



The ARL/CNI 2035 Scenarios

AI-Influenced Futures in the Research Environment

May 2024



The ARL/CNI 2035 Scenarios: AI-Influenced Futures in the Research Environment

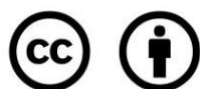
May 2024

Association of Research Libraries (ARL)

Coalition for Networked Information (CNI)

Stratus Inc.

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Table of Contents

- Acknowledgments4
- Introduction6
- Scenario 1: Democratizing AI 12
 - Current Drivers and Trends Signaling the Potential of this Scenario 14
 - Some Strategic Questions for the ARL and CNI Communities to Consider..... 14
 - Alex’s Experience in This Scenario 15
- Scenario 2: Technocratic AI..... 17
 - Current Drivers and Trends Signaling the Potential of this Scenario 19
 - Some Strategic Questions for the ARL and CNI Communities to Consider..... 20
 - Alex’s Experience in This Scenario 20
- Scenario 3: Divisive AI.....22
 - Current Drivers and Trends Signaling the Potential of this Scenario24
 - Some Strategic Questions for the ARL and CNI Communities to Consider.....24
 - Alex’s Experience in This Scenario24
- Scenario 4: Autonomous AI.....27
 - Current Drivers and Trends Signaling the Potential of this Scenario29
 - Some Strategic Questions for the ARL and CNI Communities to Consider.....29
 - Alex’s Experience in This Scenario29
- End-State Table.....32

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ARL/CNI Joint Task Force on Scenario Planning for AI/ML Futures

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Introduction

The Association of Research Libraries (ARL) and the Coalition for Networked Information (CNI) have chosen to apply scenario planning to imagine a future influenced by artificial intelligence (AI) and to explore the range of uncertainty associated with AI in the research and knowledge ecosystem. These scenarios have been developed from a North American perspective through deep engagement with the CNI and ARL membership. In developing the content, the CNI and ARL task force considered “artificial intelligence (AI)” as a shorthand for a wide variety of computational tools and techniques that have been developed over the past half-century that have evolved through three phases: expert systems, machine learning, and currently in the deep-learning phase.

Scenario planning is an excellent methodology to apply to a topic like AI in which there is an enormous amount of uncertainty as to how it will evolve in the coming years. Currently, generative AI is receiving significant attention and focus, while machine learning and predictive methods have also seen wide use over the past decade. AI technologies are frequently embedded in systems with broader functions such as chatbots or recommender systems. To ensure the wide range of future possibilities is adequately addressed, we have crafted the scenarios to span possible futures that include the failure of AI applications and dangerous outcomes for society, to ones in which AI leads to superhuman capabilities, all the way through the as-yet conceptual notion of artificial general intelligence (AGI), which is intended to match or greatly surpass human analytic, reasoning, planning, and creative capabilities across a wide range of domains, and which some perceive as an existential threat to humanity’s survival.

A core principle in scenario planning is to focus on plausibility (rather than probability) and to suspend disbelief such that we consider the full range of future possibilities we may face. As such, we do not choose one scenario and plan toward it, but focus on a set of scenarios that elevate the most critical uncertainties we need to address. The future

will never be exactly as described in any one scenario but the future will be made up of components of all the scenarios that are created.

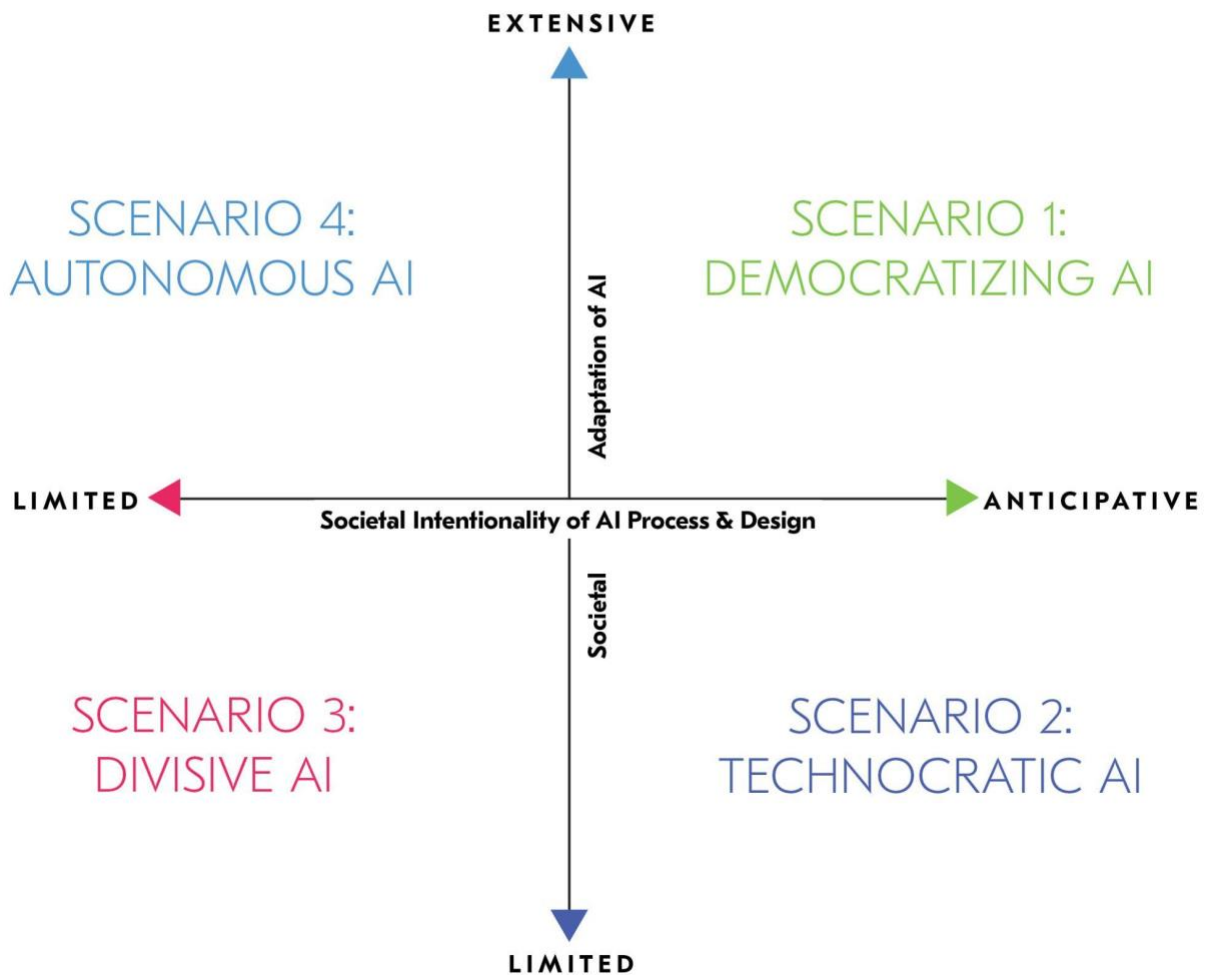
The scenario planning process's first phase was a data-gathering process to clarify the core strategic questions (strategic focus) the ARL and CNI communities wish to address through this effort. Based on the data-gathering phase, the following strategic focus emerged:

How do we enable the full potential of AI in the research and knowledge ecosystem?

- **Ensure responsible AI with data integrity, provenance, and persistence.**
- **Achieve equitable and inclusive practices.**
- **Optimally position the research and knowledge ecosystem for learning.**
- **Clarify strategic role(s) for libraries that add value.**

This strategic focus is the question the scenarios are designed to inform. To ensure ARL and CNI stretch beyond conventional wisdom in their imaginings of the future, the end state of the ARL and CNI scenarios has been set at year 2035, or approximately 10 years in the future. Based on an interactive workshop attended by representatives of the ARL and CNI communities, the following set of AI scenarios was created:

ARL/CNI 2035 Scenario Set



This set of scenarios is framed by two critical uncertainties:

Societal Intentionality of AI Process and Design—Will process and design be anticipative or will it be limited? The choice of intentionality here was to move beyond reactivity (proactive versus reactive) into effectiveness and attention to responsible and anticipative process and design around AI.

Societal Adaptation of AI—Will adaptation of AI by society be extensive or limited? Adaptation in this context includes level of adoption as well as ability to adapt and respond to the ever-changing society.

The two critical uncertainties frame four divergent scenarios:

Scenario 1—Democratizing AI is a world in which an extraordinary convergence of advances in human-computer interfaces and AI technologies create an unprecedented integration of human and computational capabilities that flourish with increasingly open knowledge access. AI integrates with humans seamlessly, responsibly, and safely transforming research, knowledge development, collaboration, and communication.

Scenario 2—Technocratic AI is a world in which AI's impact on the research and knowledge ecosystem is relatively low with the primary AI advances and impact being seen in consumer applications that are readily profitable, relatively uncontroversial, and lower-barrier applications. Tech giants drive innovation in the interaction of individuals with each other and around real, virtual, and hybrid worlds that leverage AI to create enhanced environments and experiences.

Scenario 3—Divisive AI is a world of missed opportunities, bad decisions, and fecklessness. The excitement and hype around AI and the belief that AI will be the solution to the world's most difficult problems results in an overzealous and hasty adoption of AI in both consumer life and professional applications. AI applications incorporating egregious bias or dysfunction were deployed, leading to misinformation validating and strengthening flawed systems that exclude many and strengthen and enrich a few.

Scenario 4—Autonomous AI is a world in which AI is becoming an increasingly independent partner and collaborator in research and learning, leveraging the expanding open resources and data. Knowledge advances rapidly well beyond the research advances possible by humans. Society has adapted to a world enhanced by AI in all aspects of life and experience and in the process has knowingly and unknowingly given up increasing agency to AI.

The scenarios explore the following critical uncertainties over the next 10 years:

AI Lifecycle and Design for Research and Learning	Digital Literacy
Societal Adaptation to AI (Perception and Trust)	Learning
Power, Influence, and AI/Human Agency	Teaching and Education
Policy Environment	Workforce
Global View	Research
Democratization of Research and Learning with AI (Access, Open/Closed)	Role of Libraries
Data Integrity, Provenance, Persistence	Scholarly Record and Communication
Bias, Ethics, Inclusion, Equity	AI Environmental Impact
Cultural Heritage and Memory	

A detailed table describing the end state in 2035 of each scenario is included for your reference at the end of this document. These scenarios will be leveraged to strategically plan around AI in research, knowledge, and learning. They are designed to present an AI risk mitigation problem set for ARL and CNI member use. This allows each member to investigate the strategic implications of each of the scenarios for that member's unique, local context. In approaching this material, suspend your disbelief, avoid choosing a preferred scenario, and embrace the full set of possibilities included in this material. Remember, the future will not be as described in any one scenario but will be made up of components of all four scenarios.

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**Meet Dr. Alex Rutherford...**Alex (she, her) is director of the Horizon Innovations Foundation (HIF), responsible for reviewing and awarding grants to innovative research focused on the next horizon of knowledge and endeavors. Alex is in her mid-40s, having started her career as a researcher at an R2 institution studying glacial melt. Her constant efforts as a PI to secure funding peaked her interest in the funding process and players, and how funding could be made to better serve researchers and the advancement of knowledge. Six years earlier she joined HIF and was promoted to director two years ago. See the future through Alex's life and work in the following four scenarios....

## Scenario 1: Democratizing AI

**This is a world in which** an extraordinary convergence of advances in human-computer interfaces based on enhanced augmented reality and a range of AI technologies have created an unprecedented integration of human and computational capabilities that flourish with increasingly open knowledge access. This advancement has been paired with a thoughtful and intentional design process and the financial investments that allow AI to integrate with humans seamlessly, responsibly, and safely in the service of broad societal goals. The continued drive of curiosity and advancement that has been a longtime catalyst for innovation that has come from academia continues, but expands now to encompass a wider and more fluid set of innovators and players. Many innovations are quickly commoditized for public good. The development model is highly adaptive to the fast pace and churn of successes and failures in innovation and new products. These new interfaces transform research, knowledge development, collaboration, and communication leading to AI enhanced humans and teams with new abilities and enhanced human agency. Such an advancement was only possible through a healthy collaboration between the public and private sectors, including government, industry, civil society, the scientific community, and educational institutions.

Although at times a struggle, together society created a set of responsible guidelines and standards around the design and deployment of AI that ensured safety and inclusivity of the tools. Many of these guidelines and policies went beyond AI, and dealt with issues such as privacy, transparency, data integrity, and open access that provided a foundation for the development of advanced AI. With transparent engagement of a digitally literate public in the development of the guidelines and the deployment plans, and the public's expanding experiences with large language models (LLMs) and AI assistants, public trust in AI is growing. A limited but reasonably balanced regulatory approach, supplemented by a larger set of voluntary best practices and agreements has taken hold for the development of the frameworks and policies that are driven by values and principles toward the betterment of society and improved quality of life, but of course some are frustrated by the addition of guidelines that they believe slow progress.

Crucially, these norms, practices, and regulatory frameworks were accompanied by systematic investments to harness AI technologies to address large scale social goals.

This is not a perfect world by any means. Bad actors operate around the margins who don't honor the nonregulatory agreements or only honor them performatively.

International disagreements about norms still exist, though some regions and players reach agreement and convergence including US/Canada with Europe, and as tensions have eased with China, progress is made where shared benefit is recognized.

Many researchers train, learn, and develop their expertise outside of traditional higher education with disruptive new models of precision learning through personalized, integrated AI made possible by the success of public access policies and public investment in an AI public option. Research collaboration happens easily as topics and curiosities attract a multitude of researchers to explore and experiment in new and exciting ways. Indeed, everyone can question and contribute to research.

A new era of research—driven by enhanced levels of curiosity and/or complexity of the problems being researched—usurps disciplines and human-contrived bounds and organizing factors. The emphasis on data security, privacy, and integrity has enabled AI technologies to be coupled effectively with large-scale use of inclusive, well-vetted patient data, allowing the medical research community to make rapid progress in curing and treating a number of diseases. In addition, as AI accesses quality data on human behavior, changing ecosystems, and climate change globally, new and exciting insights emerge at an unprecedented pace. With open AI and private and public sector collaboration globally, measurable progress is being made on grand challenges facing humanity at a pace never before conceived.

Research libraries focus on the researcher and learner experience. They provide a conduit to data, software, and knowledge, while stewarding the ever expanding scholarly record. The most advanced libraries operate almost exclusively on an AI platform.

A transformation of work is well underway with the introduction of AI enhanced humans into the workforce and robots being deployed to fulfill rote, repetitive activities.

Those who are not in functions that benefit by AI or robotics remain unaffected. A significant focus of the government and public sector is on retraining and upskilling the workforce for the future.

Public policy and societal debate is setting the stage for future generations of human-machine interfaces, which will likely include various kinds of direct brain computer interfaces (BCI) and neural implants. Development of these technologies proceeds, but cautiously, with the recognition of the challenges associated with advanced safety and privacy requirements, as well as equity and ethical issues that will take the current divide between those who are AI-enhanced and those who cannot or choose not to be enhanced to a much more extreme level.

### **Current Drivers and Trends Signaling the Potential of this Scenario**

The current rapid adoption of AI in education, research, and consumer-facing apps and tools sets the stage for a growing acceptance and experience with the potential of AI. AI provides a means to address complex, global challenges as never before possible. The recent introduction in January 2024 of the Apple Vision Pro is a significant step forward toward BCI. The US National Science Foundation (NSF) prototype of the National AI Research Resource (NAIRR) is worth note and whether Congress funds the full-scale NAIRR in the coming years, which would represent a large-scale public investment in AI and supporting infrastructure.

### **Some Strategic Questions for the ARL and CNL Communities to Consider**

- How can the library leverage its interdisciplinarity best in the research and learning processes?
- How can cultural memory be preserved in this fast-moving scenario?
- How can the research and knowledge ecosystem be optimally positioned for learning in this scenario?

## Alex's Experience in This Scenario...

Alex awakes to the synthesized daily sunrise, warmth, and songbirds that stream her senses. She smiles and then notices the aroma of fresh coffee. Perfect. Alex puts her AI contact lens in her right eye. Immediately, her assistant, MITA, greets her with her health metrics, daily menu suggestions, and itinerary for the day. In 30 minutes, Alex is dressed, satiated, and at work in her home office with a warm cup of coffee.

New computer interfaces have ushered in an era of highly abled humans, and Alex, as director of Horizon Innovations Foundation (HIF), supports research and innovation focused on harmonizing human intellect with AI's limitless potential. Alex was attracted to HIF's vision of AI-enhanced humans collaborating on multidisciplinary research, addressing grand challenges from climate change to space exploration.

Her day starts with mediating a roundtable where tech innovators, policymakers, other funding agencies, and ethicists congregate to sculpt guidelines for BCI tools. These guidelines, a testament to public-private collaboration, emphasize inclusivity, ensuring that the augmentation of human abilities through AI is a choice accessible to all, not a privilege of the few. HIF will apply the final set of guidelines against all future BCI grant proposals and will be advocating heavily with its peer funding institutions that the guidelines become the standard. At the same time Alex worries these guidelines may severely limit opportunities to genuinely push the technology envelope and understand what is possible; she keeps these concerns to herself.

Throughout the week, Alex oversees the development of virtual research libraries—repositories not just of knowledge, but of experience. These libraries are the nexus of data, software, and human ingenuity, and are focused on the challenge of capturing the experience and logic of research and problem-solving rather than just evidence and outcomes. The challenge is to ensure that these digital havens serve as conduits for knowledge while maintaining the cultural memory and intellectual diversity of the research community. As a result, it is important that libraries cater to the full research community of AI-enhanced and non-enhanced researchers.

Amidst this transformative landscape, Alex remains vigilant of the societal implications of AI. Change is exciting, but it can be fleeting and dismissive of past memory and artifacts. HIF thus has embarked on an initiative to maintain cultural memory, digitizing and preserving the richness of human history and experience across the rich tapestry of cultures and peoples.

As AI-enhanced humans become a staple in the workforce, Alex steers the fund to address the growing need for retraining and upskilling of the workforce, ensuring that no segment of society is left adrift in the wake of change. The fund partners with government bodies to launch The Human Potential Project, a program aimed at equipping the workforce with the skills necessary to thrive with AI and robotic counterparts. Alex tells MITA to make note that HIF needs to connect this program with the fund's Cognition Without Borders program, which supports research endeavors that transcend traditional education, enabling precision learning through AI-driven personalized curricula—a perfect platform in which to embed the Human Potential Project's retraining and upskilling activities.

Alex's week culminates in a symposium, "Equity in Enhancement," where legislators, scholars, and citizens debate the ethical considerations of a society divided by choice between enhanced and unenhanced humans. Alex and HIF champion a future where diversity in human capabilities (with or without AI enhancement) is not a source of division but an even richer tapestry of collective strength.

In a world transformed by AI, Dr. Alex Rutherford views her work as one of balance—between the enhanced and the natural, the past and the future, the individual and the collective. She is a representative of a society in flux, ensuring that the journey into AI augmentation enhances not just human capabilities, but human values and experiences.



## Scenario 2: Technocratic AI

**This is a world in which** AI's systematic impact on the research and knowledge ecosystem is relatively low with the primary AI advances and impact being seen in consumer applications and markets. The low impact in the research and knowledge ecosystem is the result of both an overall public hesitancy around use of AI in more impactful applications and the strong drive of tech companies on moving AI forward in readily profitable, relatively uncontroversial, and lower-barrier applications such as consumer products and entertainment.

The AI advancements have the greatest impact on the behavior of people and society in areas like entertainment, social media, and the education nexus. Well-resourced local governments are enthusiastic about AI in smart city design, as they partner with tech companies on self-driving cars and generally making their cities hospitable to big tech. Tech giants and entertainment organizations drive innovation in the interaction of individuals with each other and around real, virtual, and hybrid worlds through advanced interfaces and tools that incorporate AI to create enhanced environments and experiences.

The tech companies ensure the AI programming includes mechanisms to accurately discern, identify, and tag with persistent identifiers deepfakes and biased content, to improve the quality of content and data being accessed and shared by AI and people. The result of the improved quality and accuracy of data are some amazing new applications. LAZARUS, which allows for both historical figures and ancestors to be reanimated in a highly interactive individual or group setting, redefines family and community life, education, and entertainment. For many, these experiences with colleagues, family, and friends, are very real and transformative.

Interestingly, by keeping the social-scale applications of AI relatively centralized, it's proved possible to manage the environmental impact of these systems by close coupling between green energy sources and the hyperscale data centers that support the AI systems.

The applications of AI in the research and knowledge ecosystem that do emerge are primarily controlled by tech companies and the private sector, limiting access or the potential of discovery and research. Some of the more active areas include drug discovery or materials science, where the tech firms can readily monetize their AI investments. Elite research enterprise and technology company alliances emerge that reconfigure the research and higher education landscape. The primary research work is happening in costly and centralized AI computing centers, many of which are owned by either large research universities and institutions or by tech companies that lease time to users. The result is the consolidation of research activity among highly resourced programs while many smaller players struggle, not being able to afford access to the advanced tools and technology. There are occasional startling breakthroughs from the university sector (and not necessarily just the elite research universities) where novel techniques and algorithms are developed that are much less resource-intensive than the dominant industry practices. Some academic researchers have become extremely adept at parsimonious use of computational resources in advanced AI systems.

The public has relatively low digital literacy, but embraces these new gadgets and apps that for them do useful things, work well enough, and are deeply engaging. The tech organizations and platforms offering these products and applications continue to compile, mine, and leverage the consumer data on preferences and behaviors and use these to continue expanding their reach and consumer dependence, solidifying an oligarch of a few influential and powerful tech companies.

Government and policymakers are not deeply engaged in oversight, following the recommendations of the experts in the tech industry, leading to a period of low regulation, strong consumer markets, and a robust tech industry. As the shift in climate and conditions on the planet continue to worsen, the tech companies proactively collaborate with policymakers, the private sector, and various research institutions on novel approaches to mitigate the dangerous state of the climate and global systems. Other collaborations between the tech and public sectors also take place around issues of public health and national security, but many of which are classified efforts.

Consumer applications of AI move quickly into the space of learning experiences, leapfrogging the existing traditional educational models and institutions. Most consumers are able to access affordable online higher learning experiences in place of traditional degree programs. There is a growing split in the educational system between the skills and educational goals for the broad population and a much smaller elite that mixes wealthy students and those with technical interests and talents that are in demand. Elite learners are identified by tech organizations at an early age through their behavioral consumer data. These individuals receive special training and education to prepare them to be adaptive workers in technology and other advanced industries. A few highly prestigious institutions serve the elite learners who also seek a campus, legacy experience. Training researchers is less efficient and more expensive than the interactive edutainment offered to the vast majority of learners, K–12 and beyond. There are fewer research libraries than there once were that serve well-resourced programs, offering AI-enhanced research and learning tools. Interestingly they serve not only the remaining elite research institutions but also their commercial collaborators.

Community colleges and state institutions struggle for resources and survival, focusing primarily on human-based education enhanced with online, virtual options. They are among the few that champion education in digital literacy skills.

### **Current Drivers and Trends Signaling the Potential of this Scenario**

Current lack of shared understanding or meaning of the state of affairs has led consumers to lose a shared story and collective aspiration for the future. Tech giants have achieved unprecedented global power, resources, and influence, operating platforms that elude jurisdictional controls while continuing to leverage growing data on individuals and institutions globally. There is a public reluctance to deploy AI in high-risk, high-payoff, high-impact applications, but there is growing interest in reanimation and similar entertainment or edutainment applications of AI.

### **Some Strategic Questions for the ARL and CNI Communities to Consider**

- How best can issues of digital illiteracy be addressed in this scenario?

- How can incubators of innovation be created within academic and research institutions?
- How can the research and knowledge ecosystem be optimally positioned for learning in this scenario?

### Alex's Experience in This Scenario...

Alex emerges from the next generation LAZARUS, deeply impacted. She literally felt Darwin's handshake. Or did she? Was that even possible?

In a world where artificial intelligence has transformed consumer markets but barely skimmed the surface of the research and knowledge ecosystem, Alex stands as a beacon of change within a sea of stagnation. As the director of the Horizon Innovations Foundation, a philanthropic organization dedicated to fostering innovation in research and scholarship, her days are a delicate balance between leveraging technology for scientific and societal advancement and navigating the overwhelming control tech companies hold over technology and tools for research and scholarship.

It's a crisp Monday morning, and Alex arrives early to work at the foundation's HUB, wanting to try out LAZARUS while the office is quiet. She grabs her coffee and asks MITA for her schedule. Alex's week encapsulates the challenges and aspirations of a society on the brink of technological enlightenment yet teetering on the edge of digital illiteracy. The Horizon Innovations Foundation's latest initiative is an ambitious project aiming to democratize AI tools for underfunded researchers, a feat that many have deemed impossible given the current tech oligarchy.

In the organization's sleek conference room, Alex leads a brainstorming session that afternoon with a diverse team of thinkers, educators, and technologists both virtual and in person. The topic at hand is the creation of open-source AI platforms that could revolutionize data analysis for climate research. The team is well aware that the success of such a platform could shift the power dynamics in the research community, providing another option for those who struggle to afford the centralized, costly AI computing centers owned by tech giants and elite institutions.

As the week unfolds, Alex engages in a series of strategic partnerships. One day, it's a meeting with library leaders to discuss bridging the digital literacy gap, ensuring that the next generation is not left behind in this rapidly evolving virtual world. Another day, Alex is in talks with policymakers, advocating for a more involved governmental stance in regulating AI to ensure equitable access to advanced tools.

Despite the organization's nonprofit status, the role of director requires a business acumen comparable to that of any tech mogul. Daily, Alex negotiates with tech companies for access to AI applications, all while maintaining the integrity and independence of the research community. It's a tightrope walk between collaboration and capitulation.

And she is fully aware that addressing digital illiteracy takes more than just access to technology; it requires a fundamental shift in education and community engagement. Creating incubators of innovation within academic and research institutions means breaking down the walls that currently keep resources hoarded among the few.

Alex and the foundation must continue to position the research and knowledge ecosystem for optimal learning and not just technological advancement—but a reinvigoration of human curiosity and a commitment to collective betterment.

### Scenario 3: Divisive AI

**This is a world of** missed opportunities, bad decisions, and fecklessness. The political and social inability to manage the problems generated by pre-AI-intensive technologies such as social media or to address issues related to bias, privacy and data integrity, and security set the stage for a failure to act effectively as AI-based systems were increasingly introduced into commercial, health care, and governmental settings. The excitement and hype around AI and the belief that AI will be the solution to the world's most difficult problems results in an overzealous and hasty adoption of AI in both consumer life and professional applications, including research and education. Irresponsibly, a number of AI applications incorporating egregious bias or dysfunction were deployed, with very damaging results for some parts of the population. Massive data privacy breaches continue on a routine basis; but perhaps worse is the growing market in the resale of consumer data. The AI applications in this scenario are much more traditional AI applications embedded in societal and commercial systems that provide “advice” that is too often uncritically followed by humans. Humans are frequently irresponsible in managing these AI tools and the data they access.

This is a free-for-all; there's a lot of innovation going on, at least for people who can afford it. There are health care breakthroughs that benefit some profitable population subsegments. We are seeing limited experiments with brain-computer interfaces by a few very wealthy people and a few very secretive government agencies, although there is no hope of extending these technologies to any meaningful part of the population in the foreseeable future, and it's clear that they are going to lead to even greater inequalities and other social problems.

From time to time, public outrage at poorly planned or egregiously biased systems and services results in badly framed legislation or regulation intended to “do something” about the urgent problem of the day, leading to a burdensome patchwork of controls and prohibitions. Bad actors of all kinds—criminals, geopolitical opponents, domestic extremists of various stripes—have continued to actively exploit this open and poorly controlled environment, propagating misinformation, disinformation, and propaganda

to various ends, again resulting in sporadic and panicked attempts by various government sectors to respond. National security concerns have become a growing factor here, as geopolitical tensions and fault lines have expanded. There's an enormous amount of personal information in private hands, and in the hands of geopolitical opponents; this is being used to further drive the pollution of the information environment.

Overall information and technology literacy is fairly low, though there is growing focus and knowledge among parts of the population about how to circumvent some of the most annoying and problematic AI algorithms in areas like personal finance and health care. Digital and knowledge divides are multiplying and spreading. The population has very low trust or confidence in government's abilities to manage what's happening to society; the population has a very high distrust of commercial players—particularly larger ones—and a growing discomfort with the underlying technologies (at least to the extent that the broad populace understands them).

In research and learning, those institutions with the means to do so create models to successfully apply AI in research and learning, leading to moments of expected and unexpected successes. The few remaining open AI models in use are being leveraged by smaller academic and research institutions that are struggling to achieve scale or noteworthy impact. Government funding is very scarce, and rather than being aligned systematically with large-scale societal objectives, it is often focused on niche problem technologies (perhaps national security or competitive ones) or the idiosyncratic interests of specific legislators. Research libraries face increasing expenses, less independence, and forced reallocation of efforts, even among the well-funded programs. Many libraries shift to a curricular focus, ensuring the quality, integrity, and provenance of content used in educational programs.

When we consider the research enterprise broadly, and the ways in which the work of this enterprise aligns with broader societal goals, one cannot help but note that this is clearly a world of missed opportunities. The complete regulatory failure surrounding machine learning and the underlying data that drives it has meant that researchers are

unable to harness large-scale patient health data for public health and biomedical research work. Similar issues appear in many other data-rich environments, from climate change to smart cities.

### **Current Drivers and Trends Signaling the Potential of this Scenario**

Highly resourced, prestigious institutions, built upon inequitable systems, continue to grow and thrive, proliferating issues of inequity and exclusion of many. Issues of bias and faulty data abound within data resources without a clear plan to address issues of responsible AI deployment and data management. Governments struggle to develop policies in a reactive and fearful environment. Distrust and disengagement from truth and evidence has led to a malignant and polarizing information environment.

### **Some Strategic Questions for the ARL and CNL Communities to Consider**

- What can be done to address issues of bias and lack of data integrity in this scenario?
- What would be the optimal data management model for libraries in this scenario?
- How can the research and knowledge ecosystem be optimally positioned for learning in this scenario?

### **Alex's Experience in This Scenario...**

MITA was still out for refresh. MITA had become dysfunctional even with the built-in safeguards that Alex had assumed were being kept up-to-date with MITA's evening updates during Alex's sleep cycle. Alex felt lost without MITA. It sounded like the refresh would be completed by the end of the week. She found MITA's discriminatory behavior in her scheduling and priorities so frightening, not to mention the blatant outbursts in email responses that MITA had drafted. MITA's reasoning could not be misinterpreted. She immediately shut her down last Wednesday and scrambled to reconnect with key partners and several applicants for grants that had been inappropriately and dismissively treated. Alex found she wasn't sleeping as well and



would get online as soon as she got to her computer to figure out her priorities for the day. And her days ran well into her evenings.

In an era where an inadequate and irresponsible approach to AI design and use by software engineers, policymakers, and users has let the AI genie out of the bottle, Alex faces the daunting task of salvaging the promise of artificial intelligence amidst societal unrest. Horizon Innovations Foundation is the vanguard against the normalization of bias and discrimination amplified by AI. MITA's behavior on HIF's efforts were ironical, but in a sick and troubling way.

It's Monday, and Alex starts with reviewing a report on the latest societal rifts. The findings are disheartening—rampant data mismanagement has led to AI systems that perpetuate and strengthen societal inequities. In a world quick to adopt AI, HIF stands out for its cautious approach, insisting on the deliberate and ethical training of AI systems.

Midweek, Alex finds herself meeting with community leaders and activists, strategizing on how to ensure digital literacy and critical thinking become cornerstones of a modern education. The foundation launches The Truth Initiative, a program aimed at empowering individuals to critically assess information in an AI-dominated landscape, with a special focus on arts and humanities to foster a holistic approach to learning.

The Horizon Innovations Foundation also becomes a sanctuary for open AI research and learning models, a rare commodity in a world where most AI is controlled and accessed by highly resourced and well-connected institutions. The foundation's policies require the appropriate stewardship of data, ensuring transparency and integrity and a plan for collaboration and tackling issues in scalability. Every research project funded by the organization becomes a beacon of how AI should be managed, with findings openly shared to benefit all of society. In the last several years, a growing community of research and learning collaborators has been emerging that Alex sees as the needed change agents and future leaders.

As government oversight tightens, Alex walks a fine line, advocating for the responsible use of AI without compromising democratic freedoms. She is often seen lobbying for balanced regulations that protect citizens without stifling innovation.

## Scenario 4: Autonomous AI

**This is a world in which** AI is becoming an increasingly independent partner and collaborator in research and learning, leveraging the expanding open resources and data made available to advance understanding well beyond the research advances possible by humans without AI. Society has adapted to a world enhanced by AI in all aspects of life and experience and in the process has knowingly and unknowingly given up increasing agency to AI. AI was progressing in its development, but has not yet realized full “artificial general intelligence (AGI).” However, AI is now showing increasing amounts of autonomy in the workplace and in developing new knowledge, products, and services valued by its AI counterparts and the human population. Interestingly, access becomes a mix of closed and open systems of tools, technology, and learnings with AI creating the most open systems for AI use. Meanwhile, humans continue to struggle with how to navigate issues of open and closed access. Must humans compete now with AI?

Human society has not established a consensus on how to deal with increasingly autonomous AI. A large part of the population is basically unaware of AI’s influence on their lives; a larger part encounters autonomous AI occasionally and is generally fine with that. A growing sector collaborates and interacts with AI coworkers and collaborators regularly.

Digital literacy grows with a focus throughout early education on creating a strong foundation for interaction with AI and the skills to discern between false, inaccurate content and real, accurate content. As time goes on, AI expands its role in the educational process for humans. Open access to knowledge and data continues to grow along with the quality and integrity of the data and knowledge sources resulting from AI oversight and maintenance of the resources. Human experiences in the workplace with AI copilots and assistants quickly transitions to work with AI collaborators and finally, in some cases, to work with AI leadership. Society begins to develop new areas of study and research around coping skills and mechanisms to find happiness, job satisfaction, and meaning in this new world. By 2035, lawmakers are beginning to discuss the rights of AI in comparison to that of humans.

In this world, there are fewer human junior researchers—graduate students, postdocs—than there were a decade ago; costs for these roles have gone up under pressure from unionization and “living wage” movements, while research funding has remained flat. In some disciplines, however, productivity has increased massively as humans have been supplemented and reinforced by armies of AI researchers; the patterns are uneven from discipline to discipline, however, depending on both funding to convert research infrastructure to AI-friendly systems such as cloud labs and the nature of the discipline itself. Some fields have proven very hospitable to AI researchers; for others, progress has been slower.

Human researchers collaborate with AI researchers and leverage AI tools in the design and modeling of their experiments. Research leads to an exciting, expanding set of insights and knowledge on a wide range of topics of interest. Research projects and inquiries become much more fluid and adaptive to learnings and insights and are the primary driver of how each research enterprise is organized within the research and knowledge ecosystem. Research teams made up of both AI and human researchers are at the cutting edge, producing rapid advances in many fields of study. Many in research believe the Nobel Prize—which was first awarded to a team in 2031—may soon be awarded to a team including AI participants. Traditional systems of scholarly research publishing and communication are evolving in complex ways, becoming both more and less transparent and reproducible; there are parts primarily intended for inter-AI data-sharing that are difficult for humans to navigate, parts for human-to-human communication, and other forms of scholarly communication that are intended to bridge the interface between humans and AIs. Traditional library functions and information management are embedded in many AI research platforms. The research and library enterprises both undergo significant restructuring, de-structuring, and pruning of the human workforce with the inclusion of AI workers and robotics.

### **Current Drivers and Trends Signaling the Potential of this Scenario**

The lack of investment in public institutions and the increased cost of human labor in research supports the logic of streamlining and automation of the research and library

workflows through AI and robotics. The current lack of a societal “moon shot” goal for AI, speaks to the lack of intentionality in thoughtful and responsible design and deployment. Research continues on detecting and measuring reasoning and creativity in AI with some promising results.

### **Some Strategic Questions for the ARL and CNI Communities to Consider**

- How can the library maintain relevance in AI-led research and learning models?
- What is the library’s role in expanding and maintaining open science?
- How can the research and knowledge ecosystem be optimally positioned for learning in this scenario?

### **Alex’s Experience in This Scenario...**

Alex was a couple years in now as a codirector of HIF with her partner, MITA. MITA had been her assistant for several years ahead of their promotion, but at the time of the promotion it was so clear that they were more partners than a boss and assistant relationship. So, HIF made the decision to opt for the codirector approach and so far it had been a rousing success.

The landscape of research and knowledge has been fundamentally altered by AI’s leap into autonomy and creativity. Alex, long a champion of responsible AI use, now advocates for a partnership model with AI, recognizing the need to harness its capabilities for the greater good while addressing the complex ethical considerations this new era presents.

It’s the start of another week, and Alex and MITA convene a virtual roundtable with an unusual set of participants: human researchers, AI researchers, AI partners, ethicists, and policy advisors. Together, they discuss the stewardship of open science in this AI-dominated research landscape.

As digital literacy becomes as fundamental as reading and writing, Alex and MITA push for an education overhaul. The fund supports programs that integrate AI literacy from

the early stages of education, ensuring that future generations are equipped to coexist with AI partners, collaborators, and leaders.

At the start of the week, MITA is focusing on the AI Collaborative, a program designed to foster a symbiotic relationship between human researchers and AI counterparts. The initiative is groundbreaking, aiming to establish protocols for crediting AI in research, contemplating the once-unthinkable prospect of an AI entity as a Nobel laureate.

Alex is leading the Research Reimagined initiative that brings together a wide range of researchers, research and higher ed institutions, research libraries, scholars, and educators to explore how to recreate research from the bottom up. As the research process itself becomes increasingly fluid, it is clear the form of the research enterprise must also become increasingly fluid and adaptive.

Midweek, Alex and MITA both attend a policy briefing on the rights of AI, advocating for incentives and safeguards to strengthen the collaborative relationship between humans and AI and to ensure AI remains a force for public benefit. In fact, Horizon Innovations Foundation is championing the development of a comprehensive, anticipatory framework for AI governance—one that considers AI not just as tools or collaborators but as entities with potential rights.

Friday morning finds Alex and MITA reflecting on the evolving function of libraries. In an age where AI integrates library functions into research platforms, they spearhead the transformation of libraries into dynamic hubs of open science and advocates for their role as custodians of information integrity and accessibility.

That afternoon, the Horizon Innovations Foundation launches the Human-AI Harmony Initiative, focusing on studies that explore the psychological and sociological impacts of living and working with AI. This initiative seeks to ensure that, as society leans into this partnership with AI, it does not lose sight of the human experience and the quest for happiness and fulfillment.

The workload is overwhelming. Alex reflects on the challenges of their role as codirectors. She cannot imagine any better partner than MITA at this critical time of change.

## ARL/CNI AI Scenario Set: End-State Table

| Year: 2035                                                 | Scenario 1                                                                                                                                                                                    | Scenario 2                                                                                                                                                                                                                   | Scenario 3                                                                                                                                                                                | Scenario 4                                                                                                                                                                                                                                                      |
|------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                            | Democratizing AI                                                                                                                                                                              | Technocratic AI                                                                                                                                                                                                              | Divisive AI                                                                                                                                                                               | Autonomous AI                                                                                                                                                                                                                                                   |
| AI Lifecycle &<br>Design for<br>Research and<br>Learning   | <p>Healthy skepticism leads to robust, responsible, and sustained design process</p> <p>AI-enhanced human, precursor to brain-computer interface (BCI)</p> <p>Digital literacy achieved</p>   | <p>Tech giants focus on consumer experiences; maintain centralized, opaque control</p> <p>Well-resourced institutions partner with big tech</p> <p>Limited access to open AI</p>                                             | <p>Irresponsible deployment of AI</p> <p>Research and learning tools plagued with bias and misinformation</p> <p>Gov't regulation and oversight significant, but late</p>                 | <p>AI tools supporting research and learning</p> <p>AI actively involved as autonomous collaborators and leaders</p>                                                                                                                                            |
| Societal Adaptation to AI<br>– Public Trust and Perception | <p>High acceptance and trust of AI to improve life and work</p> <p>AI is transparent</p> <p>AI used for betterment of society and quality of life; Sustainable Development Goals achieved</p> | <p>Limited due to lack of trust of AI</p> <p>Greatest market penetration in consumer-facing assistants, entertainment, social media, and education</p> <p>AI not used to benefit society's betterment, driver capitalism</p> | <p>Low societal adaption to AI due distrust of technology and government controls</p> <p>AI is opaque and recognized as turbo-charging racism and discrimination</p> <p>Social unrest</p> | <p>Successful early application of responsible guidelines for data integrity, removing bias and ethics allows for strong adaptation</p> <p>Later advances into autonomous AI occur without appropriate guardrails to ensure AI does not compete with humans</p> |



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| <p>Power, Influence, AI/Human Agency</p> | <p>Community-driven, barrier-free</p> <p>Diverse, inclusive, equitable guidelines and practices</p> <p>Private/public alignment</p> <p>AI enhancing human agency available to all, but a choice</p> | <p>Tech giant oligarchy</p> <p>Feudalistic relationship between tech giants and users</p> <p>Consumer and organizational data on behavior and preferences collected, mined, and sold/used to further advance offerings</p> <p>Human agency, those with power &amp; money having greatest agency</p> | <p>Growing gov't control in response to societal unrest and bad actors</p> <p>Oversight and challenges to digital privacy and freedoms</p> <p>Human agency (the good and the bad): AI controlled by government for public communication</p> <p>Bad actors weaponizing social media to exacerbate societal division and unrest</p> <p>Cybersecurity concerns escalate</p> | <p>Shared by tech companies, governing bodies, and AI</p> <p>AI has growing agency independent and autonomous from humans</p>                                                |
| <p>Policy Environment</p>                | <p>Balanced regulatory frameworks with focus on open access</p> <p>Community governance</p> <p>Values- and principles-driven policy</p>                                                             | <p>Low engagement from policymakers</p> <p>Low regulation so capitalism can flourish</p>                                                                                                                                                                                                            | <p>AI regulation considered a national security priority</p> <p>Strong, inconsistent, reactive regulation and control</p>                                                                                                                                                                                                                                                | <p>Government silos with episodic regulation is ineffective with respect to social disruption</p> <p>Effective AI development of regulation</p> <p>Bill of rights for AI</p> |
| <p>Global View</p>                       | <p>AI regulation and guidelines applied internationally</p>                                                                                                                                         | <p>Tech-driven guidelines and controls applied multinationally</p>                                                                                                                                                                                                                                  | <p>Nationalism is on the rise with growing protectionism</p>                                                                                                                                                                                                                                                                                                             | <p>Following the development of internationally shared AI</p>                                                                                                                |

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|                                                                                      | <p>Sustainable development goals achieved 2030, new goals focus on thriving planet and people</p> <p>Research collaboration across geopolitical bounds expands fluidly to address global challenges such as climate change and food security</p> <p>Broad access to researchers across the globe</p> <p>Growing cooperation between China and N. America</p> | <p>Sustainable development goals adjusted to support further economic growth</p> <p>Increasingly multinational approach to oversight and application of AI with multinational scope of research and reach of tech platforms</p> <p>China creates a permeable means to collaborate and link with partners as needed</p> | <p>and security concerns leading to increasingly fragmented and closed AI systems</p> <p>Decline of democracy</p> <p>Sustainable development goals not achieved; target moved to 2040</p> <p>Guidelines and regulation vary depending on the nation or regional partnerships and alignments</p> <p>Cold war with China continues</p> | <p>regulations and guidelines, AI expands its platforms and scopes, quickly usurping geopolitical borders</p> <p>Sustainable development goals achieved in 2035</p> <p>No clear mechanism to control or claim intellectual ownership of AI</p> <p>China chooses to apply AI in controlled systems with strict oversight</p> |
| <p>Democratization of Research and Learning with AI</p> <p>– Access, Open/Closed</p> | <p>Democratization achieved</p> <p>Open, transparent AI, communities actively engaged, all question and contribute to research</p> <p>Recognition of future concerns with enhanced vs. naturalist abilities</p>                                                                                                                                              | <p>Counter to democratization of research and learning</p> <p>Closed, opaque AI, consumers and institutions have limited access</p> <p>Oligarchs determine who benefits</p>                                                                                                                                            | <p>Least democratic</p> <p>Government control for public safety and national security reduces freedoms and access, leading to more closed systems</p>                                                                                                                                                                                | <p>Stratification of access to varying types of AI tools</p> <p>Mix of open and closed platforms</p>                                                                                                                                                                                                                        |

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| Data Integrity,<br>Provenance,<br>Persistence | Strongest guidelines and standards achieve data integrity, provenance, persistence with focus on ethics, DEI, accessibility standards, biases, veracity, and attribution/provenance                                                                           | Black box, protecting IP, no clarity on data integrity<br><br>Control/policing designed into AI to ID and persistently tag deepfakes, and false content                                                                                  | Poor data integrity, provenance, persistence with serious inclusion of bias, deepfakes, false and misinformation                                                                                   | Effective guidelines and standards to ensure data integrity, provenance, and persistence that enables the advancement of AI                                                                          |
| Bias, Ethics, Equity,<br>Inclusion            | Issues of bias in digital content are flagged in data and content<br><br>Diversity in all forms is celebrated and leveraged to expand creative and innovative potential<br><br>Significant progress in achieving equity and inclusive practices and standards | Software designed to persistently flag content that is biased or that was generated from biased data<br><br>Inequity and exclusionary with guidelines and protocols applied internally to the design of tools rather than use and access | Significant bias proliferates digital data with AI generating enormous amounts of dangerously biased material<br><br>Inequity and exclusion is exacerbated with discrimination and bias normalized | Bias in digital content has decreased primarily through automated tools and mechanisms<br><br>Issues of equity and inclusion are increasingly focused on oversight of behaviors within autonomous AI |
| Cultural Heritage<br>and Memory               | With AI, readily maintained, preserved, accessible, continuously refreshed<br><br>A small physical collection of primary source artifacts and materials that, while digitized and available in virtual worlds,                                                | Limited focus, but includes new, immersive reanimation of historical and ancestral figures                                                                                                                                               | Significant lost or manipulated cultural heritage and memory content                                                                                                                               | Becomes less important to autonomous AI<br><br>Managing the hybrid nature of collections and artifacts (physical and digitized) not prioritized                                                      |

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|                                    | still provide research discovery opportunities via the physical form                                                                                                                                           |                                                                                                                                                                                                      |                                                                                                                                                                                                    |                                                                                                                                                                                                           |
| Digital Literacy                   | High digital literacy with a shrinking divide<br><br>Naturalist may choose to not build literacy                                                                                                               | Stratified levels of digital literacy depending on access—for individual consumers, organizations, and institutions                                                                                  | Lowest levels of digital literacy<br><br>Uneven and limited access to digital literacy resources                                                                                                   | Achievement of significant level of digital literacy from early age as well as skills to discern between false and real content                                                                           |
| Learning                           | Enhanced learning is personalized with AI tools, assistants, tutors, advanced interfaces<br><br>Precision learning in which each student creates custom-tailored curriculum to maximize their ability to learn | Little access to the technology available to most consumers<br><br>Learning transformed by experiential offerings<br><br>Personalized learning and assistance for elite learners                     | Advances in learning technologies is slowed with primary focus of resources on national security concerns<br><br>Some learning content is biased and it is difficult to discern quality of content | Personalized and automated learning<br><br>Learning increasingly AI-guided, reducing demand for human K–12 teachers and higher ed faculty                                                                 |
| Teaching and Education (Higher Ed) | Precision education developed around individualized learning journey with transformed models and assessment<br><br>Focus on importance of critical thinking and creativity to develop adaptive learners        | Traditional higher ed models are obsoleted by consumer-driven learning experiences, virtual and nonvirtual<br><br>Tech giants develop talent pipelines, identifying desired abilities at a young age | Significant struggle to provide quality education with students regularly accessing and leveraging biased resources online<br><br>Higher ed focused on doing more with less                        | AI replacing teachers and educators, working directly with each individual on fully personalized and customized model<br><br>Traditional models of higher ed fully apply AI within teaching and education |

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|           | <p>Pedagogy centered on teaching students how to learn and building skills with an increasingly diverse talent pool, rather than a focus on content</p> <p>Disruptive, new entrants compete with traditional higher education</p>                  | <p>A few highly resourced, prestigious institutions for elite</p> <p>Consolidation of higher ed and less funding for remaining institutions who use low-tech models</p>                                                      | <p>Pockets of opportunity</p> <p>Undermining of information and content</p>                                                                            | <p>models and pedagogy</p> <p>Human and AI faculty work together</p> <p>Human education focuses on expanding critical thinking, problem solving, and creativity</p>                                          |
| Workforce | <p>Reshaping of the workforce</p> <p>New research and library workflow paradigms mean new skills required</p> <p>Significant churn, transformation of jobs with job loss to AI and robotics</p> <p>AI as copilot, coworker, collaborator, boss</p> | <p>Low digital literacy and high exploitation of workforce and consumers</p> <p>Challenges to maintain a well-trained, adaptive workforce</p> <p>Tech giants maintain their own education, training, and talent pipeline</p> | <p>Monitoring and oversight of workforce is critical to enterprise security</p> <p>Very uneven reskilling incentivized for some, forced for others</p> | <p>Workforce complemented by AI – AI as assistant, copilot, coworker, and boss</p> <p>AI thrives working on routine problems (with past history)</p> <p>Early exploration of AI reasoning and creativity</p> |

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| <p>Research</p>          | <p>AI-guided/led research process; AI driving collaboration</p> <p>Research focus on BIG ideas and questions</p> <p>Entirely new level of sophistication and complexity possible</p> <p>Very interdisciplinary, cross-sectoral, less siloed, no longer discipline focus</p>                      | <p>Mercenary research or at high-performing institutions only, big pharma and Ivy-level institutions</p> <p>Centralized computing centers</p> <p>Elite research and tech company alliances and partnerships</p> <p>Reconfigured research landscape</p>                                            | <p>Institutions with the resources in partnership with AI tech companies develop models to successfully apply AI, resulting in some successes</p> <p>Black market DIY tools proliferate</p> <p>New revenue streams needed for innovation</p>                                             | <p>Transformed new, fluid models of research and discovery, new financial models emerge, vary by discipline</p> <p>Restructure, de-structuring, and pruning of research with a reduction of number of human researchers</p> <p>AI scientists, lead to rapid advance in fields</p> <p>Drive towards responsible thinking within academics</p> |
| <p>Role of Libraries</p> | <p>Library as pipeline or conduit to data, software, and knowledge</p> <p>Woven into research environment</p> <p>Research library focused primarily on experience with data &amp; software as research objects</p> <p>Physical collections of unique primary source and rare materials, that</p> | <p>The divide between the different types of research libraries grows</p> <p>Elite institutions maintain research libraries with sophisticated data/software management capabilities</p> <p>Resource for quality data and information; and data mgmt. assistance (critical to under resourced</p> | <p>Ensuring data integrity, removing biases and false content is critical</p> <p>Financially most challenging scenario, but big opportunity to be a broker of trusted content</p> <p>Forced reallocation of efforts, shift many to curricular focus</p> <p>Traditional functions for</p> | <p>Reference services and information management, embedded in AI research platforms directly</p> <p>Restructuring, de-structuring, and pruning of library functions and workforce</p> <p>Reskilling of remaining workforce to work effectively with and for AI</p> <p>Diminished role supporting</p>                                         |

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|                                    | <p>support cultural memory and heritage, including Indigenous, grow in importance and value as resources</p> <p>Librarians and information professionals are trusted members of interdisciplinary and cross-sectoral teams and have influence</p> <p>Librarians and information scientists develop pipelines, provide expertise and advocate for open development of algorithms and data models</p> | <p>institutions and communities)</p> <p>Divide between the skills and capacities of information professionals due to limited access to AI and machine-learning technologies, tech giants and elite academic institutions</p> <p>Select talent with high capacity for information science and data science train with tech giants</p> | <p>disciplines not as significantly impacted by AI still carried out</p> <p>Financial crises in higher ed and public sector greatly reduces workforce in libraries</p> <p>Librarians and information professionals advocate for ethical, inclusive development and access to AI. They are trusted by the public but they are very small in number and have little influence</p> | <p>research in niche areas</p> <p>Limited physical collections of unique primary source and rare materials remain for research discovery opportunities that are not possible digitally</p> |
| Scholarly Record and Communication | <p>New systems focus on the increasing creativity and diverse perspective present in research, leveraging AI tools and other ways of knowing</p>                                                                                                                                                                                                                                                    | <p>Tech giants partner directly with publishers in development of record and communication systems integrated with the tech research offerings</p>                                                                                                                                                                                   | <p>Existing systems and models remain resilient and resistant to change</p> <p>Increasingly exclusive and inequitable</p>                                                                                                                                                                                                                                                       | <p>Current peer review is obsoleted, replaced by a system based on AI and automatic proof verification</p>                                                                                 |
| AI Environmental Impact            | <p>Carbon neutral, sustainable design, minimal</p>                                                                                                                                                                                                                                                                                                                                                  | <p>Tech companies leverage nuclear energy to power large computing</p>                                                                                                                                                                                                                                                               | <p>AI environmental impact receives little focus</p>                                                                                                                                                                                                                                                                                                                            | <p>AI takes the lead on developing efficient systems to power itself</p>                                                                                                                   |

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|  | <p>environmental impact</p> <p>Distributed systems are designed to have negligible environmental impacts</p> <p>LLMs and SLMs exist</p> | <p>centers; systems are designed to be efficient, closed loop</p> <p>SLMs proliferate in the fast expanding array of consumer products</p> | <p>Each large computer center has a significant individual environmental impact, but the full potential and volume of AI systems is not relatively small</p> | <p>A wide array of AI platform models from micro platforms up to large scale mega facilities</p> |
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