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Research Spotlights

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Software Components and Product Variety in a Platform Ecosystem: A Dynamic Network Analysis of WordPress (p. 1339)
Sungyong Um, Bin Zhang, Sunil Wattal, Youngjin Yoo

Software components such as application programming interfaces (APIs) provided by external developers are vital to online digital platforms. Although APIs generally increase the variety of products according to anecdote, the precise relationship between the categories of APIs and product variety is not yet known. We find that APIs, regarding their use frequency, are categorized into three groups. The core is a group of frequently used APIs, whereas the periphery is a group of sparsely used APIs. In a large and mature platform ecosystem, an additional group of APIs, the regular core, mainly provided by third-party developers, emerges. APIs in the regular core are the main driver of product variety. However, we also find that the strength of this effect diminishes in a newly created product category when most of the new products are built by duplicating the usage of APIs from other products. A platform owner can stimulate developers' creativity by acting as a bridge between digital product providers and third-party developers. It can collect functional needs from third-party developers and then share them with product providers. Therefore, the latter can build APIs that developers need.

Law, Economics, and Privacy: Implications of Government Policies on Website and Third-Party Information Sharing (p. 1375)
Ram D. Gopal, Hooman Hidaji, Sule Nur Kutlu, Raymond A. Patterson, Niam Yaraghi

Widespread abuse of internet users' privacy online has prompted user advocacy groups to implore governments to intervene and protect consumer rights. To study such interventions' effects, we examine data-protection policies that policy makers and governments can enforce on websites, including consent-based user information sharing and subsidizing competing websites. Interestingly, we find that even though a consent-based policy may improve user surplus, it has the unintended consequence of increasing the number of third-parties and, thus, sharing of user information. We also determine that both consent-based and website subsidization policies may reduce competition by driving websites out of the market—to the detriment of user surplus and social welfare. Moreover, consent-based policies are not beneficial to websites, but are beneficial for third-parties. Policy makers should consider the different policy mechanisms at their disposal. Website subsidization is similar to a scalpel, enabling them to sculpt around and impact specific target markets. Consent-based policies are more comparable to a sledgehammer that uniformly affects all market segments. For circumstances where it is difficult for the government to enact a law for the entire market, website subsidization policies may be appealing alternatives, as they may yield higher user surplus than consent-based policies.

Diversity Preference-Aware Link Recommendation for Online Social Networks (p. 1398)
Kexin Yin, Xiao Fang, Bintong Chen, Olivia R. Liu Sheng

Link recommendation, such as "People You May Know" on LinkedIn, recommends links to connect unlinked online social network users. Existing link recommendation methods tend to recommend similar friends to a user but overlook the fact that different users have different diversity preferences when making friends in a social network. That is, some users prefer to connect with friends of similar profiles while some others prefer to befriend those of different profiles. For example, Jane prefers to connect with those primarily majoring in mathematics, whereas Jack prefers to befriend those in many different majors. To address this research gap, we define and operationalize the concept of diversity preference and propose a new link recommendation problem: the diversity preference-aware link recommendation problem. We then develop a novel link recommendation method that recommends friends to cater each user's diversity preference. Our study informs researchers and practitioners about a new perspective on link recommendation—diversity preference-aware link recommendation. Our study also suggests that recommender systems need to be designed to meet each user's diversity preference rather than

indiscriminately increase the diversity of recommended items for every user.

Too Tired and in Too Good of a Mood to Worry About Privacy: Explaining the Privacy Paradox Through the Lens of Effort Level in Information Processing (p. 1415)
Tawfiq Alashoor, Mark Keil, H. Jeff Smith, Allen R. McConnell

Data privacy is one of the most pressing issues today. The world is thirsty for novel, effective, and efficient policies to strike an appropriate balance between protecting individuals' privacy and creating economic value from their personal information. Whereas governmental efforts, such as the enaction of General Data Protection Regulation, California Consumer Privacy Act, and other privacy regulations, have been pushing boundaries to strike this balance, the effects of these types of initiatives on individuals' privacy awareness and behavior are uncertain, likely to be nuanced, and will take time to sort out. In this paper, we explain the privacy paradox, a phenomenon with important implications that apply to policymakers, industry professionals, and individuals. The privacy paradox refers to a mismatch between individuals' stated privacy concerns and their actual disclosure behaviors. In three behavioral experiments, we show how the paradox is revealed when individuals are cognitively tired especially when they are in a good mood. These findings do not indicate that individuals do not care about privacy because they do when they are not cognitively tired especially when they are in a bad mood. By explaining the privacy paradox, we inform existing and future privacy policies to strike that balance we all strive for.

Analyzing Frictions in Generalized Second-Price Auction Markets (p. 1437)
Karthik Kannan, Vandith Pamuru, Yaroslav Rosokha

Generalized second-price auction is the preferred mechanism for sponsored-search advertisements. In this paper, we take a twofold approach using Q-learning-based simulations and human-subject experiments to show that the low-value advertisers (who do not win the auction) exhibit highly exploratory behavior and impact the allocative efficiency of the mechanism. Moreover, we find the presence of bid-adjustment frictions (e.g., bid fee) moderates this phenomenon and results in higher allocative efficiency of the auction. Our focus on the bid-adjustment costs is motivated by the fact that both the sponsored-search platforms and policymakers can best observe and influence these types of frictions as compared with frictions that are difficult to observe (e.g., resources spent on the analysis of the market and sophistication of algorithms by the advertisers).

Satisfaction to Stay, Regret to Switch: Understanding Post-adoption Regret in Choosing Competing Technologies When Herding (p. 1455)
Haiyun (Melody) Zou, Heshan Sun, Yulin Fang

Facing hundreds of similar alternatives in any technology adoption decision, users commonly take a shortcut in the decision making: following others in the herd! Although herding is found to be an influential force for technology adoption, this research sheds light on its distal on user staying power in post-adoption evaluations. Supplementing the dominant perspective that users will stay with the chosen technology when satisfactory with the technology performance, this research proposes a new regret perspective to account for users' concerns about the competing technologies and the decision process in the technology adoption decision. A research model is accordingly constructed and tested in two longitudinal field studies on user adoption and post-adoption evaluations across competing technologies in both forms of free software and paid hardware, with samples collected in Asia and Europe. Based on the findings and insights, this research suggests to IT vendors on how to retain users in the new era with competing technologies by understanding how post-adoption regret, the predominant factor of user switching, is formed and how it can be lessened.

Does Social Influence Change with Other Information Sources? A Large-Scale Randomized Experiment in Medical Crowdfunding (p. 1476)
Yun Young Hur, Fujie Jin, Xitong Li, Yuan Cheng, Yu Jeffrey Hu

We examine how social influence changes with other information sources to influence donations to medical crowdfunding. We conduct a large-scale randomized field experiment on a leading medical crowdfunding platform, showing friends' donation information to donors in the treatment group and not to the control group, and examine how the likelihood to donate differs across the two groups. In addition, we evaluate the informational value of different case attributes in conveying the patients' need for help, by conducting a survey on Amazon Mechanical Turk. We find that for cases containing attributes with high informational value (e.g., minor patient, severe conditions), social influence is insignificant. In contrast, for cases lacking attributes with high informational value, social influence significantly increases donors' likelihood to donate. Our findings indicate that rather than generating an entrenchment effect, where cases with attributes of high informational value attract disproportionate benefits, social influence can increase donation likelihood to cases that lack such attributes, promoting more equal access to resources overall. Our findings

have significant practical value in helping businesses identify the scenarios where social influence has a larger impact, depending on the value of other sources of information available.

Spoiled for Choice? Personalized Recommendation for Healthcare Decisions: A Multiarmed Bandit Approach (p. 1493)
Tongxin Zhou, Yingfei Wang, Lu (Lucy) Yan, Yong Tan

Choice overload is a common problem in many online settings, including healthcare. Online healthcare platforms tend to provide a large variety of behavior intervention information or programs to help individuals modify their lifestyles to improve wellness. However, having too many options can significantly increase searching cost, prevent users from discovering the truly relevant interventions, and harm users' long-term healthcare decision-making efficiency. This motivates us to propose a personalized healthcare recommendation system to provide tailored support for individuals' intervention participation. The proposed framework, a deep-learning and diversity-enhanced multiarmed bandit (DLDE-MAB), integrates several predictive and prescriptive analytics components to combat the unique challenges presented in the healthcare recommendation setting. It leverages online machine learning to provide adaptive and real-time support, a theory-guided diversity promotion scheme to cover multiple healthcare needs, and deep learning to further enhance dynamic context representation. Through extensive experiments, we show that the proposed framework outperforms various competing models in terms of its adaptivity to data dynamics, diversity, and uncertainty. The proposed model and evaluation results provide important implications for business intelligence and personalized, contextualized, and agile healthcare decision making.

A Theory-Driven Deep Learning Method for Voice Chat–Based Customer Response Prediction (p. 1513)
Gang Chen, Shuaiyong Xiao, Chenghong Zhang, Huimin Zhao

In this study, we target the task of voice chat–based customer response prediction in an emerging online interaction–based commercial mode, the invite-online-and-experience-in-store mode. Prior research shows that satisfaction, which can be revealed by the discrepancy between prior expectation and actual experience, is a key factor to disentangle customers' purchase intention, whereas black box deep learning methods empirically promise us with advantageous capabilities in dealing with complex voice data, for example, text and audio information incorporated in voice chat. To this end, we propose a theory-driven deep learning method that enables us to (1) learn customers' personalized product preferences and dynamic satisfaction in the absence of their profile information, (2) model customers' actual experiences based on multiview voice chat information in an interlaced way, and (3) enhance the customer response prediction performance of a black box deep learning model with theory-driven dynamic satisfaction. Empirical evaluation results demonstrate the advantageous prediction performance of our proposed method over state-of-the-art deep learning alternatives. Investigation of cumulative satisfaction reveals the collaborative predictive roles of theory-driven dynamic satisfaction and deep representation features for customer response prediction. Explanatory analysis further renders insights into customers' personalized preferences and dynamic satisfaction for key product attributes.

The Decoy Effect and Recommendation Systems (p. 1533)
Nasim Mousavi, Panagiotis Adamopoulos, Jesse Bockstedt

Recommendation systems and the decoy effect are two popular marketing techniques that have been used for facilitating decision making. Practitioners often use decoys to help drive demand for specific items, and prior research has shown the decoy effect to be robust in traditional choice settings, with consistent reporting of an overall positive impact. Recommendation systems are also increasingly being used to present item choice sets to customers and users, assisting users in their decision-making process. However, previous work has not examined the decoy effect in the context of recommendations. The decoy effect may facilitate consumer decision making and positively impact user behavior when used with recommendation systems. However, in the recommendation context, customers often have different expectations for the reliability and quality of the presented information. Hence, a decoy as a recommendation could signal issues in system reliability, resulting in a negative effect. Our study demonstrates that depending on the recommendation context, the decoy effect can be beneficial or counterproductive. Specifically, we find in the personalized context, including a decoy minimizes the demand for the target option and pushes consumers to opt out of purchase, which deviates from the traditional decoy effect. However, a decoy increases the target item's demand in the nonpersonalized context, following the conventional decoy effect.

Physical Stores as Warehouses for Online Channels: Implications for Channel Choices Under Competition (p. 1554)
Ping Tang, Jianqing Chen, Srinivasan Raghunathan

With the development of new technology and business innovation, firms are actively adjusting their channel choices. Some retailers operate a hybrid and special omnichannel structure referred to as *New Retail* promising to tightly integrate online and physical channels. In

the meanwhile, some retailers such as Ross choose to only operate physical channels. In this paper, we provide insights into competing firms' retail-channel choices among online channel, physical channel, and omnichannel under the *New Retail* model. We find that firms' channel choices determine which channels compete directly with each other and hence the intensity of competition between firms. Firms' channel choices also give rise to three other effects-market expansion, consumer segmentation, and intrafirm cannibalization. The tradeoff among these effects along with the nature and intensity of competition determine the equilibrium channel structure in the market.

Expl(AI)ned: The Impact of Explainable Artificial Intelligence on Users' Information Processing (p. 1582)
Kevin Bauer, Moritz von Zahn, Oliver Hinz

Although future regulations increasingly advocate that AI applications must be interpretable by users, we know little about how such explainability can affect human information processing. By conducting two experimental studies, we help to fill this gap. We show that explanations pave the way for AI systems to reshape users' understanding of the world around them. Specifically, state-of-the-art explainability methods evoke mental model adjustments that are subject to confirmation bias, allowing misconceptions and mental errors to persist and even accumulate. Moreover, mental model adjustments create spillover effects that alter users' behavior in related but distinct domains where they do not have access to an AI system. These spillover effects of mental model adjustments risk manipulating user behavior, promoting discriminatory biases, and biasing decision making. The reported findings serve as a warning that the indiscriminate use of modern explainability methods as an isolated measure to address AI systems' black-box problems can lead to unintended, unforeseen problems because it creates a new channel through which AI systems can influence human behavior in various domains.

Optional Verification and Signaling in Online Matching Markets: Evidence from a Randomized Field Experiment (p. 1603)
Lanfei Shi, Siva Viswanathan

Online matching platforms could lack common informational mechanisms, such as ratings and reviews, that serve to reduce information asymmetry in transactional platforms. The lack of verified information about participants further exacerbates issues of information asymmetry in such markets. Our study focuses on a novel role of verification in such matching markets—its ability to serve as a credible signal for a user, when such verification is made optional and visible to other users. In collaboration with a leading online dating platform with no reputation mechanisms and where most of the information is self-disclosed, we design and conduct a randomized field experiment to examine not only who chooses to verify but also, the effectiveness of such optional verification for different types of users. We identify that a simple-to-implement mechanism, such as phone verification, when made optional can take on additional significance in platforms that lack alternate reputation and transaction-assurance mechanisms, especially for those in early years or those that lack other credible mechanisms to verify important information about participants. Our findings also provide insights into how optional verification has heterogeneous impacts on different platform users and can also facilitate desirable matching and benefit the platform as a whole, paving the way for examining other similar verification mechanisms.

Who's Watching TV? (p. 1622)
Jessica Clark, Jean-François Paiement, Foster Provost

This work addresses the problem of "user disambiguation"—estimating the likelihood of each member of a small group using a shared account or device. The specific focus is on television set-top box (STB) viewership data in multiperson households, in which it is impossible to tell with certainty which household members watch what. We formulate user disambiguation as a predictive problem and develop a solution for estimating the likelihood that each individual in a multiperson household watches each TV segment. This method learns priors for viewership in single-person households and then adapts them to the specifics of each multiperson household's viewership history. We formalize two ad hoc heuristics that are currently used in industry (and research) for estimating audience composition of STB data and conduct a comparative analysis using three data sources: simulated data, real large-scale viewership data, and fully labeled panel data. The results show that our method has superior performance. This approach has practical value for both advertisers and researchers who seek better understanding of TV viewership. It also has applications beyond TV advertising, such as detecting the sharing of streaming passwords among multiple households or any other situation in which multiple users share devices or accounts.

When Images Backfire: The Effect of Customer-Generated Images on Product Rating Dynamics (p. 1641)
Yue Guan, Yong Tan, Qiang Wei, Guoqing Chen

Customer-generated images (CGIs) are images posted by customers on e-commerce platforms, and they usually appear in the review sections together with review text and ratings provided by customers having purchase experiences. Despite their prevalent adoption by e-commerce platforms, the effect of CGIs on customers'

postpurchase satisfaction remains unclear. We find that CGIs lead to a decline in subsequent ratings compared with product ratings not exposed to CGIs. Furthermore, high CGI review ratings and high aesthetic quality exacerbate the negative effect, whereas reviewers' face disclosure in CGIs can alleviate the negative effect. Through cross-product analyses, we find that the negative effect is more prominent for experience goods (e.g., women's dresses) than for search goods (e.g., lightning cables). Results from a laboratory experiment show that participants experience significantly higher expectation and negative disconfirmation when reading CGI reviews with high ratings, whereas the uncertainty reduction effect is insignificant, which collectively explains the decline of subsequent product ratings from a theoretical perspective. These findings suggest that platforms and retailers should be aware of the potential negative effect of CGIs on the rating dynamics and take appropriate measures to circumvent it.

Green Data Analytics of Supercomputing from Massive Sensor Networks: Does Workload Distribution Matter? (p. 1664)
Zhiling Guo, Jin Li, Ram Ramesh

Energy costs represent a significant share of the total cost of ownership in high-performance computing systems. Using a unique data set collected by massive sensor networks in a petascale national supercomputing center, we first present an explanatory model to identify key factors affecting energy consumption in supercomputing. Our analytic results show that workload distribution among the nodes has significant effects and could effectively be leveraged to improve energy efficiency. We then establish the high model performance using in-sample and out-of-sample analyses and develop prescriptive models for energy-optimal runtime workload management. We present four dynamic resource management methodologies (packing, load balancing, threshold-based switching, and energy optimization), model their application at two levels (within-rack and cross-rack resource allocation), and explore runtime resource redistribution policies for jobs under the computational steering and comparatively evaluate strategies that use computational steering with those that do not. Our experimental results lead to a threshold strategy that yields near-optimal energy efficiency under all workload conditions. We further calibrate the energy-optimal resource allocations over the full range of workloads and present a bi-criteria evaluation to consider energy consumption and job performance tradeoffs. We conclude with implementation guidelines and policy insights into energy-efficient computing resource management in large supercomputing centers.

Extended Generativity Theory on Digital Platforms (p. 1686)
Daniel Fürstenau, Abayomi Baiyere, Kai Schewina, Matthias Schulte-Althoff, Hannes Rothe

Our research challenges the long-held assumption that generativity in platforms leads to unbounded growth. Typically, the reasoning is that boundary expansion of digital platforms, characterized by limitless growth of features (e.g., apps on Apple's iTunes) or ideas (e.g., improvements to open source code), drives their widespread use and exponential growth rates. However, our eight-year study of six large e-commerce transaction platforms reveals a different scenario. In fact, our findings contest this conventional view in two key ways: first, instead of witnessing unbounded growth in the ecosystem of developers, we observe that growth eventually stabilizes; second, we find that rather than growth attracting users, sometimes the reverse is true. We integrate these insights into an extended generativity theory, offering a more nuanced understanding of digital platform dynamics.

Which Enemy to Dance with? A New Role of Software Piracy in Influencing Antipiracy Strategies (p. 1711)
Can Sun, Yonghua Ji, Xianjun Geng

This paper studies how software firms should determine their antipiracy efforts and product prices. There are two unique aspects of our model. First, antipiracy efforts have both a *direct* effect and a *cross* effect on software piracy. Second, we capture two types of competitions when piracy exists: one between a legitimate product and its pirated counterpart, and the other between two pirated products. We show that due to pirated products' *buffer* effect not studied before, eliminating piracy does not necessarily mean higher profit for firms. This reveals an unexplored advantage of desktop software comparing with Software as a Service that can eliminate piracy. Direct and cross effects have different impacts on firms' decisions and profits. Opposite to what one might expect, when a firm's antipiracy effort becomes more effective in increasing the cost of pirating its own product but not its competitor's product, the firm becomes worse off under certain conditions. By contrast, if the effort's cross effect is higher, therefore increasing the cost of pirating its competitor's product, a firm will always be better off. The managerial implication is that if a firm ignores the cross effect, it could under-invest in anti-piracy effort, causing its profit to suffer.

A Complex Adaptive Systems Perspective of Software Reuse in the Digital Age: An Agenda for IS Research (p. 1728)
Gregory Vial

Most software on which we rely to help us organize our professional and personal lives is based on the

reuse of other pieces of software that are created and maintained by groups of software developers that work independently from one another. Oftentimes, these groups simply publish their software in the form of self-contained packages available on dedicated repositories, facilitating the widespread diffusion of their work. Whereas the production and publication of software packages fosters unprecedented levels of digital innovation, there are also drawbacks associated with software reuse (e.g., as was publicly discussed in 2021 with the discovery of the Log4Shell vulnerability). Building on previous research, our work explores the implications associated with the unprecedented scale and uncoordinated nature of packaged software reuse. We use complex adaptive systems as a generative lens to help us conceptualize the phenomenon and identify promising avenues for research and practice on this topic. Our work, therefore, draws attention to the importance of the packaged software reuse phenomenon as well as the need for research to help increase our understanding of its nature and implications considering its prevalence in software development practice and the overall importance of software in our everyday lives.

Numerological Heuristics and Credit Risk in Peer-to-Peer Lending (p. 1744)
Maggie Rong Hu, Xiaoyang Li, Yang Shi, Xiaoquan (Michael) Zhang

People often use heuristics as mental shortcuts when making financial decisions. Although the literature typically considers heuristics as behavior biases, we explore how different types of heuristics differ from one another. Through peer-to-peer lending data, we observe that borrowers who use limited attention when applying for loans tend to choose round loan amounts, simplifying the decision-making process but compromising accuracy. This *round-number heuristic* decreases their funding success rate and increases the probability of default. On the other hand, some borrowers select loan amounts in "lucky numbers" that superstitious lenders favor. This *lucky-number heuristic* caters to the lenders' preference, thus increasing the borrowers' funding success rates and reducing the likelihood of default. Our paper demonstrates that borrowers select heuristics based on their motives, leading to varying consequences. We also show that heuristics are not all the same, and people's choice of heuristics provides insight into their characteristics and can predict decision outcomes. For instance, factoring in heuristic usage information improves default prediction accuracy in our setting. Our findings can be beneficial to practitioners in refining the underwriting and screening of borrowers and loans.

All External Reference Prices Are Not the Same: How Magnitude, Source, and Fairness Shape Payment for Digital Goods (p. 1761)
Geneviève Bassellier, Jui Ramaprasad

Music, movies, e-books, news: all industries that have been impacted by free distribution of their products. For many individuals, this wide availability of free substitutes drives users' willingness-to-pay down. In this environment, how can platforms motivate consumers to pay for goods that they may be able to get for free? We demonstrate providing flexibility in payment through allowing users to "pay what you want," along with providing external reference prices (ERPs) set by different sources, that is, other similar consumers or the platform itself, can influence payment. Importantly, a site-set ERP has more influence increasing payment than a socially-set ERP. An interesting nuance to this is that when the ERP is perceived to be high, the marginal effect of an increase in ERP on payment is smaller than when it is perceived to be fair; in other words, providing a fair ERP is more effective in increasing payment than providing an ERP that is too high. Altogether, platforms can leverage these findings in designing interfaces to provide information that can motivate consumers to pay for digital goods.

Ridesharing and Digital Resilience for Urban Anomalies: Evidence from the New York City Taxi Market (p. 1775)
Yingjie Zhang, Beibei Li, Sean Qian

This article investigates how and why the traditional on-demand service (i.e., taxies) and ridesharing platforms (e.g., Uber) perform in contexts of urban uncertainty. We consider different types of unexpected urban anomalies and collect large-scale trip data on taxi and ridesharing services. Empirically, we employ a difference-in-differences econometric model to compare the platform-level performances (measured by the number of fulfilled trips) of a traditional taxi system and a ridesharing platform after urban anomaly shocks. We observe that the ridesharing platform significantly outperforms the traditional taxi platform in coping with the uncertainties brought about by unexpected anomalies. We conclude, conservatively, that the technological effect and technology-enabled supply elasticity, are the main factors determining the differences between the platforms during an urban anomaly. This work offers important insights into the design of platform strategies, especially for stimulation of the labor supply and incentivization of the adoption and use of technology in urban transportation systems in response to anomalous urban upheavals.

One of the critical success factors in information technology outsourcing projects is how partners learn through interactions with each other. This learning facilitates the complex problem-solving processes and enables partners to take different perspectives, explore alternatives, and seek innovation in outsourcing projects. For this learning to occur, partners must strive to enhance collaboration, but generally, collaboration is viewed too narrowly as partners engage in coordination and cooperation independently of each other. Our framework suggests that learning is more effective when partners collaborate by cooperating to pursue jointly determined goals and coordinating to adjust their actions toward these goals. This study compares the independent model of collaboration with the interdependent model. The interdependent model suggests that coordination and cooperation mechanisms are interdependent and jointly influence learning outcomes. The findings show that the interdependent model provides a better explanation of the impact of coordination and cooperation mechanisms on relational learning than the independent model. This finding provides a more comprehensive understanding of relationship dynamics between partners. It also provides guidance for developing collaboration mechanisms that help synergize coordination and cooperation. Our study further shows that the perceptions of coordination and cooperation mechanisms are not symmetric between clients and vendors.