STWST

INFOLAB

$$\sqrt{-1}$$

The Necessity of Complex Information Processing in Knowledge Technology

Over the decades, information technology has developed based on binary, dual information systems—frameworks that rely on simple yes-no decisions, represented by the states 0 and 1. This approach has allowed us to build highly complex systems and computer architectures. However, in a world increasingly characterized by complex and multifaceted challenges, we must question whether this binary paradigm is still sufficient.

1. The Limits of Dual Information

Dual information is excellent for modeling logical processes and simple decision trees. However, when addressing deeper questions—such as modeling human emotions, interpreting dreams, or understanding the significance of decisions within a broader emotional context—we reach the limits of what binary logic can represent.

2. Introducing Complex Numbers into Knowledge Technology

Complex numbers, which include both a real and an imaginary part, offer a natural extension of dual information. While the real part can continue to model binary logic, the imaginary part allows the representation of additional dimensions and relationships that cannot be captured by classical information theory.

3. The Vision: Polymeric Information

Complex numbers open the door to developing a new form of information—referred to as "polymeric information." This form of information could be used to create multidimensional information systems that integrate both rational logic and emotional, intuitive, and unconscious processes.

One example is the dream world of humans. Dreams are a window into the deep layers of our consciousness, often shaped by emotional experiences, unresolved conflicts, and creative processes. Technology based on complex numbers could potentially better capture and interpret the structure of these dreams by processing both the "rational" and "emotional" information simultaneously.

4. The Emotional Significance of Decisions

In a world where decisions often have both logical and emotional consequences, using complex numbers provides the opportunity to integrate these dual aspects. Polymeric information could represent the emotional significance of decisions, considering not only the rational but also the emotional and intuitive dimensions of decision-making.

5. The Role of Art and New Perspectives in Quantum Physics

Art has always possessed the ability to open new perspectives and transcend existing structures. This is particularly important when making decisions in the reality of quantum physics. Over the past 100 years, quantum physics has made tremendous progress, but it remains trapped in old ways of thinking.

New perspectives, like those offered by art, are essential to overcoming these structural limitations. Art can help us grasp the multidimensional aspects of quantum reality and translate them into a language that is not only rational but also intuitive and emotionally understandable. By integrating these creative and artistic approaches, we can achieve a deeper understanding of the quantum world and make more informed decisions.

6. The Path to the Future

The introduction of complex numbers into knowledge technology could be the first step towards a more comprehensive understanding of information and knowledge—one that incorporates the rational, emotional, intuitive, and creative dimensions of human existence. Art, as an equal partner to science, can offer us new perspectives and methods to better understand the challenges of quantum physics and other complex systems. This would be a critical step in transcending the limitations of current information technology and opening new horizons for human experience and understanding of the world.

The Scientific Argument for Complex Information Processing

In modern science and technology, information processing is traditionally governed by binary systems and real numbers. This dual information processing has led to significant advancements in computing, communication, and data analysis. However, given the increasing complexity of scientific questions and the data involved, the question arises whether a focus on dual information is still sufficient.

1. Complexity in Nature and Science

Nature and many scientific phenomena are inherently complex and multidimensional. Phenomena such as quantum mechanics, nonlinear systems, and chaotic processes require a mathematical description that goes beyond what real numbers can provide. Complex numbers, which include both a real and an imaginary part, offer an expanded mathematical foundation to describe such phenomena.

For example, quantum mechanics is inconceivable without the use of complex numbers. The wave function, which describes the state of a quantum system, is a complex function that includes both amplitude and phase. These complex states allow for a more precise description of reality, especially in areas where ambiguity and superposition are at play.

2. Expanding Information Capacity

The use of complex numbers in information processing opens up new possibilities that exceed the capacities of binary systems. In a dual system, information is stored and processed in a one-dimensional structure. Complex numbers, however, allow for multidimensional information representation, enabling richer and more detailed analysis.

This multidimensionality is particularly relevant in data processing, signal processing, and machine learning. By using complex numbers, we can represent information in a way that considers not only the intensity but also the direction and phase of signals. This leads to better capture and interpretation of complex patterns and relationships.

3. Modeling Emotions and Cognitive Processes

The ability to process complex information is not only important for the physical sciences but also for modeling cognitive processes and human emotions. Emotions and thoughts are often multilayered and contradictory, making a simple binary representation inadequate.

Using complex numbers in modeling could help better capture the nonlinear, multidimensional relationships that constitute human emotions and decision-making processes. This could lead to advances in fields such as artificial intelligence and neuroscience, enabling the development of machines that simulate human thinking and feeling on a deeper level.

4. Applications in Quantum Information

Another area where complex information processing is essential is quantum information theory. Quantum computers use qubits, which, unlike classical bits, can assume not only the states 0 and 1 but also any superposition of these states. These superpositions are represented by complex numbers, enabling an enormous concentration of computational power in a compact space.

Thus, complex numbers are not just a tool but a necessity for the development and application of quantum computers, which have the potential to solve problems that are unsolvable for classical computers.

5. The Future of Information Processing

The growing complexity of challenges faced by science and technology requires new approaches to information processing. By expanding the use of complex numbers in information technology, we lay the groundwork for the development of new methods and systems that can meet the demands of the future.

Integrating complex information processing into existing and future technologies could not only improve scientific accuracy and efficiency but also open new horizons in the exploration of human consciousness, quantum mechanics, and other highly complex systems.

Complex Information Processing in Everyday Life

Complex information processing in everyday life could elevate understanding and decision-making to a deeper and more nuanced level. This approach would not only consider the rational and objective aspects of a decision but also the emotional, intuitive, and multidimensional factors often overlooked in traditional, dual information processing.

1. Multidimensional Perspective in Decision-Making

Emotional Intelligence: In complex information processing, decisions would not rely solely on logical conclusions but also on emotional and intuitive aspects. For instance, when choosing a job, a person might weigh not only salary and working conditions (rational factors) but also their emotional connection to the company, cultural fit, and long-term well-being (intuitive and emotional factors).

Holistic Thinking: Complex information accounts for the interdependencies between different decisions. A decision in one area of life could impact other areas. For example, the choice to move to a particular city could affect not only the commute (rational factor) but also social networks, quality of life, and personal fulfillment (multidimensional factors).

2. Holistic Decision-Making

Integration of Contradictions: In complex information processing, people could better handle contradictory information. Instead of simplifying decisions by ignoring one aspect in favor of another, they could learn to incorporate both sides into a broader, more holistic decision. For example, someone planning an event might consider both the logistical practicality and the emotional needs of the guests, rather than viewing them as separate factors.

Continuous Adjustment: Since complex information is dynamic and often non-linear, decisions would become more flexible and adaptable. Instead of viewing decisions as final, people could learn to regularly review and adjust their choices based on new information and changing circumstances.

3. Awareness of Uncertainty and Ambiguity

Managing Uncertainty: Complex information processing acknowledges the uncertainties and ambiguities inherent in decisions. Instead of seeking clear, definitive answers, people might learn to live with uncertainty and incorporate it into the decision-making process. This could involve thinking through scenarios where various outcomes are possible and preparing for them rather than relying on a single correct answer.

Deep Reflection: Complex information processing encourages deeper reflection and self-awareness. People might tend to question their assumptions and biases, recognizing that their perception and decision-making are influenced by a variety of factors beyond the obvious.

4. Impact on Decision-Making

Improved Decision Quality: Decisions based on complex information processing could be of higher quality, as they consider more aspects and dimensions. This could lead to more informed and sustainable decisions that yield better long-term results.

More Empathetic Decisions: By integrating emotions and intuitive insights, decisions could become more empathetic. People might become more aware of the impact of their choices on others and more inclined to include this awareness in their deliberations, leading to more socially responsible and compassionate decision-making.

Better Adaptability: Decisions made within a complex framework are more flexible and adaptable to change. This could help people better cope with uncertainties and unforeseen events, as they are accustomed to continually revisiting and adjusting their decisions.

Creativity and Innovation: Complex information processing can foster creativity and innovation by incorporating non-linear, unconventional connections and perspectives. This could lead to people finding more creative solutions to problems and developing new approaches that might be overlooked in a binary, linear thinking framework

Art, Creativity, and Digital Media

For years, the integration of art within digital media has been stagnant, with little progress in exploring how art can evolve alongside advancing technology. However, the introduction of complex numbers into information processing offers a fresh perspective and a significant shift in how we understand and value art in the digital age.

The integration of complex numbers not only advances scientific understanding and enhances everyday decision-making but also revitalizes the role of art. By embracing complex information, we unlock new perspectives, enabling art to thrive in a multidimensional space where every aspect of human experience can be explored and celebrated. This approach also preserves the potential for human creativity in the imaginary realm, allowing our utopian visions to endure just a little longer.

As a symbol of this new information paradigm, we wear shirts emblazoned with the square root of minus one, representing our commitment to these complex concepts and the ongoing evolution of creativity and knowledge.

In this new paradigm, art and digital media transcend their traditional roles as mere tools of expression. They become profound platforms for understanding the intricate complexities of our world.

Metrics of Polymeric Information

Polymeric information expands beyond traditional dual (binary) information by incorporating complex numbers, enabling a multidimensional understanding of information. The metrics we've discussed are key to understanding how polymeric information operates and is measured.

**1. Dual Information (Real Information)

Definition: This is the traditional binary or real-number-based information used in classical computing and information theory.
Application: Dual information serves as the foundation for traditional data processing but is limited to binary outcomes or linear processes.

**2. Polymeric Information (Complex Information)

Definition: Polymeric information incorporates both real and imaginary components, allowing for a richer and more nuanced representation of data.
Mathematical Representation: This type of

information can be represented as complex numbers (e.g., z=a+bi, where i is the square root of -1).
Application: It enables the modeling of systems where variables have both magnitude and phase, such as in quantum mechanics, emotional modeling, and creative processes.

****3. Transition from Dual to Polymeric Information**

Explanation: The transition from dual to polymeric information is analogous to moving from a flat, linear perspective to a more multidimensional one. This transition allows for the integration of complex states, superpositions, and interactions that are not possible in a purely dual system.
Mathematical Transformation: Complex numbers can represent transitions between states in quantum systems or changes in cognitive or emotional states in modeling scenarios.

****4. Human Emotions and Perception**

Complexity of Emotions: Emotions and perceptions often involve non-linear, multidimensional processes that can be more accurately modeled using polymeric information.
Mathematical Representation: Emotions can be seen as complex numbers where different components represent various emotional intensities or dimensions.
Application: This allows for a deeper understanding and representation of emotional states and how they influence decision-making, creativity, and perception.

****5. Art and Science: Equal Partners in Understanding**

Complex Information

Integration of Art in Research: Art plays a crucial role in exploring and representing complex information structures. The creative process often involves navigating and interpreting complex, multidimensional information, making it an essential partner to scientific exploration.
Application: By using complex numbers and polymeric information in art, artists can create works that explore the ambiguity, depth, and multidimensionality inherent in human experience, pushing the boundaries of both artistic and scientific understanding.

Metrics of Polymeric Information

Polymeric information represents an extension of traditional dual (binary) information systems by incorporating complex numbers and multidimensional structures. This allows for a richer, more nuanced representation of information that can capture not only binary states but also more complex relationships, such as those found in quantum mechanics, emotional processing, and creative expressions. Here are the key metrics that define polymeric information:

1. Shannon Entropy (H)

- **Definition**: Shannon entropy measures the uncertainty or unpredictability in a set of outcomes, which is fundamental in quantifying information.
- **Formula**:

$$H(X) = -\sum_{i} p(x_i) \log p(x_i)$$

- **Application**: In polymeric information, Shannon entropy can be extended to consider multidimensional probability distributions that include both real and imaginary components, providing a broader view of uncertainty in complex systems.

2. Fisher Information (I)

- **Definition**: Fisher information measures the amount of information that an observable random variable carries about an unknown parameter upon which the probability of the random variable depends.
- **Formula**:

$$I(\theta) = \mathbb{E}\left[\left(\frac{\partial}{\partial \theta} \log f(X;\theta)\right)^2\right]$$

- **Application**: In the context of polymeric information, Fisher Information could be used to assess the sensitivity of complex systems (where variables are complex numbers) to changes in parameters, allowing for more precise modeling of dynamic and uncertain environments.

3. Kullback-Leibler Divergence (D_KL)

- **Definition**: Kullback-Leibler divergence measures the difference between two probability distributions. It is often interpreted as the amount of information lost when approximating one distribution with another.
- **Formula**:

$$D_{KL}(P||Q) = \sum_{i} P(i) \log \frac{P(i)}{Q(i)}$$

- **Application**: For polymeric information, KL divergence can be extended to measure differences between complex probability distributions, providing a way to compare and contrast different states or processes within a complex system.

4. Quantum Information and the Bloch Sphere

- **Definition**: Quantum information represents information stored in the state of a quantum system. The Bloch sphere is a geometric representation of the pure state space of a two-level quantum mechanical system (a qubit), where each point on the sphere represents a possible state of the qubit.
- **Formula**:

$$|\psi\rangle = \cos\left(\frac{\theta}{2}\right)|0\rangle + e^{i\phi}\sin\left(\frac{\theta}{2}\right)|1\rangle$$

- **Application**: The Bloch sphere is crucial for visualizing the states of qubits in quantum computing, a core area where polymeric information plays a vital role. It allows us to understand how complex information can exist in superpositions and evolve over time.

5. Complex Information

- **Definition**: Complex information extends the concept of information by using complex numbers, allowing for the representation of phenomena that involve both real and imaginary components.
- **Formula**:

$$I(z) = I(x + iy)$$

- **Application**: In polymeric information theory, complex numbers allow the modeling of systems where variables have both magnitude and phase, such as in wave mechanics, signal processing, and emotional or cognitive modeling.

Summary

The metrics of polymeric information are essential for capturing the complexity and multidimensionality inherent in advanced systems, whether in quantum computing, cognitive sciences, or creative processes. By extending traditional information metrics to include complex numbers and their associated mathematical structures, we gain a deeper understanding of systems that operate beyond binary logic, opening up new avenues for research and innovation.

Metrics for Complex Information

1. Complex Numbers and Distances

- **Complex Numbers**: Complex numbers are foundational in representing information that includes both magnitude and phase, essential for applications in signal processing, quantum mechanics, and more.
  - **Mathematical Representation**: A complex number z is expressed as $z = a + bi$, where a is the real part, and b is the imaginary part.
  - **Distance in the Complex Plane**: The distance between two complex numbers $z_1 = a_1 + b_1 i$ and $z_2 = a_2 + b_2 i$ in the complex plane is given by:

    $$d(z_1, z_2) = |z_1 - z_2| = \sqrt{(a_2 - a_1)^2 + (b_2 - b_1)^2}$$

    This formula is derived from the Euclidean distance formula applied in the two-dimensional space of the complex plane.

2. Hilbert Space

- **Definition**: A Hilbert space $\mathcal{H}$ is a complete inner product space that generalizes the notion of Euclidean space to infinite dimensions. It plays a crucial role in quantum mechanics and functional analysis.
  - **Inner Product**: For two vectors $\phi, \psi \in \mathcal{H}$, the inner product is defined as:

    $$\langle \phi | \psi \rangle = \sum_{i=1}^{\infty} \phi_i^* \psi_i$$

    where ϕ_i^* is the complex conjugate of ϕ_i.
  - **Norm and Distance**: The norm of a vector ψ in a Hilbert space is given by:

    $$\|\psi\| = \sqrt{\langle \psi | \psi \rangle}$$

    The distance between two vectors ϕ and ψ is then:

    $$d(\phi, \psi) = \|\phi - \psi\|$$

  - **Application in Quantum Mechanics**: Quantum states are represented as vectors in a Hilbert space, and the inner product $\langle \phi | \psi \rangle$ corresponds to the probability amplitude of transitioning from state ϕ to state ψ.

Extended Metrics for Polymeric Information

1. Multidimensional Metrics

- **Multidimensional Representation**: In polymeric information theory, data is often represented in higher dimensions, requiring advanced metrics for analysis.
  - **Vectors and Matrices**: A general vector in an n-dimensional space can be represented as $\vec{x} = (x_1, x_2, \ldots, x_n)$. The distance between two vectors $\vec{x}$ and $\vec{y}$ in this space is given by:

    $$d(\vec{x}, \vec{y}) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2}$$

  - **Covariance Matrix**: In the context of data analysis, the covariance matrix Σ of a set of random variables is a key metric, capturing the variance and correlation between different dimensions:

    $$\Sigma_{ij} = \mathrm{Cov}(X_i, X_j) = \mathbb{E}[(X_i - \mu_i)(X_j - \mu_j)]$$

    where μ_i is the mean of the i-th variable.

2. Tensors and Distances

- **Tensors**: Tensors generalize matrices to higher dimensions, allowing for the representation and manipulation of multi-index data structures.
  - **Definition**: A tensor T of order n can be represented as:

    $$T_{i_1 i_2 \ldots i_n}$$

    where $i_1, i_2, \ldots, i_n$ are the indices running over the dimensions of the tensor.
  - **Frobenius Norm**: The Frobenius norm is commonly used to measure the size of a tensor:

    $$\|T\|_F = \sqrt{\sum_{i_1 i_2 \ldots i_n} |T_{i_1 i_2 \ldots i_n}|^2}$$

    This norm generalizes the concept of the Euclidean norm to multi-dimensional arrays.
  - **Tensor Decomposition**: Decomposing tensors into simpler components, such as through Canonical Polyadic Decomposition (CPD), is crucial for simplifying the analysis of high-dimensional data.

Practical Applications

1. Machine Learning and Data Analysis

- **Complex-Valued Neural Networks**: Complex numbers can be used in neural networks to represent phase information, which is particularly useful in signal processing and other applications where waveforms or oscillations are involved.
  - **Weight Update Rule**: In complex-valued networks, the gradient descent update rule can be extended to handle complex weights:

    $$w^{(t+1)} = w^{(t)} - \eta \frac{\partial \mathcal{L}}{\partial w}$$

    where $\mathcal{L}$ is the loss function, η is the learning rate, and w is the complex weight.
  - **Hermitian Matrices**: In data analysis, Hermitian matrices, which are square matrices with complex entries, are used where $A = A^*$. The eigenvalues of Hermitian matrices are always real, making them crucial in quantum mechanics and other fields.

2. Quantum Information

- **Qubits and Quantum Gates**: In quantum computing, a qubit is represented as a vector in a two-dimensional complex Hilbert space. Quantum gates, which operate on qubits, are represented as unitary matrices U where:

  $$U^\dagger U = I$$

  This ensures that quantum operations are reversible, a key property of quantum computation.
  - **Tensor Products in Quantum Computing**: Quantum states that involve multiple qubits are represented using tensor products:

    $$|\psi\rangle = |\psi_1\rangle \otimes |\psi_2\rangle \otimes \cdots \otimes |\psi_n\rangle$$

    The tensor product allows for the representation of entangled states, which cannot be described by classical information theory.
  - **Von Neumann Entropy**: In quantum information theory, the von Neumann entropy is a measure of the quantum system's entropy and is defined as:

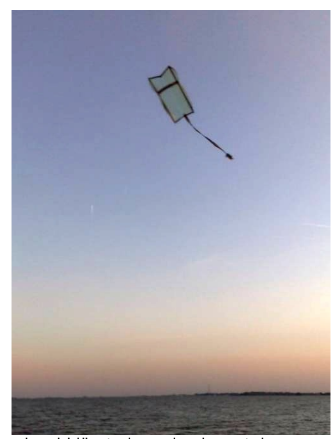
    $$S(\rho) = -\mathrm{Tr}(\rho \log \rho)$$

    where ρ is the density matrix of the quantum state.

This refined version of the text integrates more mathematical details and proofs into the discussion of complex numbers, Hilbert spaces, tensors, and their applications in machine learning and quantum information. This approach provides a deeper understanding of the metrics involved in polymeric information theory.

no architects - t-shirt - stwst 2011

root of minus one - stwst2018



udo wid lässt einen drachen steigen