Student Identified Week 2 articles (9/2/21)

Post an article that you find that is in the intersection of computing and sustainability (Week 2 of the Schedule). In particular, give a citation as you would give in the references of a paper AND a URL if one exists AND the paper's abstract.

1. McGann, Py, Rajan, Ryan, Henthorn (2008). Adaptive Control for Autonomous Underwater Vehicles, Proceedings of the Twenty-Third AAAI Conference on Artificial Intelligence. (a scholarly conference paper)
https://www.aaai.org/Papers/AAAI/2008/AAAI08-209.pdf
"We describe a novel integration of Planning with Probabilistic State Estimation and Execution. The resulting system is a unified representational and computational framework based on declarative models and constraint-based temporal plans. The work is motivated by the need to explore the oceans more cost-effectively through the use of Autonomous Underwater Vehicles (AUV), requiring them to be goal-directed, perceptive, adaptive and robust in the context of dynamic and uncertain conditions. The novelty of our approach is in integrating deliberation and reaction over different temporal and functional scopes within a single model, and in breaking new ground in oceanography by allowing for precise sampling within a feature of interest using an autonomous robot. The system is general-purpose and adaptable to other ocean going and terrestrial platforms."

2. Jones, Nicola (December 10, 2018). "Can Artificial Intelligence Help Build Better, Smarter Climate Models?" In YaleEnvironment360, Published by Yale School of the Environment. (a popular media article) https://e360.yale.edu/features/can-artificial-intelligence-help-build-better-smarter-climate-models
"Researchers have been frustrated by the variability of computer models in predicting the earth's climate future. Now, some scientists are trying to utilize the latest advances in artificial intelligence to focus in on clouds and other factors that may provide a clearer view."

3. Perera, Charith, Qin, Yongrui, Estrella, Julio C., Reiff-Marganiec, Stephan and Vasilakos, Athanasios V. (2017) Fog computing for sustainable smart cities: a survey. ACM Computing Surveys, 50 (3). ISSN 0360-0300
https://catalog.library.vanderbilt.edu/permalink/01VAN_INST/jh04bq/cdi_gale_infotracacademiconefile_A543780142

"The Internet of Things (IoT) aims to connect billions of smart objects to the Internet, which can bring a promising future to smart cities. These objects are expected to generate large amounts of data and send the data to the cloud for further processing, specially for knowledge discovery, in order that appropriate actions can be taken. However, in reality sensing all possible data items captured by a smart object and then sending the complete captured data to the cloud is less useful. Further, such an approach would also lead to resource wastage (e.g. network, storage, etc.). The Fog (Edge) computing paradigm has been proposed to counterpart the weakness by pushing processes of knowledge discovery using data analytics to the edges. However, edge devices have limited computational capabilities. Due to inherited strengths and weaknesses, neither Cloud computing nor Fog computing paradigm addresses these challenges alone. Therefore, both paradigms need to work together in order to build an sustainable IoT infrastructure for smart cities. In this paper, we review existing approaches that have been proposed to tackle the challenges in the Fog computing domain. Specifically, we describe several inspiring use case scenarios of Fog computing, identify ten key characteristics and common features of Fog computing, and compare more than 30 existing research efforts in this domain. Based on our review, we further identify several major functionalities that ideal Fog computing platforms should support and a number of open challenges towards implementing them, so as to shed light on future research directions on realizing Fog computing for building sustainable smart cities."

4. Samuel Mann, Logan Muller, Janet Davis, Claudia Roda, and Alison Young. 2010. Computing and sustainability: evaluating resources for educators. SIGCSE Bull. 41, 4 (December 2009), 144–155. https://dl.acm.org/doi/abs/10.1145/1709424.1709459
"Computing has a significant impact on sustainable outcomes and computing education for sustainability has previously been identified as an important goal. This paper aims to address a barrier to the integration of sustainability into computing teaching -- that of a perceived paucity of resources. The "framework" (Computing Education for Sustainability, CE4S) is developed that could be used by educators to access resources for the integration of sustainability in the computing curriculum."

5. Agarwala, N. (2021). Managing marine environmental pollution using Artificial Intelligence. Maritime Technology and Research, 3(2), 120-136.
https://so04.tci-thaijo.org/index.php/MTR/article/view/248053/169078
"The marine environment has deteriorated to the extent that it has begun to impact human health and the planet itself. The primary causes of this deterioration are an increasing population, the Industrial Revolution, and the increased use of fossil fuels. While the damage done to the

environment cannot be undone, the impact can be lessened with a better understanding of the ocean and with monitoring future pollution using technology. Such an effort will help achieve sustainability, as laid out by the Sustainable Development Goals 2030 of the United Nations. Though efforts have been made to monitor the ocean for pollutants, both physically and remotely, interpreting the data collected is a humongous task due to the high volume of data. In reply, technology again provides a solution. One such technology, namely 'Artificial Intelligence' ('AI'), can be used to understand and monitor marine pollution, and is the topic of discussion in this article. In doing so, the article will discuss the emerging opportunities and risks associated with the use of AI in managing marine environmental pollution through sustainability. To strengthen the argument, use-cases of AI in the marine environment and their scalability are discussed. However, these cases are considered merely a stimulus for a better and a larger variety of solutions to follow in the ever-evolving domain of AI."

7. Goel, Ashok K. "Biologically inspired design: A new paradigm for AI research on computational sustainability?." Workshops at the Twenty-Ninth AAAI Conference on Artificial Intelligence. 2015.
https://www.aaai.org/ocs/index.php/WS/AAAIW15/paper/view/10205/10173
"Much AI research on computational sustainability has focused on monitoring, modeling, analysis, and optimization of existing systems and processes. In this article, we present another exciting and promising paradigm for AI research on computational sustainability that emphasizes design of new systems and processes, and, in particular, on biologically inspired design. We first characterize biologically inspired design, then examine its relationship with environmental sustainability, next present a computational model of the process of biologically inspired design, and finally describe a few computational systems for supporting biologically inspired design practice."

8. Y. Pan, S. Maini and E. Blevis, "Framing the Issues of Cloud Computing & Sustainability: A Design Perspective," *2010 IEEE Second International Conference on Cloud Computing Technology and Science*, 2010, pp. 603-608, doi: 10.1109/CloudCom.2010.77.
"In this paper, we describe the present lack of understanding about if the potential environmental effects of transitions to cloud computing are positive or negative. We describe that research about the human interactivity implications of and for cloud computing has yet to enter the arena of Human Computer Interaction (HCI) in a significant way. We describe a short inventory of what is presently in the HCI literature apropos of cloud computing and interactivity. In addition, we offer a description of how we think the issues of cloud computing in the perspective of HCI may be framed, as well as an inventory of social issues implicated in cloud computing. Finally, we suggest some projects and

problems that may be appropriate for advancing cloud computing in the perspective of HCI with sustainability as a key goal."

9. Chantry, Matthew, et al. "Opportunities and Challenges for Machine Learning in Weather and Climate Modelling: Hard, Medium and Soft Ai." *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, vol. 379, no. 2194, 2021, p. 20200083., doi:10.1098/rsta.2020.0083.

https://royalsocietypublishing.org/doi/10.1098/rsta.2020.0083#d350388e1

"Ever since the development of the first fully programmable electronic digital computers at the end of World War 2, the cutting edge of weather prediction science has lain in the development of accurate numerical representations of the governing dynamical equations of meteorology. As begun in the 1950s [1], these numerical representations have been further developed to allow first-principle simulations of climate. Since then, numerical modelling of weather and climate have dominated meteorological forecasting, to the extent that only 10 years ago prediction using statistical empirical models seemed rather antiquated. With the recent advances in deep neural networks and other related machine learning techniques, statistical empirical prediction is firmly back in vogue. This raises a number of questions. Will the methods of artificial intelligence replace numerical models? Or, failing that, can they be used to supplement or enhance numerical models?"

10. Badea, Liana & Claudia, Mungiu-Pupãzan. (2021). "The Economic and Environmental Impact of Bitcoin". IEEE Access. PP. 1-1. 10.1109/ACCESS.2021.3068636.

https://www.researchgate.net/publication/350361329_The_Economic_and_Environmental_Impact_of_Bitcoin

The controversies surrounding Bitcoin, one of the most frequently used and advertised cryptocurrency, are focused on identifying its qualities, the advantages and disadvantages of using it and, last but not least, its ability to survive over time and become a viable alternative to the traditional currency, taking into account the effects on the environment of the technology used to extract and trade it. Based on such considerations, this article aims to provide an overview of this cryptocurrency, from the perspective of conducting a systematic review of the literature dedicated to the economic and environmental impact of Bitcoin. Using peer-reviewed articles collected from academic databases, we aimed at synthesizing and critically evaluating the points of view in the scientific literature regarding the doctrinal source of the emergence of Bitcoin, the identity of this cryptocurrency from an economic point of view, following *its implications on the economic and social environment. Subsequently, this research offers the opportunity of evaluating the level of knowledge considering the impact of Bitcoin mining process on the environment from the perspective of the energy consumption and CO_2 emissions, in order to finally analyze Bitcoin regulation and identify possible solutions to reduce the negative impact on the environment and beyond. The findings suggest that, despite high energy consumption and adverse environmental impact, Bitcoin continues to be an instrument used in the economic environment for a variety of purposes. Moreover, the trend of regulating it in various countries shows that the use of Bitcoin is beginning to gain some legitimacy, despite criticism against this cryptocurrency.*

11. Sheila Alemany, Jonathan Beltran, Adrian Perez, Sam Ganzfried(2019). "Predicting Hurricane Trajectories Using a Recurrent Neural Network"(The Thirty-Third AAAI Conference on Artificial Intelligence (AAAI-19))
Hurricanes are cyclones circulating about a defined center whose closed wind speeds exceed 75 mph originating over tropical and subtropical waters. At landfall, hurricanes can result in severe disasters. The accuracy of predicting their trajectory paths is critical to reduce economic loss and save human lives. Given the complexity and nonlinearity of weather data, a recurrent neural network (RNN) could be beneficial in modeling hurricane behavior. We propose the application of a fully connected RNN to predict the trajectory of hurricanes. We employed the RNN over a fine grid to reduce typical truncation errors. We utilized their latitude, longitude, wind speed, and pressure publicly provided by the National Hurricane Center (NHC) to predict the trajectory of a hurricane at 6-hour intervals. Results show that this proposed technique is competitive to methods currently employed by the NHC and can predict up to approximately 120 hours of hurricane path.

12. B. K. Bose, "Artificial Intelligence Techniques in Smart Grid and Renewable Energy Systems—Some Example Applications," in Proceedings of the IEEE, vol. 105, no. 11, pp. 2262-2273, Nov. 2017, doi: 10.1109/JPROC.2017.2756596. https://ieeexplore.ieee.org/abstract/document/8074546
Artificial intelligence (AI) techniques, such as expert systems (ESs), fuzzy logic (FL), and artificial neural networks (ANNs or NNWs) have brought an advancing frontier in power electronics and power engineering. These techniques provide powerful tools for design, simulation, control, estimation, fault diagnostics, and fault-tolerant control in modern smart grid (SG) and renewable energy systems (RESs). The AI technology has gone through fast evolution during last several decades, and their

applications have increased rapidly in modern industrial systems. This special issue will remain incomplete without some discussion on AI applications in SG and RESs. The paper will discuss some novel application examples of AI in these areas. These applications are automated design of modern wind generation system and its health monitoring in the operating condition, fault pattern identification of an SG subsystem, and control of SG based on real-time simulator. The concepts of these application examples can be expanded to formulate many other applications. In the beginning of the paper, the basic features of AI that are relevant to these applications have been briefly reviewed.

13. Minxian Xu, Adel N. Toosi, Rajkumar Buyya (2020), "A Self-adaptive Approach for Managing Applications and Harnessing Renewable Energy for Sustainable Cloud Computing" (arXiv:2008.13312)
https://arxiv.org/abs/2008.13312
Rapid adoption of Cloud computing for hosting services and its success is primarily attributed to its attractive features such as elasticity, availability and pay-as-you-go pricing model. However, the huge amount of energy consumed by cloud data centers makes it to be one of the fastest growing sources of carbon emissions. Approaches for improving the energy efficiency include enhancing the resource utilization to reduce resource wastage and applying the renewable energy as the energy supply. This work aims to reduce the carbon footprint of the data centers by reducing the usage of brown energy and maximizing the usage of renewable energy. Taking advantage of microservices and renewable energy, we propose a self-adaptive approach for the resource management of interactive workloads and batch workloads. To ensure the quality of service of workloads, a brownout-based algorithm for interactive workloads and a deferring algorithm for batch workloads are proposed. We have implemented the proposed approach in a prototype system and evaluated it with web services under real traces. The results illustrate our approach can reduce the brown energy usage by 21% and improve the renewable energy usage by 10%.

14. Chen, B., Marvin, S., & While, A. (2020). Containing COVID-19 in China: AI and the robotic restructuring of future cities. *Dialogues in Human Geography*, *10*(2), 238–241. https://doi.org/10.1177/2043820620934267

COVID-19 has generated interest in the potential of urban robotics and automation to manage and police physical distancing and quarantine. This commentary examines the intersection between COVID-19 management strategies and the technological affordances of robotics, autonomous systems, and artificial intelligence (AI) in urban pandemic control. Examples from China illustrate the possibilities for urban robotics and automation in a new era of urban bio-(in)security.

15. Connor Christopher D. O', Calkin David E., Thompson Matthew P. (2017) An empirical machine learning method for predicting potential fire control locations for pre-fire planning and operational fire management. *International Journal of Wildland Fire* **26**, 587-597.
[link]

During active fire incidents, decisions regarding where and how to safely and effectively deploy resources to meet management objectives are often made under rapidly evolving conditions, with limited time to assess management strategies or for development of backup plans if initial efforts prove unsuccessful. Under all but the most extreme fire weather conditions, topography and fuels are significant factors affecting potential fire spread and burn severity. We leverage these relationships to quantify the effects of topography, fuel characteristics, road networks and fire suppression effort on the perimeter locations of 238 large fires, and develop a predictive model of potential fire control locations spanning a range of fuel types, topographic features and natural and anthropogenic barriers to fire spread, on a 34 000 km2 landscape in southern Idaho and northern Nevada. The boosted logistic regression model correctly classified final fire perimeter locations on an independent dataset with 69% accuracy without consideration of weather conditions on individual fires. The resulting fire control probability surface has potential for reducing unnecessary exposure for fire responders, coordinating pre-fire planning for operational fire response, and as a network of locations to incorporate into spatial fire planning to better align fire operations with land management objectives.

16. Guo, H.-nan, Wu, S.-biao, Tian, Y.-jie, Zhang, J., & Liu, H.-tao. (2021). Application of machine learning methods for the prediction of organic solid waste treatment and recycling processes: A review. Bioresource Technology, 319, 124114. https://doi.org/10.1016/j.biortech.2020.124114
"Conventional treatment and recycling methods of organic solid waste contain inherent flaws, such as low efficiency, low accuracy, high cost, and potential environmental risks. In the past decade, machine learning has gradually attracted increasing attention in solving the complex problems of organic solid waste treatment. Although significant research has been carried out, there is a lack of a systematic review of the research findings in this field. This study sorts the research studies published between 2003 and 2020, summarizes the specific application fields, characteristics, and suitability of different machine learning models, and discusses the relevant application limitations and future prospects. It can be concluded that studies mostly focused on municipal solid waste management, followed by

anaerobic digestion, thermal treatment, composting, and landfill. The most widely used model is the artificial neural network, which has been successfully applied to various complicated non-linear organic solid waste related problems."

17. Juang, Oki, Wang, Martonosi, Peh, Rubenstein (2002). Energy-efficient computing for wildlife tracking: design tradeoffs and early experiences with ZebraNet. Proceedings of the 10th international conference on Architectural Support for Programming Languages and Operating Systems, pp. 96-117.
https://doi.org/10.1145/605397.605408
Over the past decade, mobile computing and wireless communication have become increasingly important drivers of many new computing applications. The field of wireless sensor networks particularly focuses on applications involving autonomous use of compute, sensing, and wireless communication devices for both scientific and commercial purposes. This paper examines the research decisions and design tradeoffs that arise when applying wireless peer-to-peer networking techniques in a mobile sensor network designed to support wildlife tracking for biology research.The ZebraNet system includes custom tracking collars (nodes) carried by animals under study across a large, wild area; the collars operate as a peer-to-peer network to deliver logged data back to researchers. The collars include global positioning system (GPS), Flash memory, wireless transceivers, and a small CPU; essentially each node is a small, wireless computing device. Since there is no cellular service or broadcast communication covering the region where animals are studied, ad hoc, peer-to-peer routing is needed. Although numerous ad hoc protocols exist, additional challenges arise because the researchers themselves are mobile and thus there is no fixed base station towards which to aim data. Overall, our goal is to use the least energy, storage, and other resources necessary to maintain a reliable system with a very high `data homing' success rate. We plan to deploy a 30-node ZebraNet system at the Mpala Research Centre in central Kenya. More broadly, we believe that the domain-centric protocols and energy tradeoffs presented here for ZebraNet will have general applicability in other wireless and sensor applications.

18. Li, Qi, Yu, Keyang, Chen, Dong (2021). Solar Diagnostics: Automatic Damage Detection on Rooftop Solar Photovoltaic arrays.
https://doi.org/10.1016/j.suscom.2021.100595
"Homeowners are increasingly deploying rooftop solar photovoltaic (PV) arrays due to the rapid decline in solar module prices. However, homeowners may have to spend up to ~$375 to diagnose their damaged rooftop solar PV system. Thus, recently, there is a rising interest to inspect potential damage on solar PV arrays automatically and passively. Unfortunately, recent approaches that

leverage machine learning techniques have the limitation of distinguishing solar PV array damages from other solar degradation (e.g., shading, dust, snow). To address this problem, we design a new system—SolarDiagnostics that can automatically detect and profile damages on rooftop solar PV arrays using their rooftop images with a lower cost. In essence, SolarDiagnostics first leverages an K-Means algorithm to isolate rooftop objects to extract solar panel residing contours. Then, SolarDiagnostics employs a convolutional neural networks to accurately identify and characterize the damage on each solar panel residing contour. We evaluate SolarDiagnostics by building a lower cost prototype and using 60,000 damaged solar PV array images generated by deep convolutional generative adversarial networks. We find that SolarDiagnostics is able to detect damaged solar PV arrays with a Matthews correlation coefficient (MCC) of 1.0. In addition, pre-trained SolarDiagnostics yields an MCC of 0.95, which is significantly better than other re-trained machine learning-based approaches and yields as the similar MCC as of re-trained SolarDiagnostics. We make the source code and datasets that we use to build and evaluate SolarDiagnostics publicly-available."

19. Farnsworth, A., Sheldon, D., Geevarghese, J., Irvine, J., Van Doren, B., Webb, K., Dietterich, T. G., & Kelling, S. (2014). Reconstructing Velocities of Migrating Birds from Weather Radar – A Case Study in Computational Sustainability. *AI Magazine*, *35*(2), 31-48.
https://doi.org/10.1609/aimag.v35i2.2527
"Bird migration occurs at the largest of global scales, but monitoring such movements can be challenging. In the US there is an operational network of weather radars providing freely accessible data for monitoring meteorological phenomena in the atmosphere. Individual radars are sensitive enough to detect birds, and can provide insight into migratory behaviors of birds at scales that are not possible using other sensors. Archived data from the WSR-88D network of US weather radars hold valuable and detailed information about the continent-scale migratory movements of birds over the last 20 years. However, significant technical challenges must be overcome to understand this information and harness its potential for science and conservation. We describe recent work on an AI system to quantify bird migration using radar data, which is part of the larger BirdCast project to model and forecast bird migration at large scales using radar, weather, and citizen science data."

20. P. Jaworski, T. Edwards, J. Moore and K. Burnham, "Cloud computing concept for Intelligent Transportation Systems," 2011 14th International IEEE Conference on Intelligent Transportation Systems (ITSC), 2011, pp. 391-936, doi: 10.1109/ITSC.2011.6083087.

https://ieeexplore.ieee.org/abstract/document/6083087/?casa_token=-4v_K0owZNkAAAAA:poMsxNXyLEoFNRj2yHMq3_5n7z4iIyJZRE-ty7-LmFOxnUqO8XCtHH2SmDp8qbr6jyLJpXTA

"In this paper a cloud computing based urban traffic control system is proposed. Its goals are to increase road throughput and optimise the traffic control for increased safety of the participants, reduced fuel consumption and carbon emissions. The urban vehicle control scenario assumes that the speed of each vehicle in the controlled area is set by an off-board control unit that supervises each traffic intersection. The software component responsible for that is called an Intersection Control Service (ICS). From the system's point of view, the vehicles are treated as cloud services and are discovered and invoked using a cloud computing methodology. Geographical multicast addressing is used to target all vehicles in the specified areas. ICSs are part of a city/region wide cloud system that coordinates flow of traffic between intersections. The system's optimisation objective is carried out on several planning planes simultaneously, the lowest being local to a single intersection and the highest being an entire city or region level. The ICS gathers traffic data from various sensors around the intersection, and from the vehicles themselves, creating a dynamic situation map which can be used to assess the road situation and perform short term predictions for vehicle control purposes."

21. Park, Y.-SJ and JH (2020). Security, Privacy, and Efficiency of Sustainable Computing for Future Smart Cities. *Journal of Information Processing Systems* , *16* (1), 1–5. https://doi.org/10.3745/JIPS.03.0133

"Sustainable computing is a rapidly expanding field of research covering the fields of multidisciplinary engineering. With the rapid adoption of Internet of Things (IoT) devices, issues such as security, privacy, efficiency, and green computing infrastructure are increasing day by day. To achieve a sustainable computing ecosystem for future smart cities, it is important to take into account their entire life cycle from design and manufacturing to recycling and disposal as well as their wider impact on humans and the places around them. The energy efficiency aspects of the computing system range from electronic circuits to applications for systems covering small IoT devices up to large data centers. This editorial focuses on the security, privacy, and efficiency of sustainable computing for future smart cities. This issue accepted 17 articles after a rigorous review process."

22. **Monitoring of Coral Reefs Using Artificial Intelligence: A Feasible and Cost-Effective Approach**

González-Rivero, M., Beijbom, O., Rodriguez-Ramirez, A., Bryant, D. E. P., Ganase, A., Gonzalez-Marrero, Y., … Hoegh-Guldberg, O. (2020). Monitoring of Coral Reefs Using Artificial Intelligence: A Feasible and Cost-Effective Approach. R*emote Sensing*, *12*(3), 489. doi:10.3390/rs12030489
https://www.mdpi.com/2072-4292/12/3/489/htm
"Ecosystem monitoring is central to effective management, where rapid reporting is essential to provide timely advice. While digital imagery has greatly improved the speed of underwater data collection for monitoring benthic communities, image analysis remains a bottleneck in reporting observations. In recent years, a rapid evolution of artificial intelligence in image recognition has been evident in its broad applications in modern society, offering new opportunities for increasing the capabilities of coral reef monitoring. Here, we evaluated the performance of Deep Learning Convolutional Neural Networks for automated image analysis, using a global coral reef monitoring dataset. The study demonstrates the advantages of automated image analysis for coral reef monitoring in terms of error and repeatability of benthic abundance estimations, as well as cost and benefit. We found unbiased and high agreement between expert and automated observations (97%). Repeated surveys and comparisons against existing monitoring programs also show that automated estimation of benthic composition is equally robust in detecting change and ensuring the continuity of existing monitoring data. Using this automated approach, data analysis and reporting can be accelerated by at least 200x and at a fraction of the cost (1%). Combining commonly used underwater imagery in monitoring with automated image annotation can dramatically improve how we measure and monitor coral reefs worldwide, particularly in terms of allocating limited resources, rapid reporting and data integration within and across management areas."

23. R. A. Cardenas-Tamayo et al., "Pervasive Computing Approaches to Environmental Sustainability," in IEEE Pervasive Computing, vol. 8, no. 1, pp. 54-57, Jan.-March 2009, doi: 10.1109/MPRV.2009.14.
https://ieeexplore-ieee-org.proxy.library.vanderbilt.edu/document/4736479
"This issue's Works in Progress department lists eight projects with a focus on environmental sustainability. The first three projects explore sensing and pervasive computing techniques for monitoring environmental conditions in outdoor situations. The next four projects use pervasive computing in indoor environments to inform individuals about their energy and resource consumption with the goal of positively influencing their behaviors. The final project aims to develop an energy generation infrastructure that combines multiple types of renewable energy sources."

24. Campenhout, B. Van. (2021). The role of information in agricultural technology adoption: Experimental evidence from rice farmers in uganda. *Economic Development and Cultural Change*, *69*(3), 1239-1272. https://doi.org/10.1086/703868

"Optimal decision-making among the poor is often hampered by insufficient knowledge, false beliefs, or wrong perceptions. This paper investigates the role of information in the decision to use modern inputs and adopt recommended agronomic practices among rice farmers in Uganda. Using field experiments, I tested whether the provision of technical information about the correct use of modern inputs and practices affects adoption of these technologies and subsequent rice production. In addition, I assessed whether providing information aimed at changing the perception of the expected returns on such intensification investments led to different outcomes. In both experiments, the treatments took the form of short agricultural extension information videos shown to individual farmers using tablet computers. I found that both interventions resulted in increased intensification of rice cultivation but only after accounting for the possibility of interference between farmers. These results confirm the importance of peer effects in increasing the effectiveness of information for technology adoption."

25. M. E. Peck and D. Wagman, "Energy trading for fun and profit buy your neighbor's rooftop solar power or sell your own-it'll all be on a blockchain," in *IEEE Spectrum*, vol. 54, no. 10, pp. 56-61, October 2017, doi: 10.1109/MSPEC.2017.8048842.

"Would you pay slightly more for your electricity if you knew it was sourced from photovoltaic panels on your neighbor's roof? Or, if you are that neighbor, would you use your solar power to charge a battery and dump that energy back onto the grid at peak hours, when the price was highest? The answers to these questions-which depend on how people would behave in an open energy market-are unknown, because that market does not exist. Net metering and feed-in tariff programs, the two dominant schemes for reimbursing residential energy production, pay out at a fixed rate, effectively decoupling producers from the price signals that might otherwise direct their behavior. But that may be changing. And we may have the blockchain to thank. Multiple projects are now under way to use technology that was originally intended to account for transactions in digital currency to track electricity production and put it up for sale."

26. Nishant, Rohit, Mike Kennedy, and Jacqueline Corbett. "Artificial Intelligence for Sustainability: Challenges, Opportunities, and a Research Agenda." *International journal of information management* 53 (2020): 102104–. Web.

https://www-sciencedirect-com.proxy.library.vanderbilt.edu/science/article/pii/S0268401220300967
"Artificial intelligence (AI) will transform business practices and industries and has the potential to address major societal problems, including sustainability. Degradation of the natural environment and the climate crisis are exceedingly complex phenomena requiring the most advanced and innovative solutions. Aiming to spur groundbreaking research and practical solutions of AI for environmental sustainability, we argue that AI can support the derivation of culturally appropriate organizational processes and individual practices to reduce the natural resource and energy intensity of human activities. The true value of AI will not be in how it enables society to reduce its energy, water, and land use intensities, but rather, at a higher level, how it facilitates and fosters environmental governance. A comprehensive review of the literature indicates that research regarding AI for sustainability is challenged by (1) overreliance on historical data in machine learning models, (2) uncertain human behavioral responses to AI-based interventions, (3) increased cybersecurity risks, (4) adverse impacts of AI applications, and (5) difficulties in measuring effects of intervention strategies. The review indicates that future studies of AI for sustainability should incorporate (1) multilevel views, (2) systems dynamics approaches, (3) design thinking, (4) psychological and sociological considerations, and (5) economic value considerations to show how AI can deliver immediate solutions without introducing long-term threats to environmental sustainability."

27. Azadi, M., Moghaddas, Z., Cheng, T. C. E., & Farzipoor Saen, R. (2021). Assessing the sustainability of cloud computing service providers for industry 4.0: A state-of-the-art analytical approach. *International Journal of Production Research*, 1–18. https://doi.org/10.1080/00207543.2021.1959666

"While interests in Industry 4.0 technologies such as cloud computing and the Internet of Things (IoT) are growing, an ongoing challenge is to properly evaluate the performance of the providers of such technologies. Methods have been developed and applied to assess the efficiency of cloud service providers (CSPs) for Industry 4.0. However, most existing methods suffer from such shortcomings as subjective weights and computing complexity, rendering it difficult to succinctly differentiate the performance of CSPs in a competitive market. Besides, the literature has not taken into account many different types of data such as ratios, integers, and undesirable factors that can affect the performance of CSPs. Most importantly, most existing studies do not consider the sustainability of CSPs in evaluating their performance. To address the above issues, we present a comprehensive analytical method based on data envelopment analysis (DEA) to gauge the sustainability of CSPs for Industry 4.0. Validating the usefulness of our method using a real-life dataset, we provide not only a viable means with sound

academic underpinning but also significant managerial insights for practitioners to assess the sustainability of CSPs for Industry 4.0."

28. Tanveer Ahmad, Dongdong Zhang, Chao Huang, Hongcai Zhang, Ningyi Dai, Yonghua Song, Huanxin Chen. (2021). Artificial intelligence in sustainable energy industry: Status Quo, challenges and opportunities. *Journal of cleaner production.* *https://www.sciencedirect.com/science/article/pii/S0959652621000548?casa_token=57fQAWCW8J0AAAAA:jzalb85h8GwRcvgpJwKv3zL8Y6tpviGjecWUlrbSIJ1CB_qrVYFRk7bjZERKbMlLVexDNNkT*

"The energy industry is at a crossroads. Digital technological developments have the potential to change our energy supply, trade, and consumption dramatically. The new digitalization model is powered by the artificial intelligence (AI) technology. The integration of energy supply, demand, and renewable sources into the power grid will be controlled autonomously by smart software that optimizes decision-making and operations. AI will play an integral role in achieving this goal. This study focuses on the use of AI techniques in the energy sector. This study aims to present a realistic baseline that allows researchers and readers to compare their AI efforts, ambitions, new state-of-the-art applications, challenges, and global roles in policymaking. We covered three major aspects, including: i) the use of AI in solar and hydrogen power generation; (ii) the use of AI in supply and demand management control; and (iii) recent advances in AI technology. This study explored how AI techniques outperform traditional models in controllability, big data handling, cyberattack prevention, smart grid, IoT, robotics, energy efficiency optimization, predictive maintenance control, and computational efficiency. Big data, the development of a machine learning model, and AI will play an important role in the future energy market. Our study's findings show that AI is becoming a key enabler of a complex, new and data-related energy industry, providing a key magic tool to increase operational performance and efficiency in an increasingly cut-throat environment. As a result, the energy industry, utilities, power system operators, and independent power producers may need to focus more on AI technologies if they want meaningful results to remain competitive. New competitors, new business strategies, and a more active approach to customers would require informed and flexible regulatory engagement with the associated complexities of customer safety, privacy, and information security. Given the pace of development in information technology, AI and data analysis, regulatory approvals for new services and products in the new Era of digital energy markets can be enforced as quickly and efficiently as possible."

29. Mellado B, Wu J, Kong JD, Bragazzi NL, Asgary A, Kawonga M, Choma N, Hayasi K, Lieberman B, Mathaha T, Mbada M, Ruan X, Stevenson F, Orbinski J. Leveraging Artificial Intelligence and Big Data to Optimize COVID-19 Clinical Public Health and Vaccination Roll-Out Strategies in Africa. International Journal of Environmental Research and Public Health. 2021; 18(15):7890. https://doi.org/10.3390/ijerph18157890

"COVID-19 is imposing massive health, social and economic costs. While many developed countries have started vaccinating, most African nations are waiting for vaccine stocks to be allocated and are using clinical public health (CPH) strategies to control the pandemic. The emergence of variants of concern (VOC), unequal access to the vaccine supply and locally specific logistical and vaccine delivery parameters, add complexity to national CPH strategies and amplify the urgent need for effective CPH policies. Big data and artificial intelligence machine learning techniques and collaborations can be instrumental in an accurate, timely, locally nuanced analysis of multiple data sources to inform CPH decision-making, vaccination strategies and their staged roll-out. The Africa-Canada Artificial Intelligence and Data Innovation Consortium (ACADIC) has been established to develop and employ machine learning techniques to design CPH strategies in Africa, which requires ongoing collaboration, testing and development to maximize the equity and effectiveness of COVID-19-related CPH interventions."

30. Jenny, Hubert, et al. "Using Artificial Intelligence for Smart Water Management Systems." *ADB*, June 2020, doi:10.22617/brf200191-2. https://www.adb.org/sites/default/files/publication/614891/artificial-intelligence-smart-water-management-systems.pdf

"Data-driven "intelligent" applications have become disruptors to daily living. Innovative water utilities can benefit from this digital technology revolution to improve their performance. By harnessing the power of artificial intelligence algorithms and big data analytics, water utilities can maximize information and data available to make better decisions while enhancing service delivery and reducing costs. This brief introduces the principles of artificial intelligence for water utilities embarking on this digital transformation to improve their water distribution operation in general, and to address unaccounted-for-water problems in particular. The brief describes some of the most extended applications of big data analytics and artificial intelligence-related algorithms in water supply, discusses how water utilities can pilot artificial intelligence toward the prognosis of unaccounted-for-water, and presents recommendations for implementation and preliminary cost estimates."

1. Zentao Wu (2018-09-01) Chemical Engineering Transactions, DOAJ Directory of Open Access Journals. (a journal article)
https://catalog.library.vanderbilt.edu/permalink/01VAN_INST/11nigse/cdi_doaj_primary_oai_doaj_org_article_d4f3c0dc9d024a7d8681764793b5f401
"To study the application of cloud computing technology in the early warning management of chemical water pollution accidents, the early warning management platform of chemical water pollution accidents is built based on the cloud computing technology, modern information technology and communication technology. The platform combines the cloud and terminal and then analyzes the application of cloud computing in the early warning management of chemical water pollution accidents. The early warning management of chemical water pollution accidents designed in this paper can timely collect, process and transmit the information of chemical water pollution accidents and can timely feedback the information to relevant departments. This system can save the development cost of chemical enterprises and improve the efficiency and quality of the early warning management of chemical water pollution accidents, which is of certain application value."