SIGNAL EDGE

Humanized AI

Neuro-Symbolic Intelligence

Taking Artificial Intelligence to the Next Level

NEURO-SYMBOLIC INTELLIGENCE

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Artificial Intelligence

Artificial Intelligence Artificial intelligence (AI) has taken on many forms over the years. The most common is Machine Learning where computers use a statistician's toolset to perform pattern analysis on large data sets. This draws inferences from the data patterns for the human supervisor to act on. Deep Learning, an expansion of Machine Learning, is where applications are capable of scanning unstructured data input, like images, text docs, and speech patterns, to perform basic recognition and then action.

Neural Networks have emerged as a memory infrastructure that can enable the production of prediction analytics. For instance, to detect credit card fraud, neural networks can analyze info such as payment method, time, location, item purchased, and the amount spent. Within seconds, these solutions look up over 500 data elements to determine if a transaction is suspicious. However, as these systems expand to include additional factors they often get bogged down, becoming unreliable. These AI technologies are all designed to assist users in making decisions.

Generative AI systems such as ChatGPT have recently emerged touting the ability to perform unassisted decision-making. These systems rely on token prediction to generate content derived from their training data. Content can include any form of writing, video creation, and systems automation. However, Generative AI solutions have the following issues that need resolution before widescale deployment:

1. Quality Control and Data Accuracy
   Generative AI decision-making can be easily biased by its training data. Lack of case diversity of an activity and misinformation can severely limit its capability for objective outcomes. It has often been referred to as a "mindless parrot" because it lacks the ability to generalize knowledge and can only repeat what is in its training dataset. The biggest concern in this area is hallucinations where generative AI will confidently produce decisions that are completely nonsensical and incorrect. For financial applications this can be very costly and in high-risk applications potentially dangerous.

2. Ethical & Legal Considerations
   Generative AI produces non-transparent decisions. It cannot describe why a

particular decision was made or explain the steps in making that decision. This prevents accountability producing untrustworthy systems. As a result, generation AI lacks any capacity to understand the consequences of its decisions. Without consequences, there is no facility for self-regulation or more importantly self-correction. Also, Generative AI is notorious for infringing on copyrighted material, intellectual property, and confidential information. Without consequences, this information is freely regurgitated in its output.

3. Complexity and Technical Challenges
   Generative AI is a very expensive and complex method for producing intelligence. Running ChatGPT is the equivalent to powering 33,000 households. This is on top of the more than 100 million dollars OpenAI needed to pay to train ChatGPT4. Making matters worse, Generative AI cannot be updated in real-time which mandates constant retraining which is expensive and time consuming. The current methods for producing AI and processing the vast amounts of data are coming up short on promised capability and in many cases are failing to show long-term profit potential. The AI project success rate is said by many to be only 20%, where costs typically overrun the budget by 1500%. Combine this with the escalating cost of cloud services from vendors like Azure and AWS have many early AI adopters unsure how these new technologies can benefit their businesses and be cost-effectively managed.

Unfortunately for AI, the promises far exceed their capabilities. The central problem in generating a more human-like artificial general intelligence (AGI) is that current AI methods lack the ability to understand and appreciate the content of the data patterns they predict. This lack of understanding prevents AI from generalizing the knowledge present in AI. Without generalization, decisions produced by AI lack depth and appreciation of the many elements that may be present in the context of an activity. For example, a self-driving car can be easily fooled by a person standing next to the road wearing a shirt with a stop sign. The AI has been trained to stop regardless of these additional elements present in the context of the activity.

Current artificial intelligence is basically mindless and cannot use common sense to resolve the many discrepancies that can lead to nonsensical decisions and hallucinations. The only viable method for using AI and other decision-support systems is to implement a ***human-in-the-loop*** approach that can enhance accuracy, provide transparency, and establish reliability standards by incorporating human judgement into complex activities and critical tasks.

Neuro-Symbolic Intelligence

Neuro-Symbol Intelligence enhances data decisions systems by providing an additional interpretation layer where artificial intelligence can be translated and rationalized by a human user. By introducing human interpretation, the knowledge produced by AI and other data mining operations can be harnessed into a real-time framework for incorporating the many details, subtilties, and interrelationships that contribute to correct understanding. Neuro-Symbolic Intelligence, as depicted in Figure 1, converts data to a combination of neurological states and symbolic logic. By converting to symbols and emotions, the human element can be integrated into the decision production process.

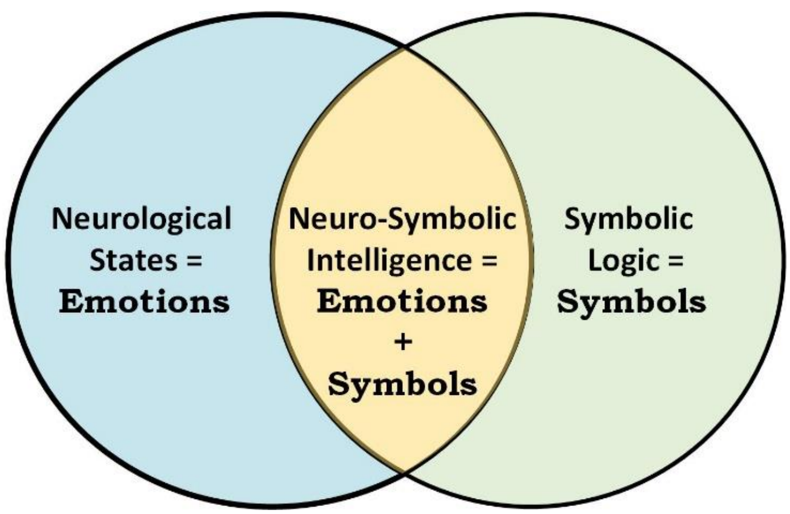


Figure 1 – Neuro-Symbolic Intelligence

Artificial Intelligence by itself is just data pattern knowledge and prediction. At best, it can only produce an approximation of intelligence that is narrowly constrained. However, combining artificial intelligence with Neuro-Symbolic Intelligence produces higher quality results that more precisely map the situation at hand. Symbols and images provide a means to generalize knowledge allowing entire concepts to be understood with specific symbol and presentation patterns. Emotions serve to modulate the data allowing for different interpretations of the same data. Associating symbolic and emotional heuristics adds a layer of detail that enables precise understanding and faster comprehension of the state of any activity. That understanding is applied to an activity context and presented in such a fashion as to generate real-time human comprehension.

Neuro-Symbolic Intelligence maintains a neurological state within a symbolic interface to create a form of data awareness that promotes rapid comprehension of complex situations. The neurological state is formed by assigning emotional variables to various symbols (images) to promote or demote their prominence in producing situational awareness. Emotional states rate the importance of different data elements in a given functional activity. For example, if an investigator feels that a witness is lying, the emotions that relate to that feeling can then be associated to those data elements of that particular interview through symbolic assignment. By capturing these emotions, Neuro-Symbolic Intelligence can focus the data elements accordingly to produce a more accurate depiction of the situation. Associating humor and a person to the stop sign symbol on the shirt in the previous artificial intelligence example would have easily corrected the self-driving car failure.

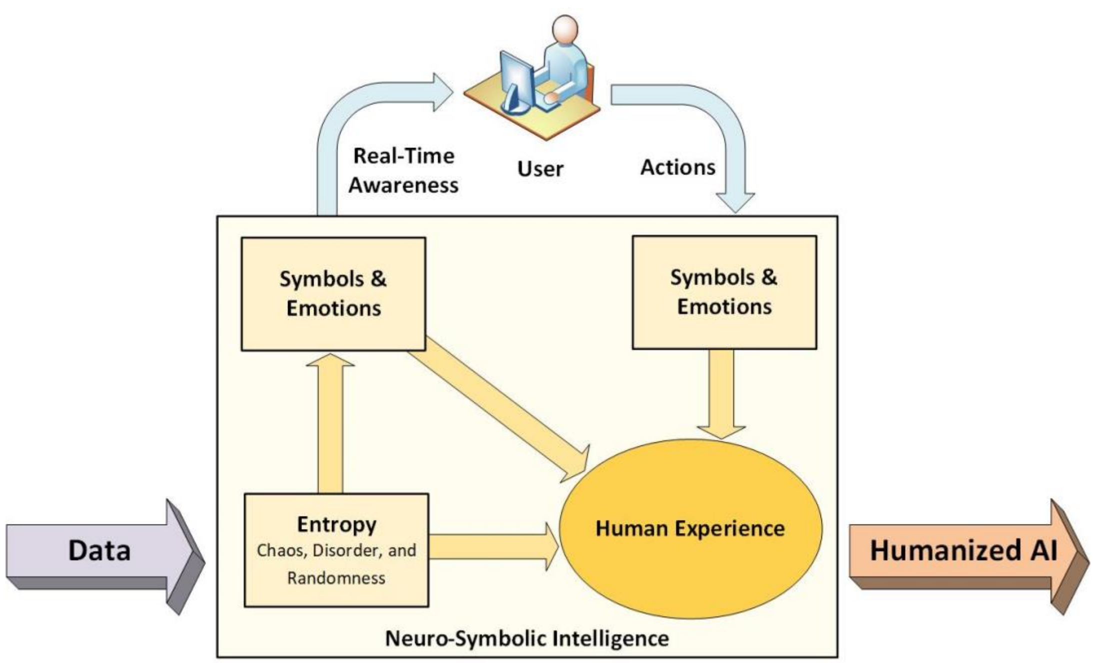


Figure 2 – Human in the Loop

Neuro-Symbolic Intelligence as depicted in Figure 2 places a **human-in-the-loop** to educate and teach the AI how to perform an activity. All data input into the system will be measured for entropy. Entropy represents chaos, disorder, or randomness and is considered the most valuable data in the data stream because it contains all of the individual data elements that could not be predicted. All predicted elements represent existing experience whose resultant actions are known and will be automated. Basically, Neuro-Symbolic Intelligence sifts through all the data to identify what it doesn't know and translates that data into a symbolic emotion infused format destined for interpretation and adaptation.

All the data together at one moment in time creates a state of real-time *awareness* that can be tapped into and understood by a user. The *awareness* is presented in the context of a user activity in such as a fashion as to generate rapid interpretation of events. The user in response to real-time situational events will experience emotional states and draws upon previous experience to make decisions in the form of actions. The data pattern, the symbolic translation, the emotions, and the human actions represent the element of "Cause". The resultant data patterns of the user actions or inactions create the element of "Effect". The foundation of human Intelligence Is based on cause-effect learning regulated by generalized knowledge and emotions. All of these elements are combined by Neuro-Symbolic Intelligence in order to pattern human decision-making and create Humanized AI.

Neuro-Symbolic Intelligence learns human intelligence from the user. How the user judges and responds to a situation and the user's emotional states are impressed into Humanized AI and form the basis for learning and repeating positive outcomes. The resultant decisions and automation will reflect human interpretation creating higher accuracy and much greater precision. Neuro-Symbolic Intelligence uses the following five stage learning process as depicted in Figure 3:

1. User Interface Produces Situational Awareness: Data is converted to symbols infused with emotions creating a user display that promotes rapid real-time comprehension.
2. Awareness Encourages the User to Create Actions: The user will react to the symbols and emotions by selecting actions that will generate a desired response.

3. Actions Generate Results: The AI measures the results of the actions through changes in its state of awareness caused by the actions.
4. Results Produce and Scale Emotions: With an understanding of good and bad and right and wrong, the AI judges the desired outcome against the actual outcome to create an emotional response and scale its intensity.
5. Emotions Regulate AI Learning: The AI learns from both good and bad experiences. Positive outcomes are repeated and negative outcomes are avoided.

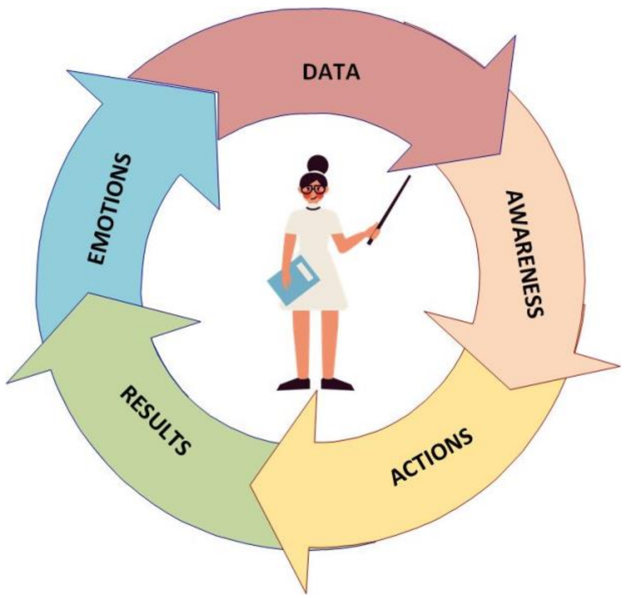


Figure 3 – Five Stages of Human Learning

Humanized AI captures the unique essence and meaning of human experience. These experiences are grouped into episodes and are cross listed with all previous experience using emotions and generalized knowledge to create a more human form of memory. Each episodic experience represents a unique sequence of the most important elements of an event and are bound into the linear context of the activity. The memories of these experiences together and in parts form an accumulative effect where each experience builds on the next, generating greater levels of intelligence and capability.

Neuro-Symbolic Intelligence divides experiences into two categories, deterministic and non-deterministic. A deterministic experience has little to no entropy and can be fully automated where cause-effect learning guides and validates all decisions-making. A non-deterministic experience has entropy present which indicates a new or unique challenge in the environment of the activity that requires adaptation. Adaptations are drawn from previous user experiences where general knowledge and emotional states contribute to selecting a new response. The user's methods for adaptation in similar situations is learned and projected back into the decision-making process to create the best decision for maximizing desired outcome.

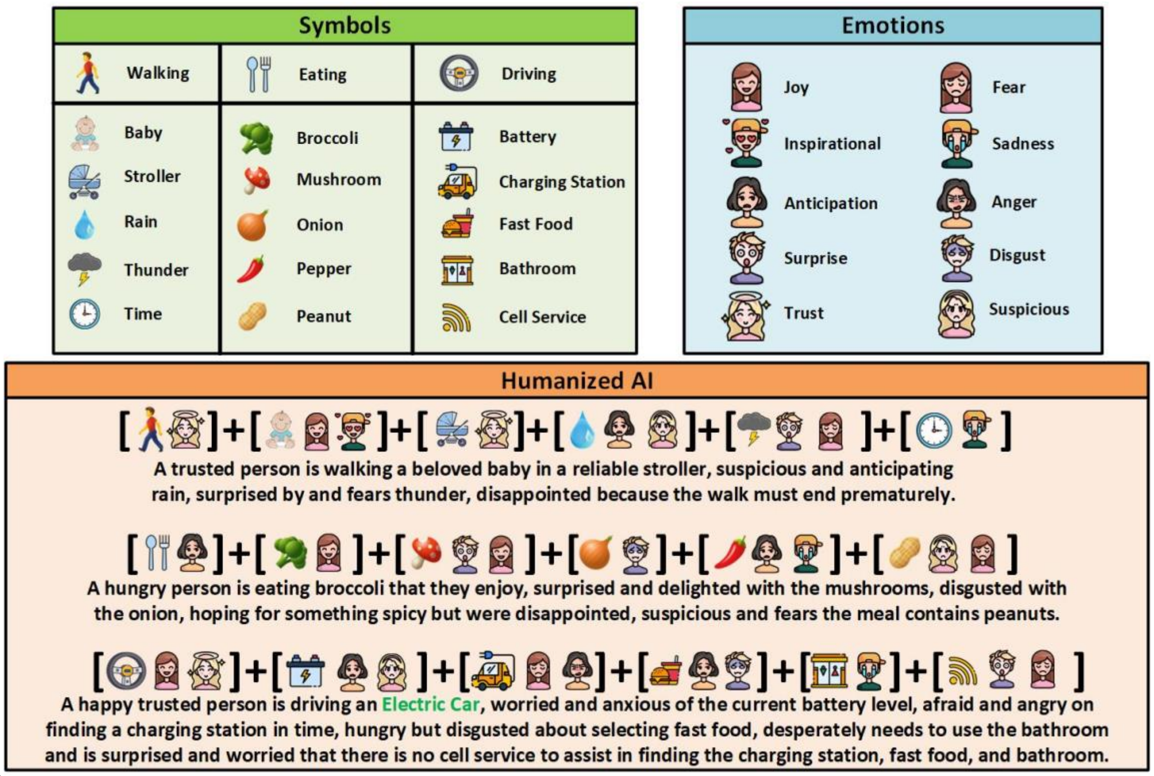


Figure 4 – Encoding the Human Experience

Figure 4 depicts the general memory structure of Humanized AI. The symbols (Green) are combined with emotions (Blue) to create Humanized AI (Orange). Figure 3 demonstrates the encoding of 3 different examples based on the activity being performed: walking, eating, or driving.

The first example encodes a walking activity using a mixture of 5 symbols and 10 possible emotional states. The symbols allow a user to generalize the knowledge and by applying emotional states, the meaning of the data can be expressed. The meaning of data is to understand why something is important, what is the context of the activity being performed, what constitutes the experience, how does it relate to previous experiences, what are the available reactions, and what are the short/long-term consequences. Humanized AI records this information into memory by simply concatenating the symbols and emotions into an activity context capturing the essence of the experience.

The driving example in Figure 4 demonstrates a unique characteristic to Humanized AI which is common sense. Common sense is a human skill known as ***transitive inference*** which is a form of deductive reasoning that allows one to derive a relationship between items that have not been explicitly compared before. A simple example is if A > B and B > C then A > C. Common sense tells us that A > C even though we have no previous experience of A and C together. In the driving example, we know that it is an Electric Car without ever being told it is an electric car. Since the driver is worried about the battery level and concerned with finding a charging station, common sense tells us that it is an electric car. Current AI is incapable of performing this level of human deduction, let alone encoding it into memory.

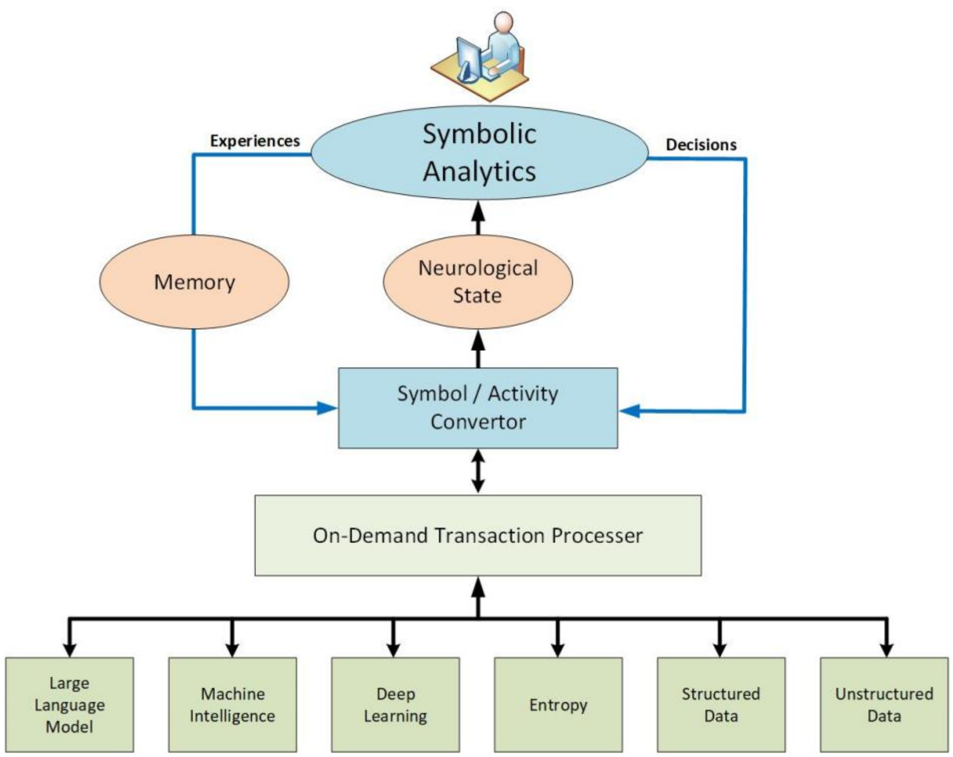


Figure 5 – Neuro-Symbolic Intelligence Architecture

Figure 5 shows the general architecture of Neuro-Symbolic Intelligence. Potential input sources can be any form of patterned data including all current forms of artificial intelligence, quantum-based entropy measurements that reflect uncertainty, structured data, and formatted unstructured data. All data inputs and outputs are controlled by an On-Demand Transaction Server which functions as a secured unified data port allowing neuro-symbolic intelligence real-time access to the different information systems to gather data and distribute actions. The transaction server runs at the request of the Symbol-Activity Convertor which translates the pattern knowledge into appropriate symbols and organizes the symbolic representations around a specific functional activity. The Symbol-Activity Convertor uses memory of similar data patterns, symbols, and emotions to perform its translation and update the Neurological State. From this architecture real-time awareness is produced and channeled into a user interface.

The user interface reproduces *awareness* and provides symbolic selections so the user can perform actions. When actions are performed, they create an experience that associates the data patterns, the activity context, the symbolic translation, and the emotional states. Each experience can then be linked to the next experience forming episodic memory that will basically contain the variant cause-and-effect data patterns of the actions. As experience is gained, actions become learned and can be automated when similar episodic patterns are encountered based on matching desired emotional states.

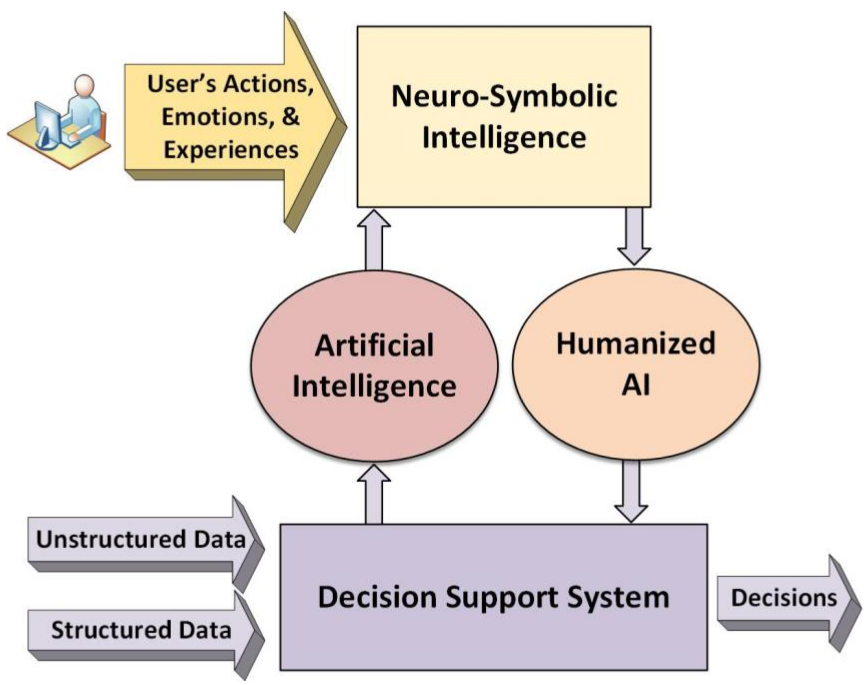


Figure 6 – Integrating Neuro-Symbolic Intelligence

Figure 6 shows the general model needed to deploy Neuro-Symbolic Intelligence. Decision Support Systems will process structured and unstructured data in order to make decisions. Decisions can be formulated from artificial intelligence using machine learning, deep learning, neural networks, or generative AI. AI systems are designed to identity data pattern convergence and anomalies and will produce their own form of data knowledge and prediction. Neuro-Symbolic Intelligence will convert the AI data and any other data into Humanized A1 that can be seamlessly integrated back into the Decision Support System.

Neuro-Symbolic Intelligence provides the following unique benefits:

1. **Real-Time Comprehension**
   Disseminating information from the vast amount of data produced by a computer can be a daunting process. The most common methods involve complicated forms and tabular dashboards that overwhelm a user with options and alerts. Unfortunately, these techniques can be counterproductive confusing users, delaying situational understanding, and taking far too much time to effectively complete an activity. Neuro-Symbolic Intelligence depicts information as a series of symbols that increase comprehension speed and assist the user in focusing on the most important elements needed in making decisions.

2. **Rationalizes**
   Rationalization is a process that allows deductive and inductive reasoning to be applied to the elements of an activity that may contribute to a desired or undesired outcome. To facilitate the reasoning function, Neuro-Symbolic AI can judge good from bad and understand the difference between right and wrong. It uses cause-effect sequences to measure and analyze potential outcomes, to select the best decision that can maximize the circumstances at hand.

3. **Data Pedigree**
   All information gathered and used by Neuro-Symbolic Intelligence can be processed into a compressed entropy format that stores data in a fraction (less than 1 percent) of its previous size. The entropy can be used to accelerate other data-driven analytics/AI systems or to reproduce the

original data stream in its entirety. This process allows the data pedigree to be maintained and provides a means to audit detailed information even in vast data sets.

4. Human-in-the-Loop (HITL)
   Although AI and other data-driven technologies with sufficient training can reliably reproduce quality decision-making in most situations, it is not absolute. There will always be situations where no previous experience exists and where ambiguities may be present. When this occurs, technology will fail and require a **human-in-the-loop** to provide the adaptation necessary to make correct decisions. Neuro-symbolic Intelligence provides an interface that highlights the ambiguities and flags the user when new circumstances are encountered allowing a human to intervene at appropriate times to assist the system in learning to make new decisions.

5. Explainable AI (ExAI)
   How AI solutions reach decisions is as much a mystery to users as it is to the developers that program and train them. Lack of transparency is a continuing problem with little foreseeable resolution. Neuro-Symbolic Intelligence functions as a gateway to generalize the knowledge produced by AI pattern analytics and applies those analytics to an activity context. This additional information provides a full accounting of the decision-making process by exposing all the causal evidence for how and why a decision was made.

6. Guardrails
   Artificial intelligence technology lacks the ability to judge when their pattern analytics are producing nonsensical decisions, a condition known as hallucinating. Neuro-symbolic Intelligence monitors all decisions made by AI and other data-driven solutions preventing unjust outcomes. It allows organizations to take full advantage of computer automation while maintaining the necessary safety net for critical applications.

7. Force Multiplication
   By increasing processing speeds, expanding knowledge sources, decreasing comprehension time, and focusing effort, Neuro-symbolic Intelligence

multiplies the overall effectiveness of users producing higher quality results in a fraction of the time. Combining pattern and content analytics into a single activity context creates highly usable intelligence that automates repetitive tasks, identifies trends, and gives users the ability to rapidly complete tasks with a high degree of precision and accuracy.

8. **Tribal Knowledge**
   Tribal knowledge is a measure of an organization's know-how and is the sum of all the history and experiences of its employees and personnel. The infusion of tribal knowledge is a mandatory step if these knowledge systems are to be used to automate critical decision-making within an organization. Neuro-Symbolic Intelligence captures this knowledge by performing content analytics with the user in combination with data patterns analytics from AI and other data-driven sources. The combination produces intelligence patterns that can be recorded, learned, and applied in future situations.

Cognitive Object Interface

The Cognitive Object Interface (COI), in reference to Figure 7, is a graphical user interface that allows an operator to be integrated into the Neuro-Symbolic Intelligence process. The COI implements an OODA Loop "Boyd Loop" decision-making framework. The OODA Loop consists of the following four stages: observation (O), orientation (O), decision (D), and action (A). The framework assists the user in making precise, effective decisions in a rapidly changing environment by continually cycling feed forward and feedback information into the process. As a result, the learning process is self-refining and teaches not just decisions, but instructs the AI on how and why a particular decision was made for each unique event of any given activity.

The COI presents a visually interactive interface that establishes the context of an activity through symbolic representation. As data is processed into the COI, it creates a cognitive state that produces awareness, allowing the user to focus on important elements of any situation. Matching symbols and selecting actions performs the activity.

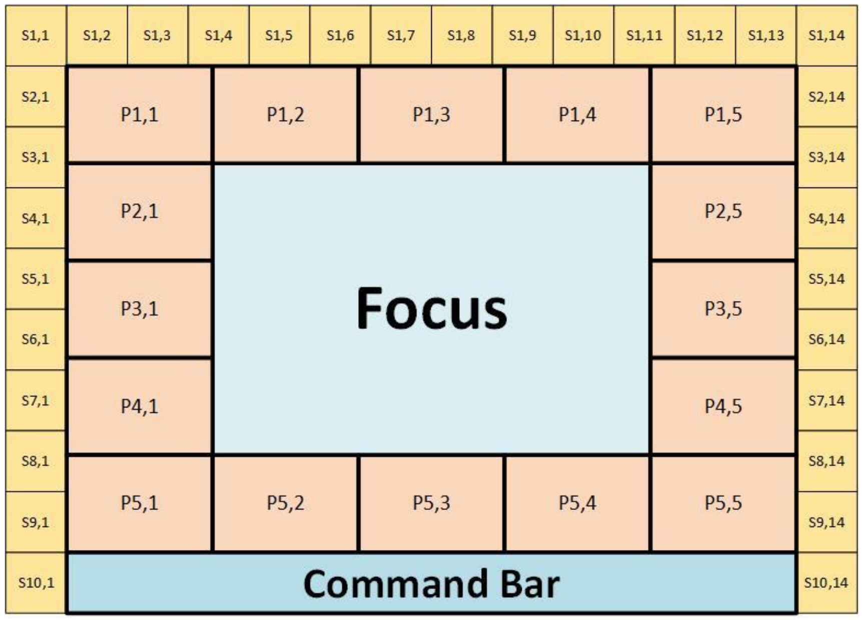


Figure 7 – Cognitive Object Interface

The Cognitive Object Interface is designed to assist the user in drawing lines between cognitive objects. By using visual symmetry (like color and symbols), the user quickly connects objects to create the intelligence (transitive inference) needed to perform the activity successfully. The COI facilitates a game simulation using the various data streams and historical data sources. The goal of the game is to successfully complete the activity based on a survival rating.

The COI organizes knowledge data into the form of cognitive objects and these objects are displayed on tiles with recognizable symbols on one of three levels.

1. *Subconscious* – Neuro-Symbolic Intelligence is tracking the motion of every object derived from all the different data streams. When objects show certain unpredictable motion patterns, the subconscious display on the outer ring (S#,#) is used to notify when cognitive objects need attention or decision-making.
2. *Peripheral* – Peripheral on the inner ring (P#,#) provides a display of cognitive objects and the objects that they may contain in a symbolic form that allows the mind to organize the objects for rapid information assimilation. Peripheral vision works on the concept of providing a visual bridge between objects in order to accelerate cognition and decision-making.

3. *Focus* – Focus is the primary vision level and will display the most relevant information about an object or group of objects. When an object is in focus, the user can select sub objects for greater focus or make decisions concerning the object using the command bar at the bottom of the COI display.

At the bottom of the display is the following command bar:

Commands – Commands are the final product of decision-making and when selected will display the available actions that apply to the situation and activity being performed.

Scheduling –Not all actions are automated, and execution is neither guaranteed nor immediate. Many actions may require human labor or outside resources that need to be scheduled.

Grouping – Allows a user to explore and set different object groups which will have a direct affect display and memory. New associations can be created and different relationships exposed.

Value Assessment – As the systems gains experience, display emphasis and action selections become automated. This category creates transparency by showing the user exacting why a decision or group of decisions were automated citing corresponding episodic memory.

Suggestions – When a user is unsure what actions to select, the COI using previous experience can provide the user with suggestions concerning the current situation with projected outcomes.

The COI provides the user with a unique comprehension of the situation at hand and the tools to interact with the data and make decisions in real-time.

On-Demand Transaction Server

The COI is supported by an On-Demand Transaction Server as depicted in Figure 8. The Transaction Server provides the general software programming framework for organizing, deploying, and sequencing different data input and output components needed to support neuro-symbolic intelligence. It provides a secure platform for integrating the many different components that contribute to the intelligence and regulates access to that intelligence.

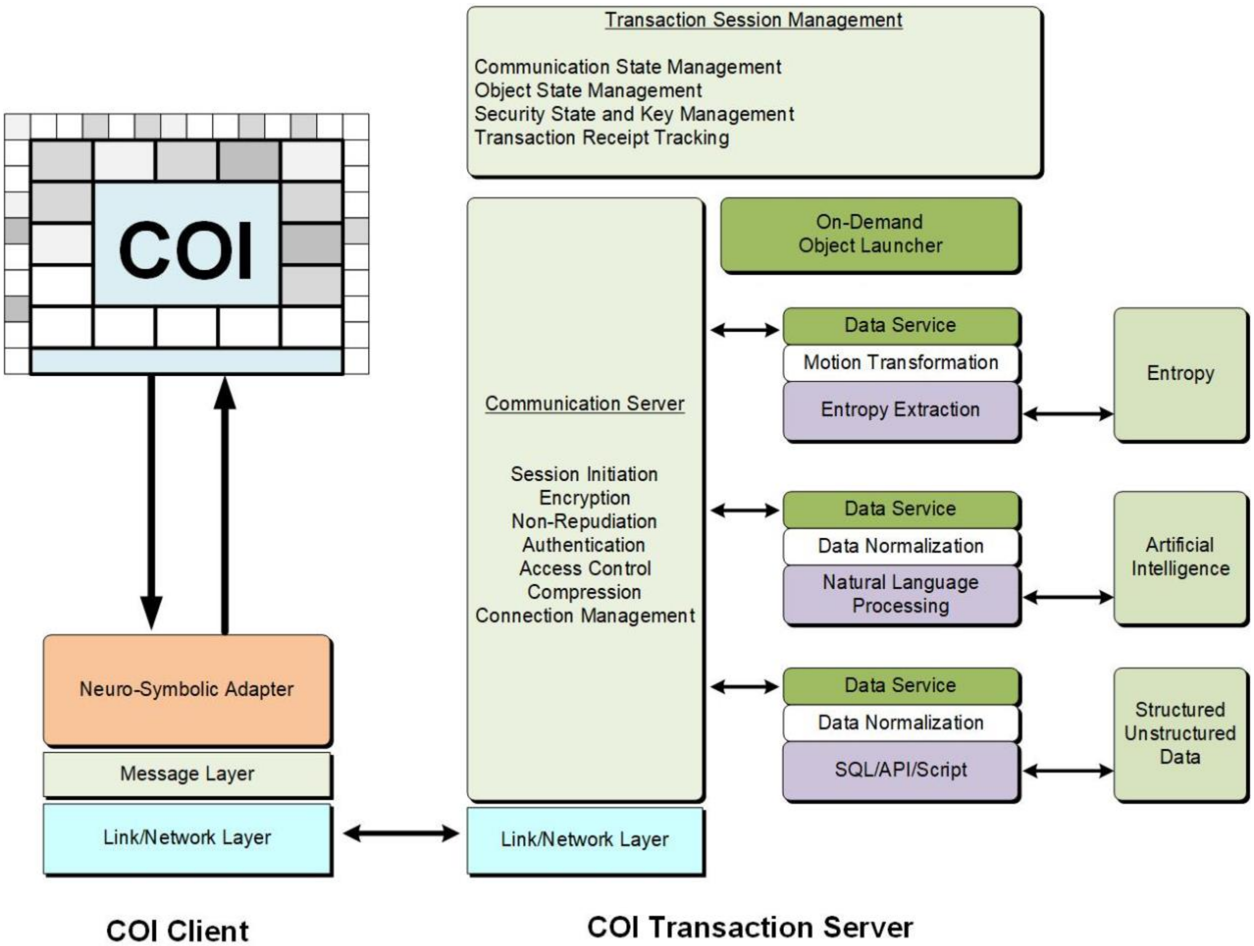


Figure 8 – On-Demand Transaction Server

The Transaction Server forms a quantum entanglement relationship with all of these different data sources allowing their data to transfer across the computer network as entropy, reducing data load by over 99.9%. Entropy represents uncertainty which is the most valuable data in the data stream. The entropy is synchronously processed into memory to form a single quantum state that represents all the data at any given moment in time. The COI connects and authenticates to the Transaction Server which will allow the COI to execute the different data services that provide real-time access to the quantum state.

The Transaction Server is a multiple process software system that incorporates a Communication Server to provide secure application services to an unlimited number of COI clients. The Communication Server manages security and will initiate a separate process thread to handle the data service request and will be responsible for channeling any resultant reply back to the COI Client.

The Communication Server does not queue objects to be launched; instead, it launches them on demand. This ensures real-time execution and allows data transactions to be run synchronously across a computer network. The Transaction Server is a high-speed secure network bridging platform for performing real-time process-to-process communication.

During deployment, the COI data requirements are identified and organized by symbolic tile requirements. Each individual COI tile represents a separate data transaction type that may need to be executed by the Server. The different transaction types are coded and plugged into the Server. As the COI executes, transaction sequences are formulated, packaged, and securely transmitted to the Transaction Server.

The COI runs in a client-server relationship based on a Request/Reply model that allows it to either push or pull data from one or more Transaction Servers. COI requests/replies can be transmitted across a Link/Network Layer using either a link layer protocol such as MIL-STD-1553 or a network layer protocol such as Internet Protocol (IP).

Conclusion

Artificial Intelligence has for many years failed to create a computer that has the capabilities of a human. Theses failures are all rooted in the fact that there is no clear understanding on how human intelligence is actually produced. They failed because they have not considered incorporating what it means to be human into the equation. Neuro-Symbolic Intelligence technology reverses this trend by allowing the human elements to be integrated into the decision-making process. All forms of computer data are continuously processed as entropy into a quantum state of real-time awareness. The awareness is converted to a visual symbolic format infused with emotional states. The symbolic format provides a means to assign general knowledge to the data and the emotional states gives the knowledge value and meaning. This form of awareness produces rapid comprehension of a situation and looks to a human operator to provide reactions. The reactions will generate results that when combined with the quantum state will produce Humanized AI which captures the human interpretation of events. The human form of intelligence is governed by emotions using cause-effect learning where positive outcomes are repeated and negative outcomes are avoided.

Neuro-Symbolic Intelligence is powered by a transaction-based middleware server that allows it to integrate with new and legacy technologies to form advanced AI solutions without the need to redesign or build new software infrastructure. The transaction server provides the mechanism for securely entangling any number of data sources into a single quantum state and providing real-time user access to that state. The transaction server is a high-efficiency process designed to run on any size computer using the least amount of computer and network resources. All communication with the transaction server is encrypted with an entropy encoding that makes it highly resilient to decryption and tampering.

Neuro-Symbolic Intelligence creates Humanized AI by copying the actions of human users. It is taught like a child using positive and negative reinforcement to learn best, most desired outcome. Neuro-Symbolic Intelligence doesn't just have answers to problems, it has a general understanding of the experience, full awareness of its environment, and an appreciation of its own existence. These elements of humanity are combined to create a process that is adaptable, learns continuously, and builds an intelligence as it gains more experience. Neuro-Symbolic Intelligence puts the human into artificial intelligence to create a system that is greater than sum of its parts.

Appendix – Sample Applications

Insurance Claims Processing

The following example demonstrates the use of vehicle insurance objects for a claims support activity managed by a COI using Neuro-Symbolic Intelligence to accelerate comprehension and decision-making. While many claim activities can be automated, the COI focuses the user on the events that require special scrutiny. The goal of the application is to protect the company by sorting out fraud, instantiation, and unprofitable policies in real-time.

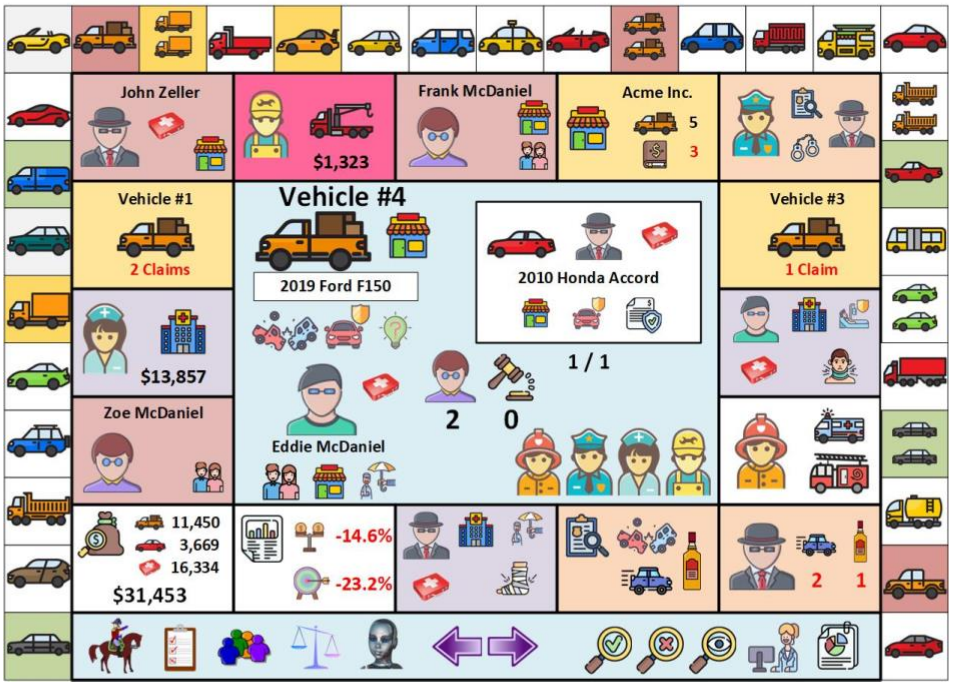
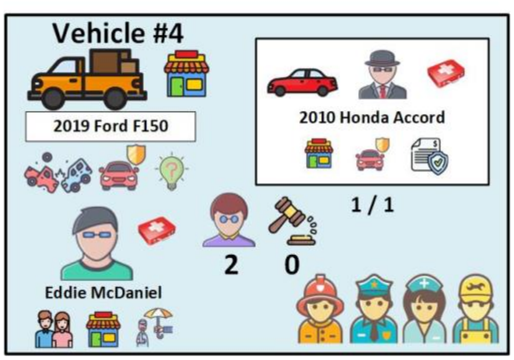


Figure 9 – Insurance Claim COI

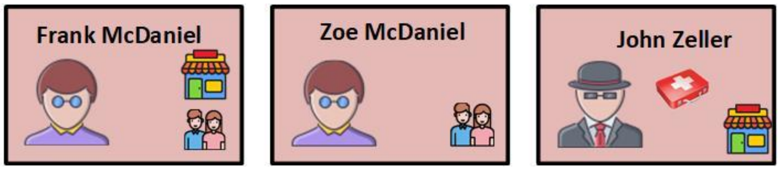
In Figure 9, the COI has detected unexpected event and is flashing a color signal on the Subconscious Row 1, Column 2 (S1,2) tile. The user pushed the tile and has brought up a specific vehicle into Focus.



A truck on a business policy was in an accident. The driver has coverage. The driver works for the business, is a family member, and was injured. The claim involves a second vehicle and that driver works for the business and was also injured. There are two witnesses and zero legal cases. The accident required a variety of outside services. User has access to policy info and all documentation. Based on previous experience, the interface recommends a subrogation claim.

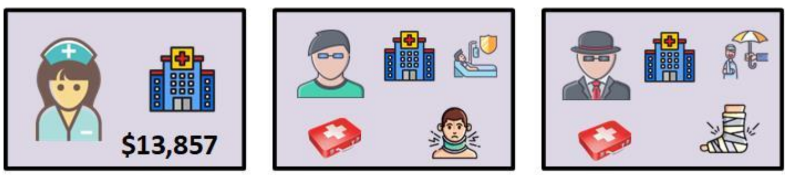
The focus is supported by tiles on the COI's peripheral level which display the various data relationships that are important to understanding the insurance claim activity.

Red Flag – (P1,4), (P2,1), and (P2,5) indicate that the policy covers 5 vehicles and has 3 recent claims.



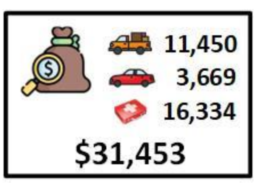
Red Flag – (P1,1), (P1,3), and (P4,1) indicate that the two witnesses are family members and one witness and the driver of the Honda both work for Acme Inc.

Subrogation – (P1,5), (P5,4), and (P5,5) indicate that the Honda driver was ticketed and arrested for DUI. The Honda driver has two previous tickets and one DUI.



Laddering – (P3,1), (P5,3), and (P3,5) indicate there are two uncapped medical expenses, a neck injury and a broken leg.

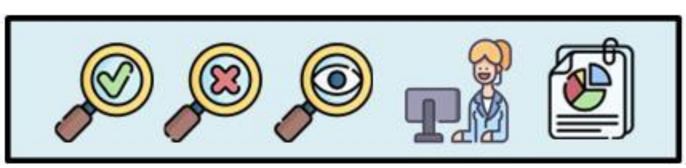
Fraud – (P1,2) indicates a potential fraud situation where the towing expenses are 121% above average.



Costs – (P5,1) displays the current expenses associated with the claim.

Bad Numbers – (P5,2) indicates that the plus/minus of the policy in underwater by 14.6% and its actuarial target in underwater by 23.2%. This policy is not making money and needs a serious rate adjustment or cancelation.

At the bottom of the display to the right are the actions available for the insurance claim in Focus:



Actions Include: Authorize Claim, Audit Claim, Investigate Claim, Contact Parties, Produce Reports

Network Security

The following example demonstrates the use of security objects for a user access activity managed by a COI to accelerate cognition and automate decision-making. The COI is monitoring the network and all security management sources. The COI is tasked with identifying cyber-attacks, preventing unauthorized access, and providing full network assurance. The goal of the game is to protect the network and maintain full compliance to the cybersecurity framework. Figure 10 depicts a Network Security COI managing a small company of 219 employees. The company has 5 departments symbolized Executive, Marketing, Manufacturing #1, Manufacturing #2, and Sales. The activity of the COI is organized around the NIST Cyber Security Framework 2.0.

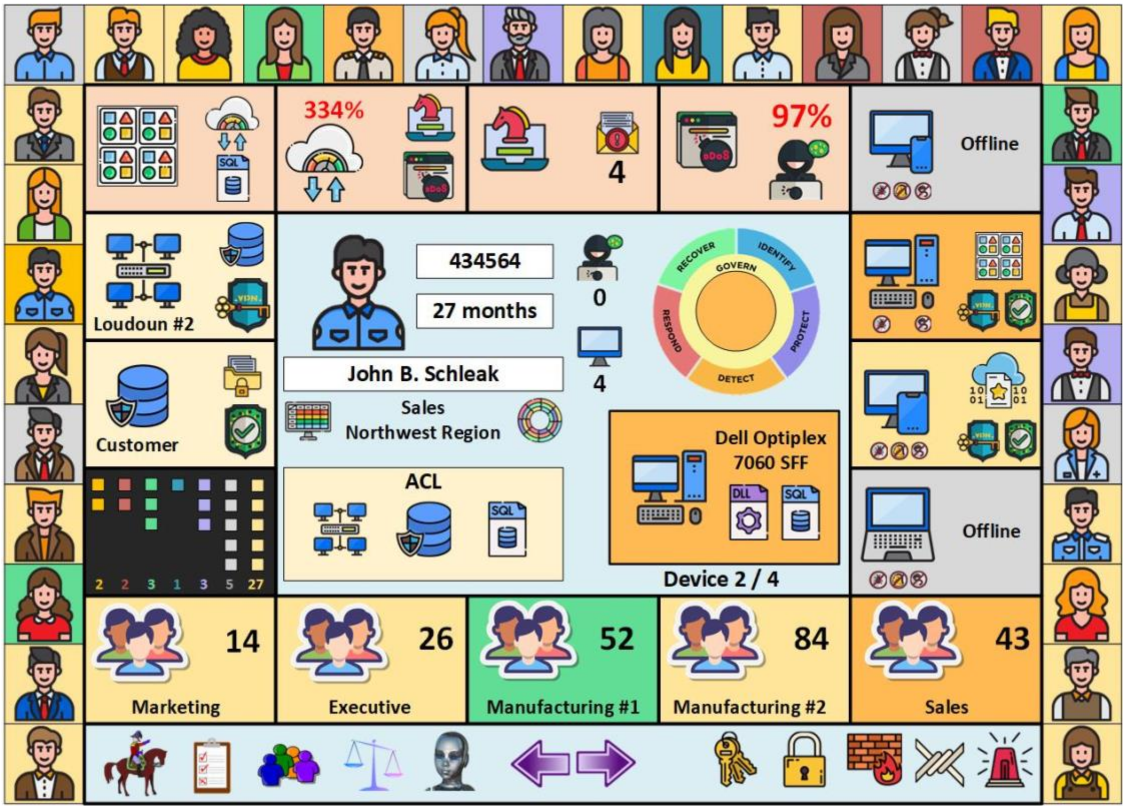
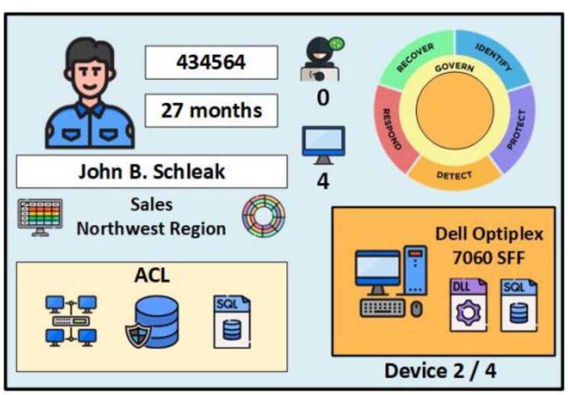
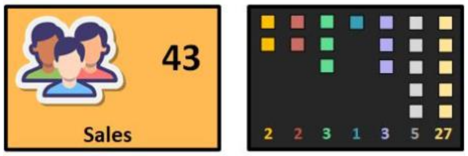


Figure 10 – Network Security COI



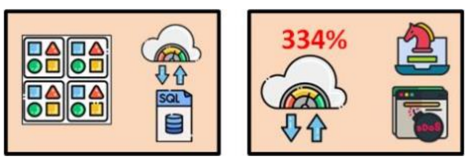
A device assigned to John B. Schleak has triggered a Detection Event Subconscious Row 4, Column 1 (S4,1). The COI is tracking the event and gathering related information that will assist the security administrator in making a decision. The COI focus area shows that John has been an employee for 27 months, has had no previous cyber security incidents, and has 4 known devices that can access the company computers. One of those devices has triggered a detection event while running SQL scripts.



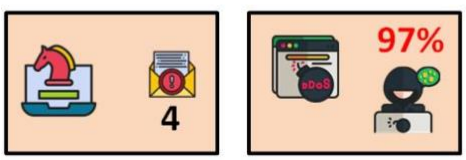
The sales department (P5,5) has triggered two detection events. The COI summaries (P4,1) the security situation of all the Sales users with color codes from the NIST framework.

John B. Schleak has 4 devices registered to operate on the company network. John's cell phone (P1,5) is offline and compliant with security updates. John's laptop (P4,5) is offline and compliant. John's tablet (P4,3) is online, compliant, and producing normal data patterns. John's desktop (P2,5) is online, not compliant with security updates, and is producing an unusual data pattern.

John is authorized to access the Customer database (P3,1) in the Loudoun #2 datacenter (P2,1).

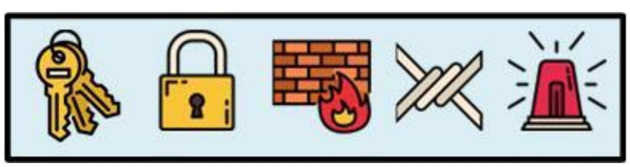


Unusual SQL data patterns (P1,1) and volume is 334% beyond normal (P1,2) with a pattern resembling a Denial-of-Service attack that may be controlled by a Trojan Horse on John's desktop computer.



The company has had 4 previous incidents of a Trojan Horse penetrating the IT infrastructure via email (P1,3). The COI estimates that there is a 97% chance that this incident is a cyber-attack (P1,4).

At the bottom of the display to the right are the actions available for the detection event in Focus:



Actions Include: Allow Access, Lock Out Device, Block at Firewall, Fence Off Device, Facility Lockdown.

The actions selected during the detection event will move the affected device to the Response Stage of the cyber security framework where the effects of the response can be further examined and additional counter-measures applied. The COI will manage each subsequent stage the same way until the device reaches final governance.

Smart Building Management

The following example demonstrates the use of IoT devices to manage a smart building controlled by a COI that accelerates comprehension and automates decision-making. The COI is tasked with sorting out sensor data and labor resources to maintain the building. The goal of the game is to protect the building by proactively identifying risks and efficiently allocating the necessary resources in a timely, efficient, and cost-conscious manner.

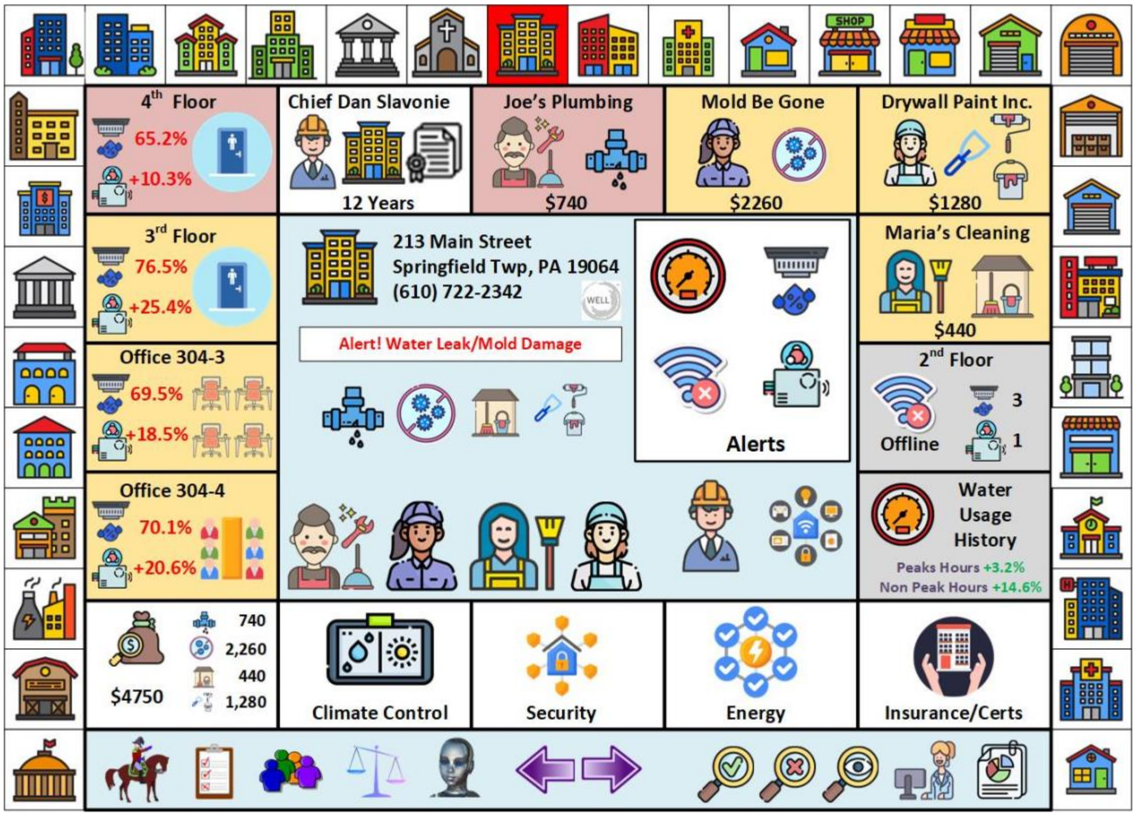
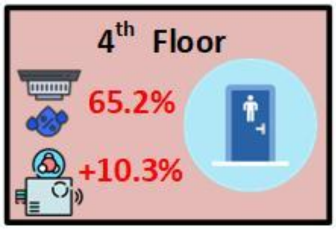


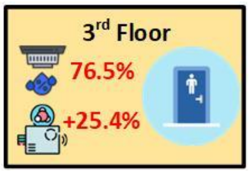
Figure 11 – Smart Building COI

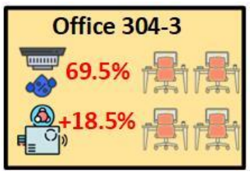
In Figure 11, a motion signal from Subconscious Row 1, Column 7 (S1,27) attracted the user to push the tile and bring up a building at 213 Main Street into Focus. The building maintains a Well Certificate to assure management excellence. The building has generated alerts on the water gauge, the humidity sensors, the air particulate sensors, and several offline sensors. The COI has determined that there is a water leak in the building with mold damage in several rooms.

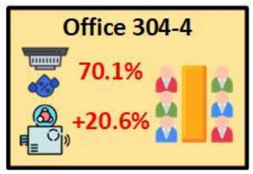
Building engineer who is in charge of the response. Engineer qualifications, schedule and contact information are available by pressing the tile Peripheral Row 1, Column 2 (P1, 2).



After an investigation, the plumber (P1,3) has identified and fixed a water leak in the 4th Floor bathroom (P1,1).

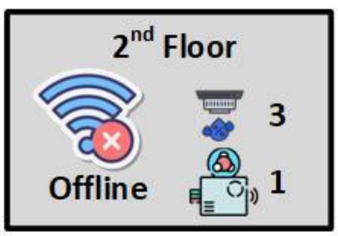


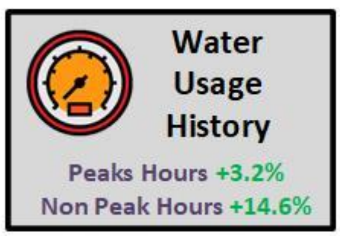




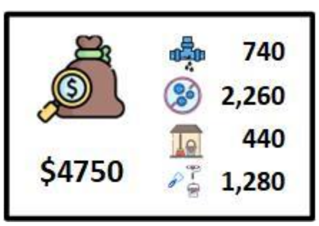
Sensor readings have led to and identified several (P2, 1), (P3, 1), (P4, 1) rooms where repairs are required.

Suggested contractors and estimates (P1,4), (P1.5). (P2,5) for mold elimination, painting, and cleaning services to fix the damaged rooms.



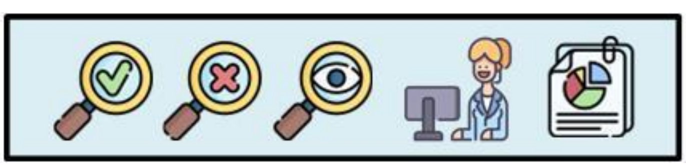


(P3,5) and (P4,5) indicate areas of unknown that require additional investigation. Three humidity and one air particle sensor are offline on the 2nd Floor. Also, continued abnormal water usage indicates possible other leaks.



Total costs for this incident are estimated in (P5,1).

At the bottom of the display to the right are the actions available for the building incident in Focus:



Actions Include: Approve Repairs, Audit Incident, Investigate, Contact Parties, Produce Report

Military Logistics

The following example demonstrates the use of Air Force military objects for a supply management activity managed by a COI to accelerate cognition and automate decision-making. The COI facilitates a game simulation using the sensor data streams to accomplish the logistic activity. As the game runs, ground units will exhaust their ammo supply and may sustain casualties. The user must identify any units outside of the range of ground supply and schedule an appropriate munitions/medical air drop. Mission success is be measured and rated on number of drops, units supplied, cargo efficiency, ground/air causalities, and time.

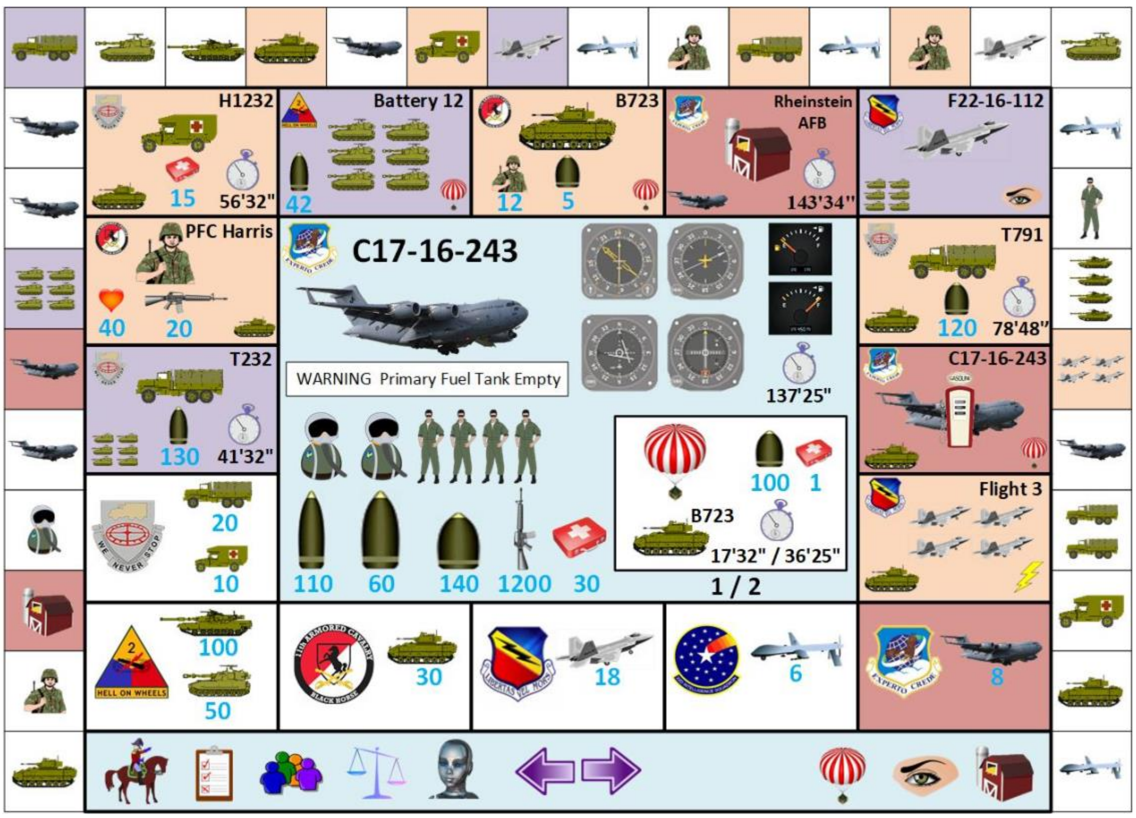
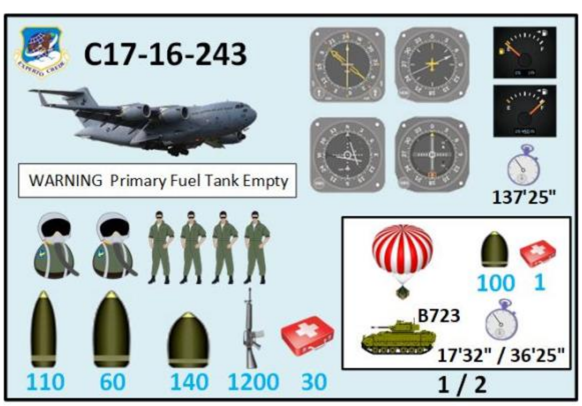


Figure 12 – Military Logistics COI

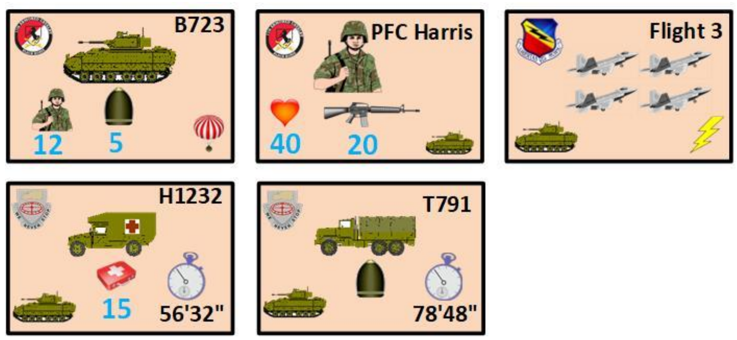


In Figure 12, the user has been notified of a problem and has brought up a specific aircraft into Focus. The aircraft is reporting a fuel warning. Included in the Focus is all information pertinent to this problem including inventory, personnel, and flight controls. Included are current orders of the aircraft which is displayed in a box in the lower right-hand corner of the focus. The symbols indicate that two air drops are currently scheduled with B723 being first with a flight time of 17 minutes 32 seconds.

The mission of the game is to provide backup logistical support for an armored division (P5,1) and mechanized regiment (P5,2) coordinating supply with a transportation regiment (P4,1).

To accomplish the mission, the user will have at their disposal a fighter squadron (P5,3), a drone squadron (P5,4), and an air lift squadron (P5,5).

(P3,5) and (P1,4) indicate that the aircraft's fuel shortage has created a problem in flight time required to complete the drop missions and get back to base.



(P1,3), (P2,1), (P4,5), (P1,1), and (P2,5) provide relevant info on the first drop mission. The situation indicates that PFC Harris is seriously wounded and there is a shortage of ammunition. Medical ground transport H1232 is 56 minutes and 32 seconds away and resupply T791 is even longer. The user determines this drop mission is priority.

(P1,2), (P1,5), and (P3,1) provide data on the second drop mission. The situation is lower priority because ammo is not critical and ground transport will only take 5 minutes longer to resupply.

At the bottom of the display to the right are the actions available for the aircraft in Focus:

Actions Include: Schedule Airdrop, Conduct Surveillance, Return to Base

Elder Care Management

The following example demonstrates the use of IoT devices to manage the needs of the Senior Living Center occupants controlled by a COI that accelerates comprehension and automates decision-making. The COI is tasked with sorting out sensor data and labor resources to maintain the health and well-being of the center's occupants. The goal of the game is to protect the occupants by proactively identifying risks and efficiently allocating the necessary resources in a timely, efficient, and cost-conscious manner.

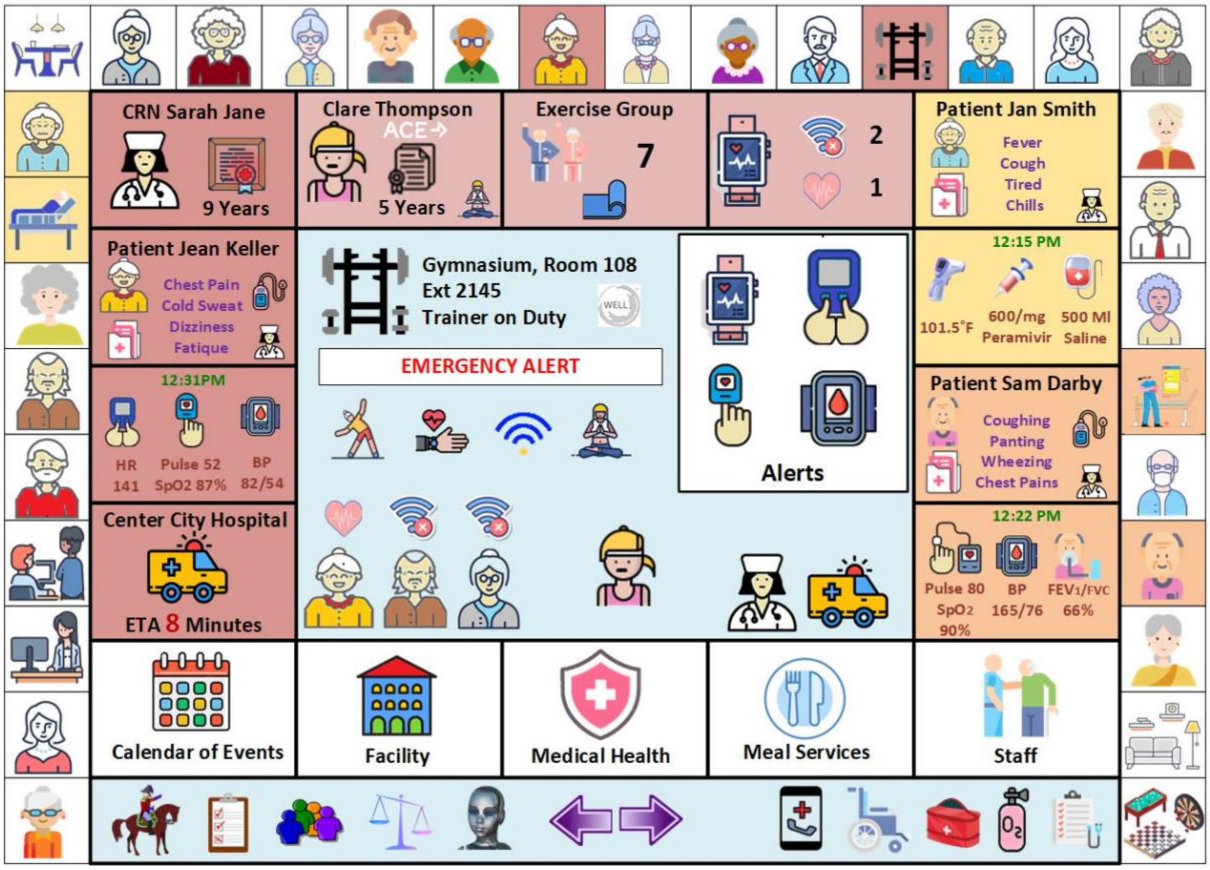
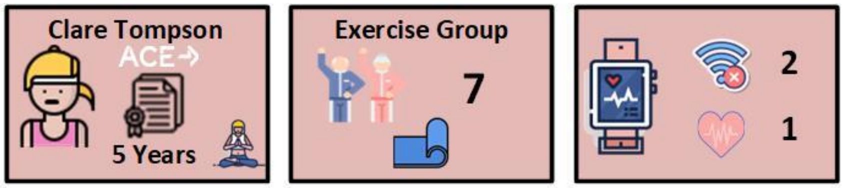
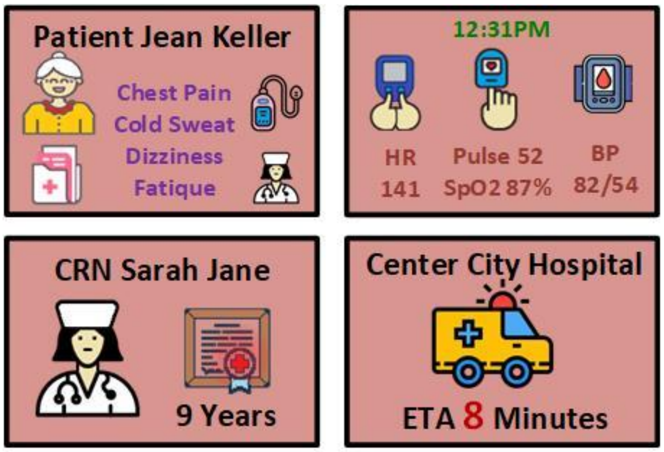


Figure 13 – Elderly Care

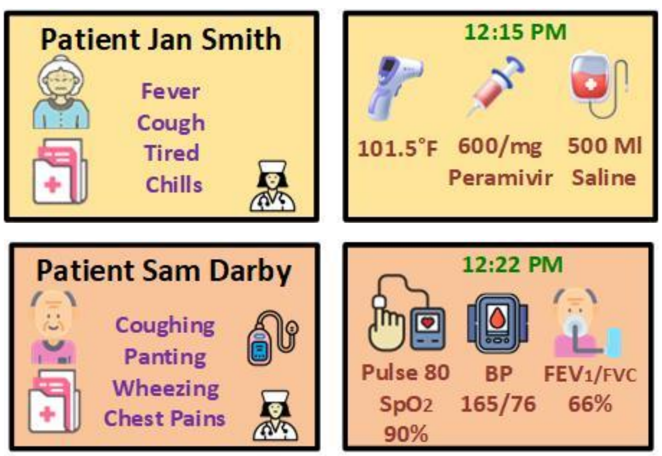
In Figure 13, a motion signal from Subconscious Row 1, Column 7 (S1,27), attracted the user to push the tile to focus on the gym. It is currently hosting a yoga exercise class, attendees wear smart watches, and all data is accessible on the network. The Gym is reporting multiple devices producing alerts: smart watches, portable EKG, pulse monitor, and blood pressure machine putting the gym in an EMERGENCY status. A CRN has been dispatched to the gym to provide assistance and has sent for an ambulance.



Ms. Thompson is an instructor conducting a yoga class in the gym monitoring attendees using smart watches and has two offline and one heart warning.



Jean Keller has generated the heart warning and is in serious distress. Sarah Jane a CRN was dispatched to the gym and has put Ms. Keller on oxygen. Ms. Keller's blood pressure is falling, pulse is weak, blood oxygen content is low, and her heart rate has gone up substantially. Ms. Keller is complaining of symptoms that could indicate that she is building to a heart attack, so Nurse Jane has called 911 and the ambulance is 8 minutes away.



Nurse Jane was also responsible for patient Jan Smith. Ms. Smith is experiencing flu like symptoms. Ms. Smith is running a mid-grade fever. She was given an antiviral drug and IV drip for dehydration.

Nurse Jane was also responsible for patient Sam Darby. Mr. Darby began to experience CPD like symptoms. His pulse is high, blood oxygen content is low, blood pressure is high, and his FEV_1/FVC level is low. Patient has been given oxygen and needs close monitoring.

At the bottom of the display to the right are the actions available for the gym in focus:

Actions Include: Call 911, Wheel Chair, Medical, Oxygen, Reports