John T. Carrola Jr.
Artificial Intelligence Solutions Architect Lead

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Booz Allen Hamilton (April 2021—Present)
Southwest Research Institute (SwRI), Applied Physics Division—19 Years of Experience

Science & Technology Innovator / Program Development / Multidisciplinary Teambuilding

Specialist, Communications, 2002–2006	Specialist, Learning Sciences & Systems, 2007–2011	Research Analyst, Applied Physics, 2011–2021	Artificial Intelligence Solutions Architect Lead, Booz Allen, 2021–Present

Mr. John Carrola is currently an Artificial Intelligence and Deep Learning Solutions Architect at Booz Allen Hamilton (BAH), and a technical lead for the Digital Transformation Team. Current work in this area centers on developing learning models for automating assessments through analysis and model integration within data-driven pipeline ecosystems.

He is also leveraging his experience in applying all-source intelligence to structure information into data-driven graph-based frameworks for intelligence analysis of the Information Environment: identifying intelligence gaps and anomalies, understanding mis/disinformation dynamics, modeling defensive and counter techniques for influence operations, and creating audience analysis models.

At SwRI Mr. Carrola was an applied mathematics and data research analyst in the Applied Physics Division's Systems and Sensors Section. There he specialized in conducting research aimed at modeling, mining, and analyzing information from diverse data sets. Other research experience and responsibilities include: engineering collection and analysis techniques, building research teams, and integrating ideas from multiple disciplines to investigate new scientific research.

His experience focuses on investigating and applying creative perspective and mathematical techniques to accomplish technical innovation and design general solutions to various problems.

Mr. Carrola routinely manages as well as performs experimental work and data analysis with his research teams, along with creating and communicating new ideas. This includes experience in designing and programming applications to analyze data using statistical packages and toolsets in MATLAB, Python and R among other languages.

His project work includes the conceptualization and development of original funded research in a variety of scientific fields for agencies including: the Defense Advanced Research Projects Agency (DARPA), the U.S. Army Research, Development, and Engineering Command (RDECOM), Air Force Installation and Mission Support Center (AFIMSC), North Atlantic Treaty Organization (NATO), and Southwest Research Institute's Disruptive Technology Internal Research and Development (DTIR&D) Program.

RESEARCH AND TECHNICAL EXPERIENCE

- OSINT / social science support
- Machine learning / machine vision
- Natural language processing
- Data mining / data science
- Statistical & experimental methods
- National security / intelligence analysis
- Trend analysis & forecasting
- Culture / group dynamics Mis-/disinformation
- Organization
- Cognition / emotions
- Identity / personas
- Uncertainty & risk
- Anomaly detection
- Threat assessment

PROFESSIONAL, ANALYTICAL, AND METHODOLOGICAL SKILLS

- Algorithm Development: Matlab, R, Python, Java, C#
- Application Development: Java, C#, Android platform
- Graphics/Video Design: Adobe Creative Suite
- 3D / Real Time Graphics: 3D Max, C4D, Unity3D, OpenGL
- Supervised, unsupervised, deep learning models
- Social analysis / structured analytic techniques
- Linear, longitudinal / multilevel, game-theoretic statistical models
- Model evaluation /selection /optimization
- Experimental, survey, observational, interview design & methodologies
- Survey design /evaluation
- Feature engineering
- Web scraping / API requesting
- Data visualization
- Theory construction / testing
- Research participant management
- Program planning and evaluation
- Proposal & technical report writing

CLEARANCE OR CITIZENSHIP

ACTIVE **SECRET** CLEARANCE

ACADEMIC SCHOLARSHIPS OR SPECIALIZED PROGRAMS

University of Texas at San Antonio (UTSA) Intelligence Community Centers for Academic Excellence (ICCAE) Scholar recipient 2018-2020

RECOGNITION

NATO Innovation Challenge (Innovation Hub):

- **Military Mobility (Second place winner; November 2023)** Solution Architect and Technical Lead
- **Multi-Domain Resilience (Finalist (4th); October 2022)** Solution Architect and Technical Lead

NATO Defense College (NDC) Competition – NATO 2099: A Graphic Novel:

- **Selected Work (2023).** Fictional Intelligence / Sci-Fi Short Story Contribution

EDUCATION

- M.S., Data Analytics (National Security / Intelligence Studies Track), University of Texas-San Antonio, 2020

- B.S., Mathematics, Texas A&M University-San Antonio, 2012

- B.A., Communication Arts (Graphics / 3D Visualization Track), University of the Incarnate Word, 2001

RELEVANT RESEARCH & EXPERIMENTAL WORK

ARMY P2MR2 Modernization & SecureRAG: Multi-Domain Data Fabric and Active Zero Trust (2024–Present):

Mr. Carrola is leading the technical and strategic development, of a framework to support a Prevent-Protect-Mitigate-Respond-Recover (P2MR2) physical security team stationed at an overseas allied partner nation installation, amidst strategic rivalry between great powers. This P2MR2 framework is designed for reporting:

1. Operations Research and Analytical Modeling
2. Threat Assessment and Capability Scoring (risk, resilience, interoperability breakdowns)
3. Annual Prioritization Efforts & Planning/Briefing Support

The framework leverages data-driven and mathematical models to guide Generative AI agents to decompose operational assets and capabilities, measure mission interoperability and incorporate redundancy into a mission's need, to enhance resilience and reduce the mission's risk.

- **Multi-Domain Decomposition & Workflow Modeling:** Developed a hierarchical architecture and ontology to unify physical, cyber, and cognitive layers within a single mission framework. Implemented ontology-led breakdown of security team protocols in a unified database, capturing logical aspects of procedures ensuring accurate tracking and understanding of capabilities across the multi-domain hierarchy.

- **Agentic AI Pipeline & Active Zero-Trust Security:** Designed a memory schema for agentic AI modules to leverage dynamic conversation-driven access (when requesting information), preventing adversarial probing and data leakage. Instead of static guardrail permissions, security rules adapt to each dialogue's context and user needs—reinforcing an active zero-trust posture. For example, investigating user roles, history and mission relevance—then calculating risk before revealing sensitive schedules or potential vulnerabilities.

- **Mathematical Interoperability & Resilience:** Applied concepts from operations research—i.e., network resilience and redundancy—to model P2MR2 protocols to measure how well different cross-domain mission components can support one another in crises, ensuring multiple pathways exist to accomplish critical tasks.

NATO : Military Mobility Innovation Challenge Internal R&D (2023-Present):

Mr. Carrola led a team of multi-domain subject matter experts, model-based engineers, and AI/data scientists, to modify the ELLISON framework (2022) for Encapsulation and Integration; developing designs to encapsulate domain behaviors and create a digital twin (DT) of those behaviors within a simulation environment.

- **Modular Composable Microservices:** designed to analyze system components and processes to abstract physical and functional layers of military and mobility networks.

- **All-Domain Data Fusion:** design to link an array of inputs from civil, military, and commercial sources, including distributed and human-in-the-loop sensors, that serve as synchronization mechanisms to update the intelligence data for the network DT.

- **Extensible Ontology**: An ontology framework was designed around analysis standards to enable interoperability and data exchange between DTs across different platforms and use cases.

ELLISON: An Integrated Solution to Entity Management for OSINT Analysis (2022-Present)

Mr. Carrola collaborated with a team of intelligence and OSINT analysts to design and implement a new semantic search methodology that enhances intelligence analysis, curating data and evidence through a tiered AI-Driven Entity Management framework, that works in parallel with the human in the loop intelligence analyst, to make intelligence analysis more effective by gathering and connecting relevant data to build a structured and interconnected system of evidence.

- **Ontology Design:** Applied graph theory and knowledge representation techniques to model typed dependencies.

- **Distributional Semantics:** Applied information theory and natural language processing to calculate statistics that capture semantic associations.

- **Narrative Relation Learning:** Applied graph embeddings and network analysis to encode information within and between event chains.

- **Similarity Metrics Integration:** Applied data analysis and geometric techniques to embed ontologies for clustering and visualization.

AFIMSC: AI/MLOps Ecosystem Framework for Automated Condition Assessment (2021-2022)

Mr. Carrola led a team of data scientists and software engineers, to develop an AI-powered visual assessment ecosystem that extracts features from infrastructure imagery, quantifies condition scores, and integrates explainable metadata into Air Force management systems for transparent assessments. Key innovations included perceptual models for analyzing structural components and a modular MLOps pipeline orchestrating data collection, image processing, and machine learning for accurate facility inspections.

- **Image Acquisition and Preprocessing:** Applied signal processing techniques such as filtering, normalization, and noise reduction to prepare images for analysis. Developed transformation and manipulation algorithms to represent the image data as matrices or multidimensional structures.

- **Feature Extraction and Region of Interest Analysis:** Customized computer vision algorithms for identifying and delineating specific features within images (e.g., edges, corners, regions). Developed custom geometric and image processing descriptors to calculate shape properties and material descriptors.

- **Development of Condition Assessment Models:** Applied statistical learning models to infer condition scores from image features. Implemented multivariate classification techniques for severity classification based on patterns of custom descriptors.

- **Data Structuring and AI Model Integration:** Modeled relationships in the data to structure the output data to fit into the BUILDER Sustainment Management System.

- **AI/MLOps for Model Management and Deployment:** Researched and developed process and operation models to model performance and quantify uncertainty, to implement an MLOps pipeline for efficient model training and deployment.

NATO: Cognitive Warfare Concept Community of Interest Facilitator and Researcher (2021)

Mr. Carrola developed and presented a data-driven framework to study cognitive biases, functional impacts, and threat scenarios related to cognitive warfare across the ecosystem of social networks and platforms to NATO's Concept Development Team. Analytical models were created to evaluate capabilities, map ecosystems, and provide recommendations.

- **Cognitive Bias Modeling:** Developed framework models to represent biases and impacts on cognition.
- **Network Analysis:** Utilized knowledge graphs and hierarchies to map relationships between entities and ideas.
- **Scenario Analysis:** Applied scenario analysis to explore combinations of biases and project possible outcomes on decisions and cognitive capabilities within the cognitive threat ecosystem.
- **Ecosystem Mapping:** Mapped knowledge graphs into different representation spaces to measure system dynamics, dependencies and visualize relationships.

SwRI Internal Research and Development (IR&D): Machine Learning Techniques for Intelligence Asset Reconstruction and Analysis (2019-2021)

Engaged in both research proposal and program work to develop techniques (deep learning; adversarial) for supporting Intelligence operations in recovering and reconstructing specified features in captured low-resolution and low-quality image data for evidence analysis.

- Categorized the reconstructed image features
- Measured accuracy and uncertainty for the generated images

UTSA Research: An Open-Source Intelligence Approach to Understand Cognitive Bias among Groups (2019)

Researched cultural groups and compared their cognitive biases toward events and social themes (e.g., 'healthcare'; 'climate change'). The approach measured biases within culturally derived social media texts to support ethnographic research using machine learning techniques; turning "Big" data into "Thick" (ethnographic) data.

- Cross-referenced the cognitive biases of groups measured in targeted datasets against relevant open-source demographic and empirical data, then approximated the diversity of cultural attitudes for context to the group's observed cultural behavior
- Validated detected biases and characterized them against relevant social trends
- Project showed cognitive biases in cultural language models can characterize social trends, to support sociological analysis through big data

Poster Presentation, National Security Collaboration Center (NSCC) UTSA Research Pitch Day: The Hackable Mind: Understanding Social Engineering Strategies for Online Detection (2019)

Described risks for a society connected through social and information networks creating a fabric of actionable human thought; the research presented implications for a nation state harnessing this social connection into action, manipulating behavior at large scales.

- Analyzed the Russian Internet Research Agency "trollfactory" group dataset for communication patterns, and categorized the social engineering strategies used to exploit cognitive biases and psychosocial vulnerabilities

SwRI-UTSA Research & Development: Investigating Methods of Defense for Adversarial Data Input in Machine Learning Models (2019)

Research proposal motivated to defend against a wide variety of data input attacks designed to influence the machine learning classification process.

- Researched a technique identifying intentionally distorted training data assets
- Model would fingerprint adversarial data counter-examples, for the future detection of suspicious anomalies within the training dataset

SwRI IR&D: Dialogue Interrogation Games—A Framework for Active Social Engineering Defense (2018)

Inspired by the DARPA Active Social Engineering Defense (ASED) program, developed a framework that uses dialogue games and chatbots with adaptive personas to profile social engineering attackers. By shifting focus from the attack itself to the adversary, the system employs psychological and linguistic tactics to extract identifying information through strategic, extended dialogue.

- **Dialogue Game (DG) Framework:** Utilized game theory to design interrogation moves that uncover both direct and indirect attacker traits. Each "move" maximizes the attacker's response diversity, increasing opportunities to reveal personal details.

- **Alter Ego (AE) Bots:** Created collections of persona-driven chatbots that engage and mislead adversaries. Applied Natural Language Processing (NLP) and behavioral modeling, to design deceptive strategies for the bots to covertly interrogate attackers while portraying varied dialogue styles.

- **Persona Switching & Coordinated Strategies:** Implemented machine learning to adapt chatbots' behavior by aligning with attacker cues and optimizing information gathering. Cognitive psychology and linguistics informed dialogue moves that encourage adversaries to disclose more.

SwRI IR&D: Shape Memory Alloys for Aerospace and Space Applications— Forecasting Technological Gaps in Nitinol-based Shape Alloy Research from Metadata and Language in Scientific Publications (2017)

Developed and programmed a systematic approach using machine learning techniques to analyze the text and metadata of scientific articles for identifying risk indicators, before adopting emerging technologies into production.

- Utilized an abstraction and categorization methodology to identify a dataset's essential elements of interests

- The technical gaps identified in candidate technologies, prompted design teams to optimize designs and work within the constraints of the identified technical challenges.

SwRI DT IR&D: Novel Power Generation from Bacteria (2017)

Inspired by the DARPA Vanishing Programmable Resources (VAPR) program, proposed and developed a concept with goal of bio-electronics with the goal of physically disappearing when needed; and brought together both mechanical engineers and microbiologists to test a new method of exploiting bacterial behavior to generate power.

- Collaborated on developing the predictive model for power generation from the bacteria, and extending previous models[3,4,5] for measuring the biophysical behavior of the swimming bacteria and its effect on the system and power output

- Conceptually developed and managed the project

SwRI IR&D: Enhanced Attribution of Cyber Attacks Through Cognitive Tagging and Attack Signature Analysis (2016)

Inspired by the DARPA Enhanced Attribution program, developed a method to improve cyber-attack attribution by analyzing attack signatures across the attack lifecycle and applying cognitive-based tagging to link persona information with cyber actions. The project differentiated automated from manual attacks, identified attacker tools and expertise, and uniquely identified human attackers through covert cognitive tagging, aiming to trace attacks to specific individuals and confirm accountability.

- **Initial Reconnaissance (Initial Recon) Signatures Framework:** Prototyped a system to extract Initial Recon signatures from human interactions in both BLUE and RED environments. Used activity abstraction tools to characterize interactions with initial attack tools and applied our DARPA cognitive fingerprinting research to create discriminatory perceptual decision tasks.

- **Cognitive-Based Activity Tagging for Persona Tracking:** Extended our cognitive fingerprinting method to implicitly track and identify human attackers. Utilized covert cognitive authentication research to engage users with new cognitive tasks, enabling hidden tagging of activities for persona tracking and comprehensive accountability in both RED and BLUE spaces.

- **Automated vs. Manual Attack Detection Design:** Executed experiments to distinguish automated from manual attacks in BLUE space by analyzing attack signatures and identifying tools and attacker skill levels.

SwRI IR&D: Fingerprinting Digital Manipulations for Visual Media Forensic Applications (2016)

Inspired by the DARPA Media Forensics (MediFor) program, proposed, developed and programmed experimental visual media forensics software, to automatically detect image manipulations and provide information about the manipulation techniques performed—to strengthen the intelligence value of the image.

- Developed a methodology to fingerprint image editing tools at the pixel-level when they alter an image
- Focused on building a taxonomy of basic image editing tools, to attribute a variety of forgery methods

SwRI IR&D: Privacy-Aware Communication via Knowledge Synchronization and Dialogue Games (2015)

Inspired by the DARPA Brandeis program, developed a user-centered privacy communication framework that empowers data owners to control and interact with their data. This Human Data Interaction (HDI) research merged cognitive bias modeling, specifically a Homeostatic User Bias model, with Dialogue Game Theory to enable secure and transparent negotiations of data usage policies between owners and holders. The system ensures the contextual integrity of personally identifiable information (PII) and other sensitive data.

- **Homeostatic User Bias Model:** Created a cognitive model that differentiates users based on their data sharing preferences and policies. The model facilitated knowledge synchronization about data affordances using adaptive interactions to define user-specific contexts.
- **Knowledge Synchronization Games (KSGs):** Prototyped a dialogue-based system for data owners and holders to negotiate data space contexts using combinatorial game theory principles. This verifiable system established explicit and implicit HDI policies governing data usage.
- **Data Guard:** Modelled a system pipeline to maintain the contextual integrity of negotiated data spaces by describing policies and labels related to HDI data—detecting and responding to influences, violations, or changes in the data space using algorithmic representations of data owner and collector intents.

SwRI IR&D: Application of Quantum Mechanics to Connect Language & Perception in Context-Aware Communication (2015)

Inspired by the DARPA Communicating with Computers (CwC) program, developed a framework using principles from quantum mechanics to enable context-aware communication by linking language and perception. The research focused on identifying object affordances (what objects can or can't do) and creating Elementary Composable Ideas (ECIs) through this framework. The aim was to allow machines to understand and communicate like humans, bridging abstract concepts with physical reality, and to build a reusable ECI library for communication in various applications.

- **Quantum Mechanics Framework:** Prototyped a quantum mechanical model to detect object affordances via symmetry, then combined utility-maximizing statistical methods with diversity-maximizing strategies.
- **Elementary Composable Ideas (ECIs):** Built a library of ECIs with unique conformal representations and mathematical encodings. The ECIs represented both physical objects and abstract concepts, enabling the construction of complex ideas from simpler elements, like the emergent cognitive strategies observed in our DARPA Active Authentication work.
- **CommIL Language for Context-Aware Communication:** Developed 'CommIL', a formal language to link words to ECIs for effective human-machine communication. Machine learning approaches were used to link perceived object properties and affordances with ECIs, for training machine models to construct complex ideas in different scenarios.

RDECOM: Passive Computer Vision Tracking Methodologies for Multi-Touch Soft Tissue Interfaces and Simulations (2013-2015)

The military medical community through RDECOM needed to minimize the use of live tissue and cadavers for training purposes. Mr. Carrola devised an innovative means of developing synthetic tissue and passively tracking it by computer vision and machine learning algorithms for real-time, augmented reality medical training simulations.

This invention (Patent US 9,218,660 B2)[2] was reported at the 2013 NextMed/MMVR, Medicine Meets Virtual Reality conference.

- Designed experiments and corresponding test matrices of additives' effects on the materials, to develop synthetic skin with stiffness comparable to human epidermis for medical training simulations
- Analyzed the effects of the different additives to the material

- Quantified which interacting agents had significant effects on the synthetic material, resulting in a comparable stiffness to human skin

DARPA: Active Authentication Using Covert Games in Mobile Applications (2013-2014)

Led the development of a cognitive-based authentication biometric for mobile devices (Android platform), working with cognitive science researchers to collect and analyze specific behavioral characteristics and usage patterns common to touchscreen interfaces on mobile devices.

- Devised the experimental strategy and implementation plan to analyze the interactive elements in user interfaces, and developed a game-theoretic framework to programmatically authenticate users as they interacted with the device

- Utilized principal component regression techniques to help design, develop, and test which covert game-like interactions most accurately discriminated users with the least amount of disruption on mobile devices

- Collaborated with his research team to evaluate the concept using:

- Hypothesis testing, collecting and evaluating the discriminatory efficacy of the system with participant data, and applying receiver operating characteristic (ROC) analysis to the data for calculating the system's rate of hits, misses, correct rejections, and false alarms

DARPA: Active Authentication Using Covert Cognitive Interrogation Games (2011-2013)

Investigated a new cognitive-based authentication biometric developed for DARPA's Active Authentication program.

- Led the software development for this authentication concept, successful proposal and predictive model based on experimentally observed cognition patterns[1]

- Used cross-discriminability analysis and regression techniques to compare model variables and evaluate the robustness and uniqueness of the cognitive-based authentication signature

- Tested and validated the new authentication biometric system by establishing statistical significance, sampling methodologies and sample size requirements in the human participant experiments

John Deere, AT&T, U.S. Air Force: Modeling, Training and Simulation Programs (2003-2015)

Mr. Carrola's expertise and creativity using various polygonal modelers, mathematics, and graphic design tools supported several real-time training and simulation projects.

- Developed real-time 3D animations and data visualizations using various 3D technologies (Autodesk 3D Max, Cinema4D, Unity3D)

- Supported increasing visual realism in the simulations through shader and render engine development (GPU programming; Cg; OpenGL), and processing polygonal structures for UV mapping / unwrapping and complex texturing

- Experience applying various programming environments, languages and scripting (JavaScript, C#, Java, Python) towards designing interactive components and GUIs for software and real-time applications

PUBLICATIONS & PATENTS

1. **Carrola, J**., Guillory S., Borsky G. (2023). Through a Quantum Lens: Beyond Borders and into the Complex Forces Shaping Social Reality of the Balkans and Eurasia". Europe-Eurasia Experts Network (E3N) Strategic Concepts Journal (*Booz Allen Hamilton Internal*)

2. *"What Online-Offline (O-O) Convergence Means for the Future of Conflict"*. (2022) **John T. Carrola** (Co-author); Sean A. Guillory
   a. https://information-professionals.org/what-online-offline-convergence-means-for-the-future-of-conflict/

3. Wheeler, J., Varner, D., **Carrola, J**., Dahlberg, C., Thornton, T., Bohil, C., Terry, K. (2013). Covert cognitive games and user response patterns. *IT Professional* volume 15, issue 4, year 2013, pp. 16 – 19

4. **Carrola, John T**., et al. "Machine vision systems and methods for analysis and tracking of strain in

deformable materials." U.S. Patent No. 9,218,660. 22 Dec. 2015.

5. Başağaoğlu H, S Allwein, S Succi, H Dixon, **JT Carrola Jr**, S Stothoff (2013). Two- and three dimensional lattice-Boltzmann simulations of particle migration in microchannels. *Microfluidics and Nanofludics*, 15(6):785-796.

6. Başağaoğlu H, **Carrola JT**, Freitas CJ, Başağaoğlu B, Succi S, 2014. Lattice Boltzmann simulations of vortex entrapment of particles in a microchannel with curved and flat edges. *Microfluidics and Nanofluidics*, DOI 10.1007/s10404-014-1509-5

7. Başağaoğlu H, **Carrola JT**, Freitas CJ, Başağaoğlu B, and DeSilva M, 2014. Numerical analysis of vortex entrapment of particles with respect to bacterial adhesion on implants. Presentation. Biomedical Engineering Society's Annual Meeting, San Antonio, TX, October 22-25, 2014