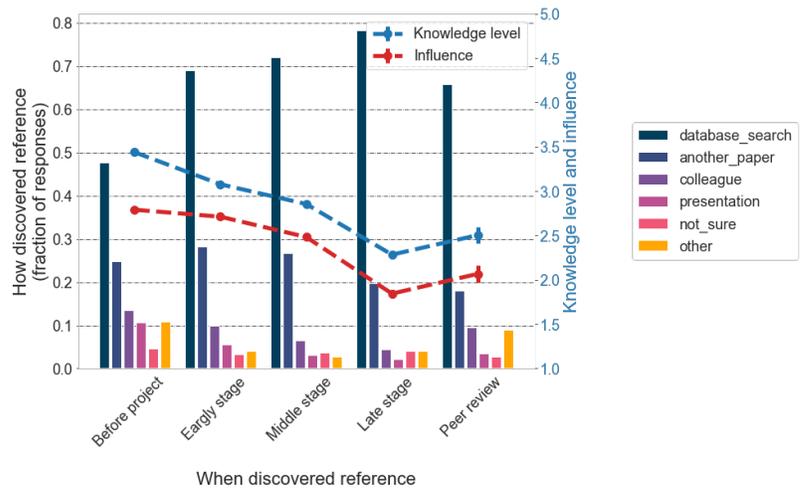
MISHA TEPLITSKIY, a former postdoctoral fellow at LISH, is now an Assistant Professor at the School of Information at the University of Michigan where he studies how social and organizational factors affect scientific discovery. He is especially interested in evaluation practices in science and whether they promote or stifle innovation. His approach relies on field experiments with scientists as they conduct their work, and applying computational tools to large-scale observational data.



Famous papers are discovered in more ways, read more carefully, and are up to **200% more likely** to influence research choices than obscure ones

What Do Citations Measure?

The intellectual impact of research papers is difficult to measure directly, so it is often measured with citations. However, not all citations denote intellectual impact (influential citations), as authors also cite papers to help position their own contribution in a literature (positional citations). The distribution of these citation types in the academic literature is poorly understood, although it is often assumed that famous papers attract more positional citing. Using approximately 25,000 ground-truth citation types provided by 12,670 authors in 15 academic fields via survey, this research shows that the opposite is true. Overall, most citing is positional: 54% of cited papers had little to no intellectual impact on authors, who did not read the papers closely. However, citations of highly cited works were 3 to 4 times more likely to reflect substantial impact. Famous papers are thus even more impactful than their citation counts suggest. To explain this surprising pattern, the research team proposes a conceptual model of citing in which researchers read and cite differently across a two-stage project lifecycle. In the first stage, researchers seek the highest quality works to inform their research choices, and use papers' status as a heuristic for their quality. Researchers consequently select famous papers, read them carefully, and become influenced by them. In the second stage, as researchers write up their results, they conduct more targeted search for prior work that helps with the narrative, and are less sensitive to the quality of those works. LISH provides observational and experimental evidence consistent with this model: researchers use citations as a heuristic for quality, and highly cited papers are much more likely to be invoked in the first-stage of citing. Famous papers thus drive the research frontier even more than their citations suggest, in part because researchers assume these papers are better.



TECHNOLOGY COMMERCIALIZATION

LISH examines how entrepreneurs assess market conditions for advanced technologies. LISH has developed courses and cases pertaining to taking technologies and building ideas into market-ready products or enterprises.

Technology Commercialization Online Course

LISH developed a massive open online course (MOOC), “Launching Breakthrough Technologies”, co-taught by Karim Lakhani and Vish Krishnan, Rady School of Business at the University of California San Diego, with HarvardX to disseminate the knowledge and skills required for successful technology commercialization. With an enrollment of over 7,000; students explored how entrepreneurs match promising technology with customer needs to launch successful new businesses. Using real-world examples, students were taught how to apply critical thinking to commercialize technologies, and learned about the venture creation process from founders, funders, and industry experts. The focus of the course was a systematic process for technology commercialization to bring cutting-edge innovations out of the lab and into the world. After its first run in Spring 2019, the course was revamped and relaunched as “Technology Entrepreneurship: Lab to Market” in Spring 2020. The course now has over 45,000 students enrolled.

MOOC Guest Speakers • **TOP ROW:** Noubar Afeyan, Shreya Dave, Robert Langer, David Miller, Conrad Holloman, Ramana Nanda • **BOTTOM ROW:** Warren Katz, Rana el Kaliouby, Peter Barrett, Tim Miano, Irwin Jacobs, Sam Kogan

Kangatech

LISH researchers developed a Harvard Business School case study on KangaTech, an Australian-based sports-technology startup, exploring the approach the firm took in the commercialization of their unique product in the world of sports science. The case walks learners through the decisions KangaTech managers were faced with as they spun their startup out of an Australian Rules Football Club, the North Melbourne F.C., to a stand alone entity. The case provides learners with opportunities to explore key decisions that need to be made when commercializing a new product, such as customer value proposition, value creation, value capture and product-market-fit.



If Kangatech was around 10 years ago, then I might have played 100 more games in the AFL. For me, it was really a huge help for the last couple of years in my career.

JARRED WAITE
FORMER AUSTRALIAN FOOTBALL LEAGUE PLAYER



BUSINESS OF SPORTS

LISH partners with key industry leaders across professional sports to think through difficult business and performance problems both on-field and off-field and solve them, while extracting key insights that will have an impact on practice.

“Consuming Contests” with the Australian Football League

Led by HBS doctoral candidate Patrick Ferguson, LISH studied how the announcement of injury-induced changes to teams’ line ups can estimate the effect of outcome uncertainty on spectator demand for contests. Drawing on game-level data from the Australian Football League, LISH found large effects of game outcome uncertainty on demand for live sports: a one-standard deviation increase in the outcome uncertainty of a game causes, on average, an 11.2% increase in game-day attendance. LISH estimates the level of outcome uncertainty that maximizes game-day attendance and finds that demand for live sport is greatest when the home team has a win probability of approximately 53%. Together, these results suggest that the popularity of contest-based entertainment (e.g., sports, competitive ‘reality’ TV programs) is partly explained by consumer preferences for suspense and the resolution of uncertainty.

AUSTIN SECHREST graduated from Harvard College in May 2020 with a Bachelor’s degree in Statistics and a Secondary in Government. He spent the summer and fall of 2019 at LISH assisting Patrick Ferguson with background research, data collection, and data analysis for his paper regarding season ticket holder incentives in the Australian Football League. His work with professional sports data in a research environment helped him prepare for his postgraduate work with the Boston Red Sox. While at Harvard, he was a two-time captain and three-time All-American for the varsity water polo team. He also was a member of the Harvard Sports Analysis Collective and volunteered with local organizations including Big Brothers Big Sisters.



Less Information, More Comparison, and Better Performance

In collaboration with Anton Paar SportsTec, the producers of skills.lab, a state-of-the-art football training simulator used by elite athletes in Germany and Austria, and with Henry Eyring (London School of Economics) and Sebastian Koppers (DFB), LISH implemented a field experiment that manipulates the performance feedback with regard to passing and speed received during training by 117 professional and semi-professional football players. LISH found that across a range of different performance measures relative feedback is at least as effective as—and often more effective than—feedback that contains both relative and absolute information. Specifically, players who receive feedback that contains only relative information are approximately 14% more accurate at passing—and complete the drill 17% faster—than players that receive feedback that contains both relative and absolute information.

Exploratory analysis of physical, technical and tactical data in professional football

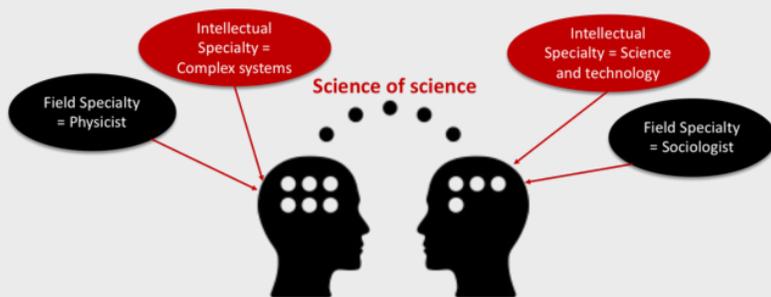
LISH worked with Sheffield United (SUFC)—a Premier League football club—to explore the relationship between physical, technical and tactical outputs in professional football. LISH’s work has explored the association between team-level performance outputs (e.g., total goals, possession, and ball movement) and player-level GPS outputs (e.g., measures of running distance, running speed, and number of explosive efforts). As Tareq Hawasli, Director of Sheffield United (2016-2019) says, “in three to five years time, every Premier League club and other football teams will have a dedicated analytics team that will form a checks and balances system for decision making. This will incorporate the traditional way of thinking with the future of data.” Insights generated by this project will help inform the strength & conditioning and player development practices at SUFC.

NETWORKS

An aspect of digital transformation is the rise of online platforms. LISH researches how network effects of these platforms and their members drive interaction, production, and collaboration.

Engineering Serendipity: The Role of Cognitive Similarity in Knowledge Sharing and Knowledge Production

Led by LISH postdoctoral fellow Jacqueline Lane, this research paper explores how serendipitous encounters affected and even fostered innovation and creativity among scientists. Taking 15,817 scientist pairs, LISH designed and executed a natural field experiment at a medical symposium. LISH found that too much or too little intellectual similarity leads to few opportunities for sharing insight and knowledge. Physical space redesign can be temporarily rearranged to encourage knowledge sharing opportunities and new ideas.



Charlie Day (CEO, Innovation and Science Australia) chatting with Rem Koning (Assistant Professor of Business Administration, Harvard Business School) after a panel on research collaboration at IGL 2019 — Berlin



LAURA ROSENDAHL HUBER

After having enjoyed more than four very productive years at the Max Planck Institute for Innovation and Competition in Munich (Germany), Laura Rosendahl Huber joined the Strategic Management and Entrepreneurship group at the Rotterdam School of Management (Netherlands) as an assistant professor in September 2019. In this role, she will continue her research on female entrepreneurship and the evaluation of policy measures aimed at fostering entrepreneurship and innovation. At the same time, she will continue her collaboration with LISH on a large scale research project that aims to gain a better understanding of the dynamics of online education programs and their impact on future labor market outcomes.



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