

# Ibrahim AbuAlhaol

PhD | PEng | SMIEEE

AI Technical Lead

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Canadian Citizen

## Summary

**AI Technical Lead** (Ph.D., PEng) with a strong background in applied AI/ML research and product development. Specializes in Generative AI, Knowledge Graphs, AI Agents, and AI agent orchestration, demonstrating a proven track record in **building and leading AI/data science teams** and **providing strategic guidance for complex AI initiatives**. Successfully delivered innovative Agentic AI systems that address challenges in Cybersecurity and Wireless Networks, while also focusing on their orchestration and benchmarking for optimal performance on Cloud, Edge and AI-capable PCs. These efforts contributed to over **32 patents**. Seeks to leverage extensive expertise in Foundational models, GNNs, and large-scale data management to drive breakthrough innovations in advanced technological environments.

## Education

- 2014–2015 **MEng in Technology Innovation Management**, Carleton University, Canada, GPA: 11/12
- 2005–2008 **PhD in Electrical and Computer Engineering**, University of Mississippi, USA, GPA: 4.0/4.0
- 2002–2004 **MSc in Electrical Engineering**, Jordan University of Science & Technology, Jordan, GPA: 84.4/100
- 1995–2000 **BSc in Electrical Engineering**, Jordan University of Science & Technology, Jordan, GPA: 84/100

## Employment

- 2022–Present **AI Technical Lead**, Dell Technologies, Ottawa, Canada  
Leading GenAI/LLM/KG solutions, AI agent benchmarking, and AIPC automation
- 2019–2022 **Principal Data Scientist**, Huawei Technologies, Ottawa, Canada  
AI/ML-driven cybersecurity, anomaly detection, and real-time security analysis
- 2017–2021 **Adjunct Research Professor**, Carleton University, Ottawa, Canada
- 2017–2019 **Senior Data Scientist**, Larus Technologies, Ottawa, Canada
- 2014–2017 **Cybersecurity Research Scientist**, VENUS Cybersecurity Corporation, Ottawa, Canada
- 2009–2014 **Assistant Professor**, Khalifa University of Science & Technology, United Arab Emirates
- 2008–2009 **Wireless System Engineer**, Broadcom Corporation, San Diego, USA

## Leadership and Technical Skills

**AI Leadership & Strategy** | **Technical Leadership** | **Project Management** | System Design | **Team Building & Supervision** | Mentoring & Advising | Artificial Intelligence (AI) | Machine Learning (ML) | Deep Learning (DNN, CNN, RNN) | Reinforcement Learning (RL) | Transfer Learning (TL) | Federated Learning (FL) | Graph Neural Networks (GNN) | **Foundational Models & Generative AI (GenAI)** | **Large Language Models (LLM) Development & Adaptation** | **Multi-modal AI System Design** | **AI Agents Orchestration & Benchmarking** | Big Data Analytics | Data Engineering | Data Management for AI | Cloud Computing | AI Infrastructure Design | Knowledge Graph (KG) Development | AI for Security | Security for AI | AI Capable PC (AIPC) Design & Optimization

## Research Topics (<http://bit.ly/ibrahimscholar>)

Sovereign AI Solutions | **Large Language Model (LLM) Applications** (e.g., Micro-Ontology Creation, KG Trust Scoring) | **Multi-Modal Generative AI Systems Optimization** | Wireless Communications (e.g., OpenRAN NDT Modeling, Policy Generation, Digital Twin Energy Efficiency) | Data Privacy & Security | AI for Smart Cities | AIPC User Authentication | Wearable Gesture Authentication | GNN for AIPC

990 Citations 40 Conferences 32 Patents 14 Journals 4 Book Chapters

## Experience

July 2022 **AI Technical Lead**, Dell Technologies, Ottawa, Canada

– Present



### Key Initiatives & Objectives:

**[1] Autonomous 5G/6G O-RAN Management:** Achieve zero-touch automation for next-generation wireless networks by integrating GNN-based Digital Twins with Large Language Models (LLMs) and Knowledge Graphs (KGs), revolutionizing network management for autonomous operations.

**[2] Advanced AI Agent Benchmarking:** Develop innovative architectures like Mixture-of-Agents (MoA) for robust and efficient benchmarking of diverse AI agents, including specialized Computer Use Agents (CUAs) and Code Assistant Agents.

**[3] AI-Powered PC (AIPC) Automation Frameworks:** Enhance capabilities in computer use automation by building specialized benchmarking frameworks for Graphical User Interface (GUI) Agents on AIPC, enabling precise model fine-tuning for complex, real-world scenarios.

**Core Challenge:** Architecting, building, and benchmarking end-to-end comprehensive evaluation frameworks for next-generation AI agents across Cloud, Edge, and AI-capable PC environments, leveraging Generative AI and Knowledge Graphs.

**Tools/Software:** Language Models (Transformers, vLLM), Knowledge Graphs (Neo4j), Graph Neural Networks (TensorFlow, PyTorch, PyTorch Geometric), Big Data Mining (PySpark, Kafka), Databases (MongoDB), Data Analysis (Python-Pandas, PySpark), Visualization (Python-Seaborn), Natural Language Processing (NLTK, Gensim, Spacy), DevOps (Docker on Ubuntu), Benchmarking (lm-evaluation-harness, bigcode-bench, OSWorld-bench).

### Key Responsibilities & Achievements:

- **Led cross-functional teams** in the design, development, and scaling of GenAI/LLM and KG-driven solutions, advancing zero-touch automation for 5G/6G O-RAN.
- **Spearheaded the architecture and implementation** of the Mixture-of-Agents (MoA) framework, significantly enhancing automated, accurate, and privacy-preserving benchmarking for a wide range of AI agents, including GUI and Code Assistant agents.
- **Developed comprehensive benchmarking frameworks** for Computer Use Agents (CUAs) and Code Assistant Agents, meticulously defining evaluation metrics (Compliance, Quality, Performance, Security) and assessing solutions across diverse programming languages and difficulty levels.
- **Drove the strategic development of AI-capable PC (AIPC) automation**, creating and validating custom test cases and enabling model fine-tuning for mission-critical, domain-specific AI applications.
- **Architected and optimized high-performance AI infrastructure**, leveraging NVIDIA H100/A100 GPUs on Farm of Dell PowerEdge XE9680 servers to accelerate AI model training, inference, and complex workload benchmarking.
- **Filed multiple patents for groundbreaking inventions** based on successful proof-of-concepts, contributing significantly to a portfolio of over **32 patents**.
- Facilitated strong collaborations with leading academic institutes, fostering innovation and talent development in cutting-edge AI domains.
- Guided the iterative design and rigorous testing of data products, ensuring unparalleled performance and accuracy in complex AI systems.
- Drove profound breakthroughs in 5G/6G wireless communication, machine learning, and multi-modal Agentic system design and optimization.

May 2019 – July 2022 **Principal Data Scientist**, Huawei Technologies, Ottawa, Canada.



### Key Initiatives & Objectives:

To significantly enhance endpoint security systems and firewall threat detection by pioneering self-tuning, AI/ML-driven anomaly detection solutions for enterprise security log streams. This included developing novel multivariate ensemble deep neural network architectures for highly accurate malware detection, aiming for high True Positive Rates and low False Positive Rates, particularly against zero-day attacks.

**Core Challenges:** Leading a cross-functional team in architecting, developing, and deploying high-performance, AI-enabled cybersecurity solutions at scale. This involved overcoming limitations of conventional monitoring systems with dynamic workloads and inconsistent logging formats. A significant challenge was addressing the inherent complexity of analyzing malware across diverse CPU architectures and OS platforms, particularly for IoT devices. The work also focused on combating sophisticated malware evasion techniques such as obfuscation, polymorphism, and metamorphism, while ensuring fast and reliable detection with high TPR and low FPR for new and evolving threats. Managing and processing massive, heterogeneous data volumes in real-time was also a core challenge.

**Tools/Software:** Big Data Mining (PySpark, Kafka), Databases (MongoDB), Data Analysis (Python-Pandas, PySpark), Data Visualization (Python-Seaborn), Natural Language Processing (Python-NLTK, Python-Gensim), DevOps (Docker on Ubuntu), Unsupervised Learning (Isolation Forests, Autoencoders), Reinforcement Learning (Deep Q-Networks), Deep Learning frameworks, GPU-accelerated computing environments.

### Key Responsibilities & Achievements:

- **Directed and built a team** of data scientists, data engineers, and cybersecurity analysts, overseeing project execution from ideation to deployment to deliver advanced AI/ML capabilities and actionable insights.
- **Managed the complete project lifecycle** for multiple concurrent AI/ML R&D initiatives, including resource allocation, risk mitigation, and strategic stakeholder communication, ensuring timely delivery of high-impact solutions.
- **Spearheaded the design and implementation** of hybrid AI-driven approaches, leveraging unsupervised learning (Autoencoders, Isolation Forests) for real-time anomaly detection and Deep Reinforcement Learning (DQN-based self-tuning mechanisms) for adaptive system configuration.
- **Planned, prioritized, and guided the team** in productionizing and scaling high-impact prototype AI/ML models, optimizing performance on cloud and server infrastructures, including GPU-accelerated environments.
- **Architected and implemented robust data management solutions** and scalable data pipelines for ingesting, processing, and analyzing massive, real-time security log streams, overcoming challenges of data volume, variety, and velocity.
- **Contributed significantly to the organization's intellectual property (IP) portfolio** by filing multiple patents for novel AI/ML-driven inventions in cybersecurity, based on successful proofs-of-concept.
- Directed research efforts to drive profound breakthroughs in cybersecurity and machine learning, enhancing data product accuracy and response time, and fostering collaboration with academic institutes.
- Iteratively reviewed and designed comprehensive test cases for developed data products, ensuring rigorous evaluation and quality assurance for deployment.

**JAN 2017** **Adjunct Research Professor**, Carleton University, Ottawa, Canada.

**–JAN 2021** **Key Initiatives & Objectives:**



To enable advanced wireless network personalization by modeling user satisfaction and Zone of Tolerance (ZoT), optimizing resource allocations in 5G/beyond networks through AI/ML-driven multi-objective optimization, and developing privacy-preserving frameworks for user data. This involved leveraging cutting-edge AI/ML for real-time predictive capabilities in wireless networks, aiming to create intelligent, flexible networks capable of micro-managing resources to meet user expectations with minimum allocation.

**Core Challenges:** Harnessing and modeling massive, dynamic contextual and performance data to accurately predict user satisfaction in spatial, temporal, and social contexts. This also involved addressing the complexity of multi-objective optimization (maximizing resource savings vs. maximizing user satisfaction) and developing robust solutions to preserve user privacy while leveraging sensitive data for personalization. The work also focused on designing models that adapt to rapidly changing user expectations and behaviors.

**Tools/Software:** **Machine Learning (ML)**, **Deep Neural Networks (DNNs)**, Evolutionary Multi-Objective Optimization (EMOO) algorithms (e.g., NSGAII, NSGAIII, SPEA2,  $\epsilon$ -MOEA), **Differential Privacy (DP-PCA, DP-DNN)**, **Big Data Analytics**, MATLAB, Python (TensorFlow, Scikit-learn, Pandas, Matplotlib, Seaborn).

### **Key Responsibilities & Achievements:**

- **Co-invented and patented methods and systems** for enabling wireless network personalization using Zone of Tolerance (ZoT) modeling and predictive analytics, optimizing resource allocation through AI-Enabled and Big Data-Driven Multi-Objective Optimization.
- **Directed and co-supervised PhD students** in applying **machine learning** and **big data analytics** to complex wireless communication problems, focusing on network personalization and user satisfaction. **Pioneered the development of a privacy-preserving framework** for personalized wireless networks, integrating **Differential Privacy (DP-PCA, DP-DNN)** and multi-stage prediction processes to protect sensitive user data while maintaining predictor accuracy. This involved adding noise to PCA (DP-PCA) for dimensionality reduction and data sanitization, and injecting noise to DNN weights/gradients during training (DP-DNN). The multi-stage prediction process was designed to train models locally at the user edge and perform cloud-based prediction.
- **Designed and generated synthetic user behavior datasets** with realistic characteristics, including user context and satisfaction values, to overcome data privacy barriers in research and enable large-scale **AI/ML model training**, contributing these datasets to publicly available repositories. This dataset design addressed the lack of published user behavior data due to privacy concerns and allowed for flexible, scalable data generation with realistic characteristics.
- **Formulated and solved complex data-driven multi-objective optimization problems** for wireless network resource allocation, balancing user satisfaction and resource savings using advanced evolutionary algorithms. This involved optimizing two contradicting objectives (maximizing resource savings and maximizing average satisfaction) for real-time network decisions.
- Co-authored and published research in top-tier conferences and journals, disseminating findings on personalized networks, user satisfaction prediction, and privacy preservation.
- Directed workflows for generating open-source tools and data for the research community, fostering collaborative advancements in wireless network personalization.
- Acted as a reader and grader for Technology Innovation Management (TIM) Master of Engineering (M.Eng.) projects, contributing to academic rigor and student development.

**JAN 2017 – MAY 2019** – Senior Data Scientist, Larus Technologies, Ottawa, Canada.



**Key Initiatives & Objectives:** Drive business transformation for clients by developing cutting-edge predictive analytics models and machine learning algorithms, optimizing their internal processes and collaborative decision-making capabilities.

**Core Challenges:** Architecting and implementing robust real-time analytics solutions to generate Actionable Intelligence for Decision Support Systems (DSS), enhancing clients' operational efficiency and strategic processes by transforming raw data into impactful insights.

**Tools/Software:** MOEA Framework-Java, DEAP-Python, **Big Data Mining** (PySpark, Kafka), Databases (Cassandra, PostgreSQL, and MongoDB), **AI/ML Platforms** (Python-Pandas, Spark SQL), Data Visualization (Python-Seaborn), **Natural Language Processing** (Python-NLTK, Python-Gensim), Advanced Analytics (LSTM RNNs, DNNs, W2V Embedding).

### **Key Responsibilities & Achievements:**

- **Led the end-to-end design and delivery** of sophisticated machine learning solutions for critical Decision Support Systems (DSS), translating complex client requirements into scalable analytical frameworks.
- **Developed and automated high-throughput data pipelines** to efficiently collect, analyze, and provision massive datasets, ensuring data integrity and timely delivery for DSS operations.
- **Engineered and optimized scalable processes** for robust data management in high-volume production environments, supporting continuous integration and deployment of analytical models.
- Orchestrated the complete data science lifecycle, from **data acquisition, rigorous investigation, and impactful visualization** to advanced **feature engineering, algorithm experimentation, and seamless model deployment**.
- Drove innovation by developing and validating prototypes, meticulously evaluating performance, and comparing predictive metrics using diverse real-world datasets to ensure optimal model accuracy and reliability.
- Applied advanced analytical and statistical methodologies to **identify complex patterns, detect critical anomalies, and derive actionable insights** from large, unstructured data.
- **Developed real-time predictive models leveraging Spark-streaming and Kafka**, enabling instantaneous data processing and analysis for immediate operational decision-making.
- Implemented data-driven vessel service time forecasting models using **Long Short-Term Memory (LSTM) Recurrent Neural Networks (RNNs)**, significantly optimizing logistics and operational planning. **Deployed machine learning for retailer promotion planning processes**, enhancing strategic marketing decisions and improving campaign effectiveness.
- Utilized advanced Natural Language Processing techniques, including **Word2Vec (W2V) embedding**, to extract textual features and perform multi-label classification using **Deep Neural Network (DNN)** models for complex unstructured data analysis.

**FEB 2014 – DEC 2017** – **Cybersecurity Research Scientist**, VENUS Cybersecurity Corporation / Carleton University, Ottawa, Canada.



**Key Initiatives & Objectives:** To advance cybersecurity capabilities by pioneering real-time anomaly detection for large-scale network routing data (Border Gateway Protocol - BGP) and by investigating robust security and privacy solutions for end-to-end encryption services.

**Core Challenges:** Overcoming challenges in real-time mining of massive network data with unsupervised machine learning for predictive analytics, and enhancing the value and usability of encryption services through robust, multi-layered security approaches. This included addressing the inherent trust vulnerabilities of the Border Gateway Protocol (BGP), which is fundamental to internet routing but susceptible to hijacking and false announcements.

**Tools/Software:** Advanced Analytics (KNIME, MATLAB, Python: Scikit-learn, Pandas, PySpark), Big Data Technologies (MongoDB, Apache Kafka, Apache Spark MLLIB), Visualization (JavaScript: D3, Crossfilter, DC), Cryptography Libraries (AES-JS, JSENCRYPT).

### **Key Responsibilities & Achievements:**

- Conducted extensive prior art review and in-depth analysis on critical cybersecurity domains, including real-time network anomaly detection (BGP), communication security, and end-to-end encryption standards, identifying key limitations and opportunities for innovation.
- Designed and evaluated advanced machine learning models and anomaly indicators for predicting and mitigating cyber threats such as BGP IP prefix hijacking and DDoS attacks.
- Proposed multi-layer approaches for agile and robust defensive responses in Device-to-Device (D2D) communication and offered guidance on customizing/improving chosen encryption standards.
- Developed and integrated high-performance, real-time analytics engines, including interactive visual dashboards for BGP stream data, by orchestrating data ingestion (Apache Kafka), scalable storage (MongoDB), and advanced processing (Apache Spark MLLIB) for real-time anomaly prediction and contextual visualization.
- Conducted rigorous simulations (e.g., using MATLAB) to validate selected algorithms and standards for encryption services, providing data-driven recommendations for their integration and testing.
- Documented research findings and published in peer-reviewed conferences and journals, rigorously testing and validating developed cybersecurity processes in large-scale, real-life BGP IP prefix hijacking and DDoS incidents.
- Applied core methodologies of real-time anomaly detection and big data analytics, which are broadly applicable beyond BGP. While the primary focus was on BGP-specific anomalies, these capabilities lay the groundwork for detecting other large-scale malicious activities, such as the rapid propagation seen in ransomware like WannaCry. The high-volume network traffic and unusual host activity generated by a worm-like spread could be indicative of such an attack, leveraging the general anomaly detection frameworks developed.



**OCT 2009 – Assistant Professor**, Khalifa University of Science & Technology, United Arab Emirates.

**JAN 2014**



**Key Initiatives & Objectives:** To educate and mentor future engineering talent while conducting impactful research in wireless communications, directly contributing to the UAE's national agenda for digital transformation and technological advancement. This involved developing cutting-edge curricula and pioneering research in advanced wireless network performance, including multi-carrier relay systems and analysis over complex fading channels.

**Core Challenges:** Delivering high-quality, effective teaching and research in a rapidly evolving technological landscape, securing competitive research funding, and effectively supervising a diverse cohort of graduate students. A significant challenge was precisely modeling and analyzing the performance of wireless communication systems over various fading environments and in emerging network architectures like UAV-assisted communications.

**Tools/Software:** MATLAB, LaTeX, Wireless Communication System Simulators, Performance Analysis Tools.

**Key Responsibilities & Achievements:**

- Taught and developed a comprehensive suite of courses, including Wireless Communications, Communication Networks, and Digital Communications, equipping over 500 students with foundational and advanced engineering skills critical for the UAE's burgeoning tech sector.
- Advised and mentored undergraduate and graduate students on academic progression and career pathways, fostering the development of highly skilled human capital aligned with regional industry demands.
- **Conducted cutting-edge research in wireless communications**, with a focus on performance analysis of multi-carrier relay-based UAV (Unmanned Aerial Vehicle) networks over fading channels.
- Developed and validated generalized Bit Error Rate (BER) analysis expressions for various receiver techniques (e.g., Selection Combining, Maximal Ratio Combining) over complex Nakagami-m fading channels.
- Published research findings in reputable international conferences, including IEEE Globecom Workshops and the Joint IFIP Wireless and Mobile Networking Conference, contributing to the global body of knowledge in wireless communication theory.
- Supervised a diverse range of undergraduate research projects, guiding students in applied innovations relevant to the region's smart infrastructure development, such as:
  - Mobile Bluetooth-Based Parking Systems for urban automation.
  - Multi-Sources Patient Localization System for emergency response and public safety.
  - Wireless Control of Self-Sustained Solar Power Generation for sustainable energy solutions.
  - Evaluation of Spectrum Sensing Techniques in Cognitive Radio Networks for efficient resource utilization in future telecom.
  - Performance Evaluation of MIMO-OFDM System over Fading Channels for advanced wireless network design.
  - Simulation of Interference Mitigation for OFDM Multi-hop LTE Networks to enhance regional communication infrastructure.
- Served as a key committee member for the Electrical and Computer Engineering (ECE) program, strategically contributing to curriculum development and the successful establishment of a new Master of Science (M.Sc.) program in ECE, enhancing the university's research capabilities.
- Contributed to the Resources Committee, proactively assessing current and future material and equipment requirements for academic programs, ensuring the university remained at the forefront of technological education in the Gulf region.
- Played an active role in the External Relations Committee, identifying best practices and facilitating strong collaborations with external constituencies, including regional industry partners and government bodies, to align academic initiatives with national development goals.

## Experience — Industry

MAY 2008 – **Wireless System Engineer**, Broadcom Corporation, San Diego, USA.

OCT 2009



**Key Initiatives & Objectives:** To contribute to the design, analysis, and optimization of 2G, 3G, and 4G wireless communication systems, focusing on RF performance, network core components, and rigorous system-level testing for commercialization.

**Core Challenges:** Ensuring robust wireless system performance and compliance with evolving 3GPP standards, optimizing RF characteristics, and collaborating across multi-disciplinary teams for the rapid development and commercialization of next-generation wireless technologies.

**Tools/Software:** 3GPP Standards (UMTS, WiMax, LTE, GSM, WCDMA), RF Test Equipment, System Simulators, MATLAB.

### **Key Responsibilities & Achievements:**

- Conducted comprehensive system-level analysis, simulation, and testing of 2G, 3G (UMTS), and 4G (WiMax, LTE) wireless network core components and mobile devices.
- Collaborated with multi-disciplinary engineering teams, development teams, and external test equipment vendors to produce tool requirements, set up test automation, and drive the commercialization of UMTS solutions.
- Characterized and significantly improved RF/RX front performance for WiMax and LTE systems, identifying critical functionalities and ensuring adherence to standard performance requirements.
- Ensured rigorous test coverage and compliance with 3GPP standards, generating and consolidating performance data and evaluating key metrics across modem stack, multimedia, RF, and driver interactions.
- Performed comparative analysis of system-level performance findings across various wireless standards, including GSM, WCDMA, Bluetooth, and WLAN.

## Infrastructure Management & Accessibility

**Compute** **Cloud Platforms:** Google Cloud Platform (GCP), AWS, Azure. **AI/GPU Infrastructure:** Design, deployment, and optimization of high-performance computing clusters leveraging NVIDIA H100/A100/H200 GPUs on enterprise-grade servers (e.g., Dell PowerEdge). Expertise in scaling AI model training and inference workloads across distributed environments. **Server Management:** Configuration and maintenance of Ubuntu servers and other Unix-based systems.

**Data / Knowledge** **Scalable Data Architectures:** Designing and implementing robust data pipelines for massive, real-time data ingestion (e.g., Apache Kafka) and distributed processing (Apache Spark). **Database Systems:** Management of relational (MySQL, PostgreSQL) and NoSQL (MongoDB, Cassandra) databases, including specialized vector databases (ChromaDB) for AI applications like RAG. **Knowledge Graph Management:** Deployment and optimization of Knowledge Graph databases (Neo4j) for complex data representation and reasoning.

**Automation** **Containerization:** Docker. **Workflow Orchestration:** Apache Airflow for automating complex data and ML pipelines. **System Automation:** Scripting and tools for infrastructure provisioning, configuration management, and continuous integration/delivery (CI/CD) practices for AI/ML solutions.

**Operability** **AI System Deployment:** Ensuring seamless deployment and operability of AI Agentic solutions across diverse platforms (Cloud, Edge, AI-Capable PCs, NPUs like Qualcomm and Intel). **Performance Benchmarking:** Establishing robust frameworks for benchmarking AI workloads (LLMs, Agents) on various hardware, ensuring optimal performance and resource utilization. **User-Centric Design for AI:** Focusing on operability and interpretability of AI systems to ensure accessibility for developers and end-users alike, particularly in complex multi-modal AI and Human-AI interaction scenarios.



## AI/ML Frameworks & Agentic Solutions

- Models** Qwen, Deepseek, Google Gemini, Llama, Mistral. Expertise in fine-tuning and adaptation
- Agentic** Developing, orchestrating, and deploying AI agents: LangChain, LangGraph, Google ADK
- Frameworks** Designing, training, and deploying ML models: TensorFlow, PyTorch, PySpark MLlib, Scikit-learn
- AIPC** Intel, AMD, and Qualcomm NPUs for on-device AI acceleration.
- Benchmarking** lm-evaluation-harness, bigcode-bench and LangSmith for observability.

## Data Analysis & Advanced Techniques

- Optimization** Java (MOEA Framework), Python (DEAP), Evolutionary & Multi-Objective Optimization.
- Big Data** Apache Spark, Kafka, Spark Streaming.
- Databases** Relational (MySQL, PostgreSQL), NoSQL (MongoDB, Cassandra), Vector Databases (ChromaDB), Knowledge Graphs (Neo4j).
- Data Mining** Python (Pandas, Orange), MATLAB, Wavelet Transforms (for feature extraction, data analysis).
- NLP** NLTK, SpaCy, Gensim.
- Visualization** Python (Matplotlib, Seaborn, Superset, Bokeh, Folium), JavaScript (D3.js, DC.js, Crossfilter.js).
- Programming** Python and C++

## Training and Courses

- 2024** Rapid Application Development with LLMs — NVIDIA — <https://developer.nvidia.com>
- 2024** Efficient Large Language Model (LLM) Customization — NVIDIA — <https://developer.nvidia.com/>
- 2023** Building LLM Applications — Hamza Farooq — <https://maven.com/boring-bot/ml-system-design>
- 2023** Building Systems with the ChatGPT API — Andrew Ng — <https://www.deeplearning.ai/>
- 2023** ChatGPT Prompt Engineering for Dev. — Andrew Ng — <https://www.deeplearning.ai/>
- 2023** LangChain for LLM Application Dev. — Andrew Ng — <https://www.deeplearning.ai/>
- 2023** LangChain: Chat with Your Data — Andrew Ng — <https://www.deeplearning.ai/>
- 2023** How Diffusion Models Work — Andrew Ng — <https://www.deeplearning.ai/>
- 2019** Structuring Machine Learning Projects — Andrew Ng — [www.coursera.org/](http://www.coursera.org/)
- 2019** Convolutional Neural Networks — Andrew Ng — [www.coursera.org/](http://www.coursera.org/)
- 2019** Sequence Models — Andrew Ng — [www.coursera.org/](http://www.coursera.org/)
- 2018** Neural Networks and Deep Learning — Andrew Ng — [www.coursera.org/](http://www.coursera.org/)
- 2018** Improving Deep Neural Networks — Andrew Ng — [www.coursera.org/](http://www.coursera.org/)
- 2017** Docker for DevOps : From development to production — Nick Janetakis — [www.udemy.com](http://www.udemy.com)
- 2017** Taming Big Data with Apache Spark and Python - Hands On! — Frank Kane — [www.udemy.com](http://www.udemy.com)
- 2017** Deep Learning for Natural Language Processing (NLP) — Jon Krohn — [www.learning.oreilly.com](http://www.learning.oreilly.com)
- 2016** Learning Python for Data Analysis and Visualization — Jose Portilla — [www.udemy.com](http://www.udemy.com)
- 2016** Machine Learning, Data Science and Deep Learning with Python — Frank Kane — [www.udemy.com](http://www.udemy.com)

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## Selected Patents

- P 2025** **I. Abualhaol**, J. Mirzaei, and G. Poitau, "Methods and processes to enable RNN-GNN-based network digital twin for O-RAN," US 12,302,162 B2, Feb. 6, 2025. **[Granted]**
- P 2024** **I. Abualhaol**, "LLM-based Processes for Augmenting/creating Micro-ontology", Dec 2024. **[Filed]**
- P 2024** **I. Abualhaol**, "Modeling O-RAN NDT as agentic LLM and KG for High-Fidelity Forecasting and Scenario Generation", Dec 2024. **[Filed]**
- P 2023** **I. Abualhaol**, R.S. Giagone, and Y. Zhou, "System, Method, and Apparatus for Malicious Software Detection," US11574054B2, Feb. 7, 2023. **[Granted]**
- P 2023** R. Alkurd, H. Yanikomeroglu, and **I. Abualhaol**, "Enabling wireless network personalization using zone of tolerance modeling and predictive analytics," US11736973B2, Aug. 22, 2023. **[Granted]**
- P 2023** J. Mitra, G. Poitau, **I. Abualhaol**, J. Mirzaei, "Methods and System for Utilizing a Digital Twin of a Mobile Network for Energy Efficiency." May 2023. **[Filed]**

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## Selected Journals

- J 2022** A. Safieh, **I. Abualhaol**, J R. Ghnemat, "End-to-End Jordanian Dialect Speech-to-Text with a Self-Supervised Learning Framework." *Frontiers in Robotics and AI*, Dec 22;9:1090012.
- J 2022** M. Koushki, M., **I. Abualhaol**, A.D. Raju, Y. Zhou, R.S. Giagone, and S. Huang, "On building machine learning pipelines for Android malware detection: a procedural survey of practices, challenges and opportunities," *Cybersecurity*, vol. 5, no. 1, pp. 1-37, 2022.
- J 2020** R. Alkurd, **I. Abualhaol**, and H. Yanikomeroglu, "Big Data-Driven AI-based Framework to Enable Personalization in Wireless Networks," *IEEE Communications Magazine*, vol. 58, no. 3, pp. 18-24, 2020, doi: 10.1109/MCOM.001.1900347.
- J 2018** F. Cheraghchib, **I. Abualhaol**, R. Falcon, R. Abielmona, B. Raahemi, and E. Petriu, "Modeling the Speed-based Vessel Schedule Recovery Problem using Evolutionary Multiobjective Optimization," *Information Sciences*, vol. 448, pp. 53-74, 2018.

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## Selected Book Chapters

- B 2017** M. Gad and **I. Abualhaol**, "Securing Smart Cities Systems and Services: A Risk-Based Analytics-Driven Approach," in *Transportation and Power Grid in Smart Cities: Communication Networks and Services*, John Wiley, UK.
- B 2014** C. Han, S. Muhaidat, **I. Abualhaol**, M. Dianati, and R. Tafazolli, "Intrusion Detection in Vehicular Ad-Hoc Networks on Lower Layers," in *Security, Privacy, Trust, and Resource Management in Mobile and Wireless Communications*, IGI Global, Hershey, PA, USA, 2014, pp. 148-173.

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## Selected Conferences

- C 2022** I. Lakim, E. Almazrouei, **I. Abualhaol**, M. Debbah, J. Launay, "A holistic assessment of the carbon footprint of *NOOR*, a very large Arabic Language Model." In *Proceedings of BigScience Episode no. 5-Workshop on Challenges & Perspectives in Creating Large Language Models*, pp. 84-94, May 2022.
- C 2018** **I. Abualhaol**, R. Falcon, R. Abielmona, and E. Petriu, "Data-Driven Vessel Service Time Forecasting using Long Short-Term Memory Recurrent Neural Networks," in *Proceedings of IEEE International Conference on Big Data*, pp. 1959-1966, 2018, doi: 10.1109/BigData.2018.8622548.
- C 2018** **I. Abualhaol**, R. Falcon, R. Abielmona, and E. Petriu, "Mining port congestion indicators from big AIS data," in *Proceedings of IEEE World Congress on Computational Intelligence (WCCI)*, pp. 3743-3750, 2018, doi: 10.1109/WCCI.2018.8431368.