

A New Kind Of Science

a new kind of science is revolutionizing the way we understand the universe, technology, and our place within it. This emerging field is characterized by its interdisciplinary approach, leveraging computational methods, complex systems theory, and innovative experimentation to explore phenomena that traditional science often struggles to explain. Unlike classical science, which relies heavily on reductionism and linear models, this new paradigm embraces complexity, emergence, and the interconnectedness of systems. As a result, it opens up exciting possibilities for breakthroughs across various disciplines, from physics and biology to social sciences and artificial intelligence. In this article, we delve into the core principles of this new kind of science, its methodologies, and its implications for the future.

Understanding the Foundations of a New Kind of Science

1. Embracing Complexity and Emergence

One of the defining features of this new science is its focus on complex systems—networks of interacting components that give rise to unpredictable and often novel behaviors. Traditional science tends to simplify systems to isolate variables, but this approach can overlook the richness of real-world phenomena.

1. Complex systems are characterized by nonlinear interactions,

feedback loops, and adaptive behaviors.

2. Emergence refers to properties or patterns that arise from the collective interactions of system components, which cannot be predicted by examining individual parts alone.
3. Understanding emergence is key to explaining phenomena such as consciousness, market dynamics, and biological organization.

2. Computational Modeling and Simulations

At the heart of this new science is the use of advanced computational tools to model complex systems.

1. Agent-based models simulate interactions of individual entities to observe emergent behavior.
2. Cellular automata provide simplified representations of spatially distributed systems, illustrating how simple rules can produce complex patterns.
3. Machine learning algorithms identify patterns and relationships within vast datasets, facilitating discovery beyond human intuition.

3. Interdisciplinary Approach

This science dissolves disciplinary boundaries, integrating insights from physics, biology, computer science, mathematics, and social sciences.

1. By combining diverse perspectives, researchers can develop more holistic models and explanations.
2. This approach fosters innovation, as ideas from one field often inspire breakthroughs in others.
3. It encourages collaboration across traditional academic silos,

accelerating scientific progress.

Key Methodologies and Techniques

1. Data-Driven Discovery

The proliferation of big data has become a cornerstone of this new science.

1. Data mining and statistical analysis uncover hidden patterns in complex datasets.
2. Network analysis maps relationships and interactions within systems, such as social networks or neural circuits.
3. Data visualization helps interpret multi-dimensional information, revealing insights that raw numbers cannot.

2. Digital Experimentation

Traditional experimentation is complemented with virtual simulations.

1. Digital twins replicate real-world systems in silico, enabling testing and optimization without physical constraints.
2. Simulation environments allow for rapid iteration, scenario testing, and sensitivity analysis.
3. This approach reduces costs and accelerates discovery cycles.

3. Algorithmic and Theoretical

Innovation

Developing new algorithms and theoretical frameworks is essential.

1. Evolutionary algorithms mimic natural selection to optimize solutions.
2. Information theory quantifies the flow and transformation of information within systems.
3. Complexity theory provides measures and classifications for different types of systems and behaviors.

Implications and Applications of a New Kind of Science

1. Advancements in Artificial Intelligence and Robotics

AI systems inspired by complex adaptive systems are more robust, flexible, and capable of autonomous learning.

1. Deep learning models emulate neural network architectures, leading to breakthroughs in image and speech recognition.
2. Swarm robotics draw from principles of collective behavior seen in nature, enabling decentralized control for tasks like exploration and search-and-rescue.
3. Understanding emergence helps create AI that can adapt to unforeseen circumstances.

2. Innovations in Medicine and Biology

The application of complex systems science is transforming healthcare.

1. Personalized medicine considers the dynamic interactions within biological networks to tailor treatments.
2. Modeling biological processes at the systems level enhances understanding of diseases like cancer and neurodegeneration.
3. Bioinformatics leverages data-driven approaches to discover new drugs and therapies.

3. Sustainable Systems and Environmental Science

Addressing global challenges requires holistic models of ecological and social systems.

1. Climate modeling incorporates feedback loops and nonlinear dynamics to improve predictions.
2. Urban planning benefits from simulating traffic flow, resource distribution, and social interactions.
3. Understanding resilience and tipping points aids in designing sustainable and adaptable communities.

The Future of a New Kind of Science

1. Democratization of Scientific

Discovery

Advancements in computational tools and open data promote wider participation.

1. Citizen science initiatives harness collective intelligence for data collection and analysis.
2. Open-source modeling platforms democratize access to sophisticated simulation tools.
3. This inclusive approach accelerates innovation and broadens the scope of inquiry.

2. Ethical and Philosophical Considerations

As models become more complex and autonomous systems more prevalent, ethical questions arise.

1. How do we ensure responsible use of AI and simulations?
2. What are the implications of understanding consciousness or free will through complex models?
3. Addressing these issues requires interdisciplinary dialogue and the development of new ethical frameworks.

3. Challenges and Opportunities

While promising, this new science faces hurdles.

1. Computational limitations and data privacy concerns need ongoing attention.
2. Interpreting complex models remains a challenge, demanding new analytical tools.
3. However, the potential benefits—more accurate predictions, innovative solutions, and deeper understanding—are immense.

Conclusion

A new kind of science is redefining our approach to understanding the natural world and human-made systems. By embracing complexity, leveraging computational power, and fostering interdisciplinary collaboration, this paradigm opens up unprecedented opportunities for discovery and innovation. As it continues to evolve, it promises to solve some of the most pressing challenges of our time, from health and environmental sustainability to technological advancement. Embracing this new science will be essential for shaping a resilient, intelligent, and interconnected future.

A New Kind of Science is revolutionizing the way we understand the universe, blending interdisciplinary approaches to uncover fundamental principles that underpin complexity across scales. This transformative perspective challenges traditional scientific paradigms by emphasizing computational exploration, simple rules, and emergent phenomena as core drivers of natural systems. As we delve into this innovative framework, it's essential to understand its origins, core concepts, implications, and how it diverges from classical science.

What Is "A New Kind of Science"?

A New Kind of Science (NKS), popularized by Stephen Wolfram in his groundbreaking book, represents a paradigm shift in scientific methodology. Unlike conventional science that often relies on mathematical equations and analytical models, NKS advocates for a computational approach—using cellular automata, simple programs, and algorithmic exploration—to understand complex behaviors. It posits that simple, rule-based systems can generate the rich diversity of phenomena observed in nature, from the patterns on a zebra's skin to the evolution of galaxies.

Origins and Motivation

The roots of NKS trace back to Wolfram's curiosity about how complexity arises from simplicity. Traditional science, rooted in physics and mathematics, often struggles with modeling complex, stochastic, or chaotic systems. Wolfram argued that reliance on differential equations and statistical methods sometimes obscures the underlying mechanisms of complexity. His insight was that many natural systems could be better understood through computational experiments—building simple models, observing their behavior, and seeking patterns.

Core Principles of A New Kind of Science

1. Computation as a Fundamental Process

At the heart of NKS is the idea that the universe itself operates as a computational system. Rather than viewing physical laws solely through equations, NKS suggests that the universe can be modeled as a vast network of simple programs executing rules that produce complex outcomes.

1. Simple Rules Can Generate Complexity

One of the central tenets is that simple algorithms or rules—like those governing cellular automata—can produce a staggering array of behaviors. For example, Wolfram's Rule 110 cellular automaton is Turing complete, meaning it can perform any computation given the right input and resources, despite its simplicity.

1. Emphasizing Emergence and Self-Organization

NKS emphasizes emergence, where complex structures and behaviors arise spontaneously from the interactions of simple components. This approach shifts focus from top-down explanations to bottom-up processes, where local interactions lead to global order.

1. Universality of Computational Laws

The idea that many systems, whether biological, physical, or social, can be understood through universal computational principles. This universality suggests that the same underlying rules can generate the diversity of phenomena we observe.

Methodologies in A New Kind of Science

Computational Experimentation

Instead of solely relying on mathematical derivations, NKS encourages computational experiments. Researchers write simple programs or rules and observe their behavior over time, seeking patterns, stability, or chaos.

Classification of Systems

Systems are classified based on their behaviors:

1. Class 1: Produces homogeneous, uniform patterns.
2. Class 2: Generates periodic, stable structures.
3. Class 3: Exhibits chaotic, aperiodic behavior.
4. Class 4: Shows complex, localized structures capable of universal computation.

This classification helps in understanding what kinds of simple rules lead to what kinds of complexity.

Use of Cellular Automata and Other Simple Models

Cellular automata (CA) serve as primary tools for simulating how local rules lead to complex global patterns. Researchers also employ other simple computational models like Turing machines, random Boolean networks, and agent-based models.

Implications of A New Kind of Science

Rethinking Scientific Laws

NKS suggests that many scientific laws are approximations or emergent phenomena from underlying simple rules. This challenges the traditional view that complexity requires complex explanations.

Insights into Natural Phenomena

By modeling natural systems with simple rules, scientists can gain insights into:

1. Pattern formation in biological tissues
2. Fractal structures in geology and physics
3. Traffic flow and urban growth
4. Neural network dynamics
5. Evolutionary processes

Advancing Artificial Intelligence and Robotics

Understanding emergence and self-organization through simple algorithms informs the development of autonomous systems and artificial intelligence that can adapt and evolve without explicit programming.

Unifying Disparate Disciplines

NKS promotes an interdisciplinary approach, bridging physics, biology, computer science, and social sciences, emphasizing the universality of computational principles across domains.

Divergence from Traditional Science

Aspect	Traditional Science	A New Kind of Science
Approach	Mathematical modeling, analytical solutions	Computational experiments, rule-based models
Focus	Derivation of equations, exact solutions	Observation of

emergent phenomena from simple rules |

| Complexity | Often seeks to simplify or linearize | Embraces complexity arising from simplicity |

| Tools | Differential equations, statistical methods | Cellular automata, Turing machines, simulations |

While classical science emphasizes predictability and mathematical rigor, NKS accepts and explores unpredictability and complexity as natural and informative features of systems.

Challenges and Criticisms

Despite its innovative approach, NKS faces criticism:

1. **Reproducibility and Verification:** The vast space of simple rules can make it difficult to verify which rules correspond to real-world phenomena.
2. **Limited Empirical Data:** Critics argue that computational models sometimes lack direct empirical validation.
3. **Scalability:** Some complex systems may require enormous computational resources to simulate accurately.
4. **Philosophical Concerns:** Debates about whether computation alone can fully explain physical or biological phenomena.

Nevertheless, NKS continues to stimulate research and debate, inspiring new methodologies and perspectives.

Practical Steps to Engage with A New Kind of Science

1. **Explore Cellular Automata**
 1. Experiment with simple CA rules like Rule 30 or Rule 110.
 2. Use online simulators or programming languages to visualize behaviors.
 3. Analyze how small rule changes affect complexity.

1. Embrace Computational Experimentation

1. Develop small programs to model natural phenomena.
2. Observe emergent behaviors and classify them.
3. Document patterns and seek underlying principles.

1. Cross-Disciplinary Learning

1. Study systems biology, physics, computer science, and mathematics.
2. Look for common computational principles across disciplines.

1. Contribute to Open-Source Modeling

1. Share models and findings with the community.
2. Collaborate on large-scale simulations of complex systems.

1. Keep Abreast of Emerging Research

1. Follow journals and conferences focused on computational science and complexity.
2. Engage with online communities and forums.

Future Directions and Opportunities

A New Kind of Science opens avenues for innovation:

1. Modeling Climate and Ecosystems: Using simple rules to simulate complex environmental interactions.
2. Designing Self-Healing Materials: Applying principles of emergence to material science.
3. Developing Autonomous Systems: Creating robots capable of evolving behaviors through simple rules.
4. Understanding Consciousness: Exploring how simple neural interactions give rise to subjective experience.

As computational power grows and algorithms become more sophisticated, the potential for NKS to transform science remains

vast.

Conclusion

A New Kind of Science offers a compelling framework that emphasizes the power of simple rules, computation, and emergence in understanding complexity across all domains. By shifting focus from purely mathematical models to computational experimentation, it expands our toolkit for exploring natural phenomena. While challenges remain, the principles of NKS inspire a more integrated, flexible, and fundamentally different approach to scientific discovery—one that recognizes that the universe's richness often arises from the simplest of beginnings.

Access to ***A New Kind Of Science*** in downloadable format has revolutionized self-directed education and independent learning. In the past, learners often depended on physical libraries, bookstores, or limited institutional resources to access educational materials. Today, digital availability has transformed this landscape, making valuable content instantly accessible to anyone with an internet connection. This shift reflects a broader change in how knowledge is distributed and consumed in the digital age.

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collections of legally available books, particularly public domain and open-access works. These platforms ensure content authenticity and provide a reliable foundation for self-directed learning.

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Responsible use of digital resources is essential for maintaining ethical standards and data security. Ethical downloading respects intellectual property rights and supports authors, researchers, and publishers. It also helps ensure the sustainability of free knowledge-sharing initiatives. By choosing legitimate platforms, users protect themselves from risks such as malware, corrupted files, or misleading content.

Digital access to ***A New Kind Of Science*** also fosters intellectual curiosity. With information readily available, learners are more likely to explore new topics, disciplines, and perspectives. Digital books encourage experimentation and discovery, allowing users to move beyond predefined curricula and pursue knowledge driven by personal interest.

Interdisciplinary learning is another significant benefit of digital resources. Learners can easily combine ***A New Kind Of Science*** with materials from different fields, creating connections between ideas and concepts. This cross-disciplinary approach supports critical thinking and creativity, helping learners develop a more

holistic understanding of complex subjects.

Critical analysis is strengthened through exposure to diverse sources. Digital access allows learners to compare multiple perspectives, evaluate arguments, and assess the credibility of information. Engaging with ***A New Kind Of Science*** alongside related works encourages independent thinking and informed judgment, essential skills in both academic and professional contexts.

For students, digital books provide practical advantages that support academic success. Downloadable materials allow for offline study, exam preparation, and revision without constant internet access. Annotation tools help students organize notes and highlight key concepts, improving study efficiency and comprehension.

Professionals also benefit from the convenience and immediacy of digital resources. Downloading ***A New Kind Of Science*** allows professionals to reference relevant information quickly, update their knowledge, and support ongoing skill development. In fast-changing industries, access to up-to-date information is essential for maintaining competence and competitiveness.

Digital organization further enhances the value of downloadable books. Users can categorize files, create searchable libraries, and back up content using cloud storage solutions. This organization ensures that valuable learning materials remain accessible and easy to manage over time, supporting long-term learning goals.

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features ensure that ***A New Kind Of Science*** can be accessed by a wider audience, promoting equal opportunities in education.

Environmental sustainability is another important consideration. By reducing reliance on printed materials, digital downloads help conserve natural resources and reduce the environmental impact associated with printing and transportation. While digital technologies have their own ecological footprint, the shift toward electronic resources represents a more efficient approach to knowledge distribution.

The global reach of digital content supports cultural exchange and shared learning experiences. Downloading ***A New Kind Of Science*** enables learners from different countries and backgrounds to access the same materials, fostering collaboration and mutual understanding. Digital access contributes to a more connected and informed global community.

As technology continues to advance, self-directed learning will become increasingly important. The ability to download ***A New Kind Of Science*** reflects an adaptive approach to education that aligns with modern learning environments. Digital literacy is now a core competency for learners at all levels.

In summary, downloading ***A New Kind Of Science*** illustrates the transformative impact of technology on self-directed education. Through portability, convenience, interactivity, and ethical access, digital resources empower learners to take control of their educational journeys. Responsible and informed use of digital platforms enables users to fully leverage ***A New Kind Of Science*** for personal enrichment, academic achievement, and professional development in the digital age.

Questions & Answers About a new kind of science

N o	Question	Answer
1	What is 'A New Kind of Science' by Stephen Wolfram about?	'A New Kind of Science' explores the idea that simple computational systems, like cellular automata, can produce complex behaviors, challenging traditional scientific methods and proposing a new framework for understanding natural phenomena through computation.
2	How does Wolfram's concept of computational irreducibility impact scientific research?	Computational irreducibility suggests that some processes cannot be shortcut or simplified, meaning that understanding their outcomes requires step-by-step simulation, which influences how scientists approach modeling complex systems.
3	In what ways does Wolfram's 'A New Kind of Science' influence modern computational science?	The book encourages the use of cellular automata and simple programs to model complex systems, inspiring new research methods in fields like physics, biology, and computer science that leverage computational experiments over traditional equations.
4	What are some criticisms of Wolfram's 'A New Kind of Science'?	Critics argue that the book overstates the universality of cellular automata, lacks sufficient empirical validation, and sometimes dismisses conventional scientific approaches without adequately integrating them.

5	How does 'A New Kind of Science' relate to the concept of emergence?	Wolfram's work emphasizes how simple rules in computational systems can lead to emergent complex behaviors, providing a framework for understanding emergence as a fundamental aspect of natural phenomena.
6	Can Wolfram's ideas be applied to real-world scientific problems today?	Yes, researchers are applying Wolfram's computational approach to areas like material science, biology, and cryptography to model complex systems and develop new algorithms inspired by his theories.
7	What is the significance of cellular automata in Wolfram's 'A New Kind of Science'?	Cellular automata serve as the primary example of how simple, discrete, local interactions can generate intricate global patterns, illustrating Wolfram's thesis that complexity arises from simplicity in natural systems.

computational science, scientific revolution, complex systems, emergent behavior, interdisciplinary research, scientific methodology, data-driven science, simulation modeling, scientific paradigm, technological innovation

A New Kind Of Science

eBook Resource

A New Kind Of Science eBooks provide structured digital knowledge.

Core Discussion

Digital books help readers maintain productivity.

Practical Use

A New Kind Of Science eBooks support consistent study routines.

Conclusion

Digital reading improves access to information.

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They represent a practical response to evolving learning expectations.

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A New Kind Of Science eBooks align with structured knowledge systems.

Stability encourages confidence in materials.

Resilient knowledge adapts over time.

A New Kind Of Science eBooks support intentional learning by encouraging focused reading.

Studying with A New Kind Of Science

Studying with A New Kind Of Science in digital format allows learners to approach content in a more structured, flexible, and efficient way. Unlike traditional printed materials, digital documents provide tools that support active learning, deeper comprehension, and long-term retention. By applying effective study strategies, learners can maximize the educational value of A New Kind Of Science and turn it into a powerful learning resource.

One of the most effective approaches is breaking chapters into smaller, manageable sections. Large blocks of information can be overwhelming and reduce focus. Dividing content into sections encourages gradual progress and helps learners absorb information step by step. This method also makes it easier to schedule study sessions and maintain consistency over time.

After completing each section, summarizing the content in your

own words is highly recommended. Summaries help clarify understanding and reinforce key concepts. Writing brief notes or outlines based on A New Kind Of Science content enables learners to process information actively rather than passively consuming it. These summaries can later serve as quick revision materials before exams or discussions.

Regularly reviewing highlighted sections is another essential study practice. Highlights draw attention to important ideas, definitions, or arguments that require reinforcement. Periodic review sessions strengthen memory retention and help identify areas that may need further clarification. Digital highlights remain accessible and searchable, making review sessions more efficient than flipping through physical pages.

Creating a consistent study routine further enhances learning outcomes. Allocating specific time slots for reading and review promotes discipline and reduces procrastination. Digital formats allow flexibility in choosing study locations and devices, making it easier to integrate learning into daily schedules.

Active learning strategies

Active learning transforms A New Kind Of Science from a static document into an interactive study tool. Asking questions while reading, making predictions, and connecting new information with prior knowledge improves comprehension. Learners can add questions or reflections as annotations, creating a dialogue with the text that deepens understanding.

Teaching concepts learned from A New Kind Of Science to others is another powerful strategy. Explaining ideas in simple terms reinforces understanding and highlights gaps in knowledge. This method can be applied during group study sessions or personal

review by summarizing content aloud.

Using Digital Features

Digital features significantly enhance the study experience with A New Kind Of Science. Search functionality allows learners to locate keywords, concepts, or references instantly. This saves time and supports efficient cross-referencing, especially when working with lengthy documents or multiple sources.

Copying references and quotations digitally simplifies academic work. Learners can quickly extract relevant passages for essays, reports, or research projects. When copying content, it is important to maintain proper citations and respect copyright guidelines to ensure ethical use of information.

Bookmarks are another valuable feature for efficient study. Marking important chapters, sections, or reference pages allows quick navigation during revision. Bookmarks help learners resume reading exactly where they left off and organize content according to study priorities.

Digital annotation tools further support active engagement. Notes, comments, and highlights can be added directly to the document, keeping insights closely connected to the source material. These annotations can be edited, expanded, or reorganized as understanding evolves over time.

Some readers also support linking annotations to external notes or documents. This integration allows learners to build a comprehensive study system that combines A New Kind Of Science with supplementary resources such as lecture notes, articles, or multimedia content.

Efficiency and productivity benefits

Digital features reduce repetitive tasks and improve productivity. Instead of manually searching for information, learners can rely on built-in tools to streamline study processes. This efficiency frees up time for deeper analysis, reflection, and practice.

Synchronizing notes and progress across devices further enhances productivity. Learners can switch between devices without losing annotations or bookmarks, maintaining continuity in their study workflow.

Group Study

Group study adds a collaborative dimension to learning with A New Kind Of Science. Sharing insights and discussing key points helps reinforce understanding and exposes learners to different perspectives. Collaborative learning encourages critical thinking and clarifies complex topics through discussion.

When engaging in group study, it is important to share A New Kind Of Science content legally. Only free, public domain, or authorized versions should be distributed directly. For paid editions, sharing official links or references ensures compliance with copyright regulations while still enabling collaboration.

Group members can exchange summaries, annotations, or discussion questions based on A New Kind Of Science. These shared materials support collective learning while allowing individuals to maintain their own notes. Digital platforms make it easy to collaborate asynchronously, accommodating different schedules and learning styles.

Discussion sessions focused on specific chapters or themes help structure group study effectively. Assigning sections to different

members for review or presentation encourages accountability and deeper engagement. Each participant contributes unique insights, enriching the overall learning experience.

Collaborative tools and platforms

Cloud-based tools facilitate collaborative study by enabling shared documents, comments, and feedback. Study groups can use shared folders or collaborative note-taking apps to centralize materials related to A New Kind Of Science. This approach keeps resources organized and accessible to all members.

Respectful communication and clear guidelines enhance group study outcomes. Establishing expectations for participation, note-sharing, and discussion ensures productive collaboration and minimizes misunderstandings.

Maintaining Quality

Maintaining the quality of A New Kind Of Science files is essential for effective study. Low-quality or corrupted files can hinder readability, disrupt learning, and cause frustration. Ensuring that downloaded files are complete and legible supports a smooth and reliable study experience.

Before using A New Kind Of Science for study, learners should verify file integrity. Checking page completeness, image clarity, and text readability helps identify potential issues early. If a file appears incomplete or corrupted, obtaining a fresh copy from a trusted source is recommended.

High-quality files preserve formatting, structure, and navigation features such as tables of contents and hyperlinks. These elements enhance usability and make study sessions more efficient. Poorly scanned or improperly converted documents may lack searchable

text or clear layout, reducing their educational value.

Choosing reputable and legal sources for downloads ensures better quality and safety. Official publishers, libraries, and recognized platforms typically provide well-formatted and verified versions of A New Kind Of Science. Avoiding unreliable sources reduces the risk of errors and security threats.

Updating and replacing files

Over time, improved editions or corrected versions of A New Kind Of Science may become available. Periodically checking for updates ensures access to the most accurate and relevant content. Replacing outdated files with newer versions helps maintain a high-quality study library.

Archiving older versions separately allows reference if needed while keeping primary study materials current and organized.

Building effective study habits with A New Kind Of Science

Combining structured study methods, digital tools, collaborative learning, and quality control creates a comprehensive approach to learning with A New Kind Of Science. These practices encourage consistency, deepen understanding, and support long-term retention.

Effective study habits evolve over time. Reflecting on what methods work best and adjusting strategies accordingly leads to continuous improvement. Digital formats offer flexibility to experiment with different approaches and customize the learning experience.

Final thoughts on studying with A New Kind Of Science

Studying with A New Kind Of Science becomes significantly more

effective when learners apply structured reading strategies, leverage digital features, collaborate responsibly, and maintain high-quality materials. By breaking content into sections, summarizing insights, using search and annotation tools, participating in group discussions, and ensuring file integrity, learners can transform *A New Kind Of Science* into a powerful and reliable study companion. These practices support deeper comprehension, stronger retention, and more meaningful learning outcomes over time.