# AI-AUGMENTED AUTOMATION FOR DEVOPS, A MODEL-BASED FRAMEWORK FOR CONTINUOUS DEVELOPMENT IN CYBER-PHYSICAL SYSTEMS

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***Abstract****- The main purpose of this paper is to review how AI-augmented Automation for DevOps is helping the modeling of Cyber-Physical Systems. The growing complexity in the creation and operation of Cyber-Physical Systems (CPS) necessitates a more effective engineering methodology. The main objective of the paper is to develop a better understanding of the model-based framework for more effectively supporting large and complex Cyber-Physical Systems (CPS) software and system engineering using AI augmentation. Recent years have seen a rise in the popularity of DevOps, a methodology that encourages developers and operations personnel to work together more closely on systems [1]. When it comes to system design and integration, using artificial intelligence (AI) is helpful, but it's still restricted due to its tremendous potential. AI technology is expected to play a significant role in the future automation of many major corporations [1]. While the number of organizations investing substantial money in software development is continually expanding, AI is still a developing technology. An integrated AI-augmented framework for the automatic continuous creation of CPSs is the goal of the project, which will use a model-based approach [1]. Model-Driven Engineering (MDE) ideas and methodologies will be covered thoroughly to give a model-based framework with appropriate approaches and associated technology.*

***Keywords:*** *Machine learning, clinical research, clinical trials, biotechnology, Biomedical innovation*

## I. INTRODUCTION

A few examples of systems that have become intriguing artificial intelligence application sectors include the Internet of Things, Web of Things, and "Smart Systems" settings. When faced with the increased CPS standards, AI approaches, models, and tools must overcome various obstacles. Examples of non-functional criteria that must be considered by engineers include memory and CPU resource limitations; energy consumption; the safety of both technology and humans; delay-tolerant communications; and the ability to make decisions on one's own [2]. Cyber A physical system is a new kind of system that combines computing with communications and/or control. To keep tabs on and make changes to the physical environment, the processing components coordinate and interact with sensors and actuators. Our goal in this work is to provide a consistent language and taxonomy for the CPS domain so that the field may speak with one voice [2]. Defining a modeling language and offering a method of communication amongst engineering process stakeholders are the goals of this model, which outlines the most essential ideas in the CPS and their connection.

Computational algorithms are seamlessly integrated with physical components such as robots and other equipment in cyber-physical systems. Multiple decision-making entities (multi-agents) are common in these types of systems. Smart Factories are the manufacturing term for CPS [2]. Manufacturers are increasingly turning to artificial intelligence (AI) to help them automate their operations to the next level. Many elements of factory planning, scheduling, and maintenance may benefit from deep learning [2,3]. Using artificial intelligence, decision-making in very complex data settings may be made more efficient and effective while also incorporating a growing amount of information in these intelligent systems.

It is possible to create a model-based framework with the help of Model-Driven Engineering (MDE) ideas and methodologies. This framework will make it possible to look at and analyze data acquired during both the design and runtime phases, resulting in AI-enhanced solutions that can be tested in real-world scenarios including sophisticated CPSs. Using DevOps methods, the framework is designed to work with IT operations as well as software development [4]. The project's goal is to enable AI for IT operations (AIOps) so that decision-making processes may be automated and system development activities can be completed more efficiently. Furthermore, advances in artificial intelligence (AI) must guarantee that systems are properly constructed and that we can have confidence in their behavior (i.e. requiring both accountability and explainability) [5]. To address background, goals, and the suggested strategy, this document provides an overview of the project. To better understand how businesses might be influenced by continuous deployment and operations management, researchers are doing the study. Using the AI-enhanced framework, DevOps teams can analyze live and historical event streams, extract relevant insights from events for continuous improvement, speed up deployments and increase communication while also reducing downtime with proactive detection [5]. When it comes to automating decision-making processes and completing system development chores, the project focuses on enabling AI for IT operations (AIOps).

## II. PROBLEM STATEMENT

The main problem that this paper will address is to develop a better understanding of how AI augmentation can be applied in solving the challenges posed by Cyber-Physical Systems. The current systems in the fields of Industry 4.0, health care, self-driving vehicles, or smart grids are examples of highly communicative systems (usually embedded) in which software permits progressively sophisticated functionalities [6]. Even as CPSs expand in size and sophistication, there will be new problems when they are deployed and used in the real world. There is no doubt that using artificial intelligence approaches will have a positive impact on the whole development process. Using the project's architecture, specialized AI-augmented solutions may be observed and analyzed before being verified in real-world industrial settings involving complicated CPSs of various sizes [6]. Many major corporations have already begun to see the future of work being automated thanks to AI. While the number of firms investing substantial money in software development is continually expanding, AI is still in its infancy as a development and design tool.

## III. LITERATURE REVIEW

### *A. Artificial Intelligence and Machine Learning (AI/ML) in CPS engineering process*

Another important feature of the DevOps and CPS engineering processes is the application of artificial intelligence in general and machine learning in particular. As a result of the widespread use of such ideas and practices in a regulated business, systems may quickly learn to make more automated decisions and take actions, sometimes even without the need for direct human intervention [6,7]. As a result, a response strategy is required to guarantee that artificial intelligence technologies be used safely and beneficially. This approach must take into account both the consequences of (co) decision-making by computers and the ethical difficulties that arise as a result. the legal definition of artificial intelligence [7]. The goal of the CPS engineering process is to guarantee that systems are developed responsibly and that they contribute to the public's confidence in their ability to function. Supporting both explainability [7] (i.e., being able to explain and defend judgments) and responsibility [7,8] is particularly important in this context" (i.e., justifying, based on given explanations, decisions, and actions taken by stakeholders involved in the CPS engineering process).

### *B. AIOps - Artificial Intelligence for IT Operations*

AIOps is required for a successful digital transformation. Forward-thinking executives add meaning to IT data to enable automation and improved business results as a result of the transformation of operations. Gartner [7], [8] created the term AIOps to describe solutions that use AI/ML approaches to solve DevOps issues. As the number of technologies in your IT infrastructure grows, the interdependencies between them get more complicated. The IT infrastructure is shared across a growing number of corporate services and apps, further complicating matters. Because of the speed and frequency with which these services, apps, and the underlying infrastructure are updated, humans can't keep up with all of the changes. We need the assistance of a machine to do this. Real-time, context-rich data lakes are created by AIOps to minimize the amount of noise in current performance and fault management systems and enhance automating, with the end objective of reducing the amount of time to resolutions.

Incorporating AIOps [9] into the DevOps pipeline to improve continuous deployment and operations management is a major problem. Additionally, to automate typical operational processes with the assistance of AI, AIOps analyzes measurements and applies prediction models to get meaningful data and insights. By combining AIOps with ML, large data may be used to develop predicted results that speed up root-cause analysis (RCA) and reduce the average time to repair [9]. AIOps (MTTR). The ITOps can continually improve, saving your business time and money as a result of giving intelligent, actionable insights that promote more automation and cooperation. Along with MDE, it serves as an important supplementary tool for CPS development since it is more efficient and adaptable [9].

### *C. Mapping*

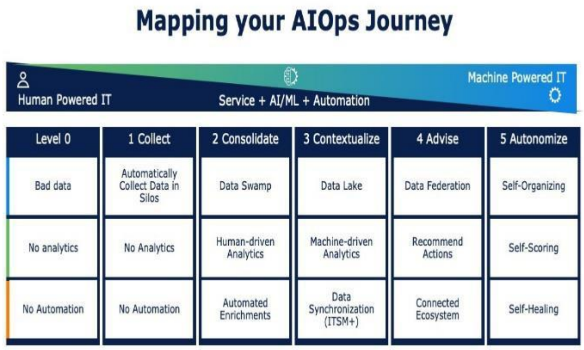


Table i: Mapping the AIOps

### *D. Model-Driven Engineering (MDE) for CPSs*

MDE has grown in popularity during the previous two decades as a tool for software developers. Increasing the degree of abstraction makes it easier to deal with more complicated systems like CPSs [10] as a result. With the growing use of models as deliberate abstractions of systems and their surroundings, new difficulties, such as digital twinning, are arising in industrial applications. When MDE first came out, it was primarily used to generate code from abstract platform-independent descriptions at a high level. As a result, the scope of MDE has expanded throughout time to include a broader range of difficult software engineering tasks, such as model-based software testing, verification, and measurement [10]. MDE will contribute to this project in three ways: by improving abstraction principles and approaches, by making operations easier to automate, and by assisting with the integration of new technologies across all design and development processes. AIDOaRt will transform and then manage heterogeneous data originating from various engineering processes, hence contributing to the explicit modeling undertaken in other project domains [10,11]. Increasing productivity and software quality are two of the promised benefits of moving to model-driven techniques, according to business leaders. To create and develop our framework, we want to use MDE as our software engineering paradigm in AIDoaRt.

### *E. AI-augmented Toolkit for CPSs*

Complementary AI-augmented features must be created and then utilized per the demands of different types of CPS undergoing development to enhance the essential Infrastructure and Platform [11]. The AI-enhanced Toolkit will be established and developed as part of the project to achieve this goal. They provide enhanced capability for a variety of CPS development activities. For each step of the development lifecycle, a specific AI support toolkit will be included in the toolkit.

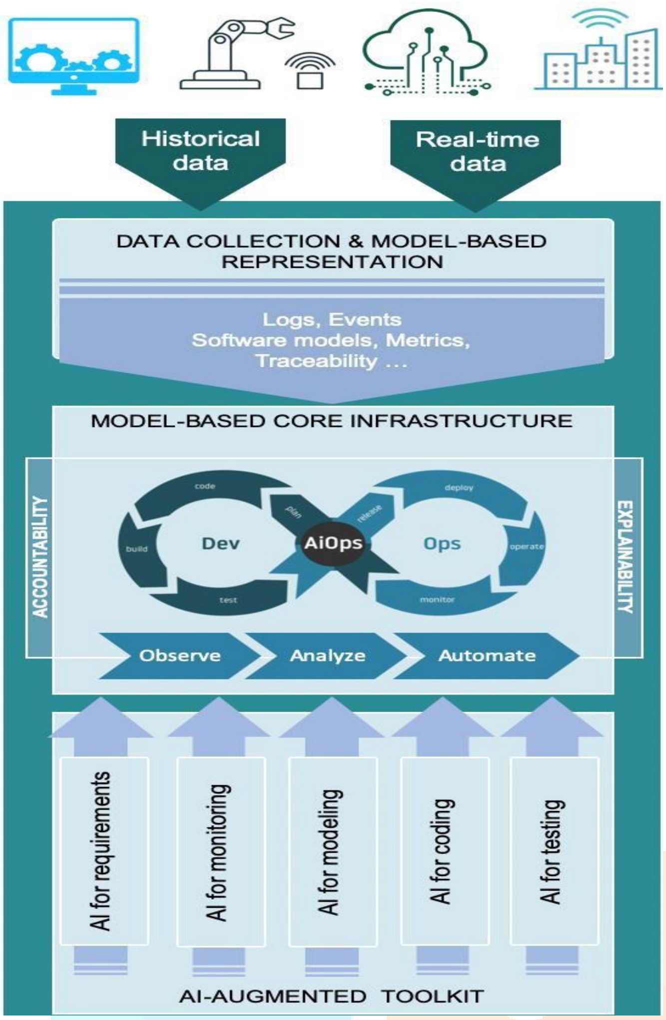


Fig i: AI-augmented solutions

**AI for requirements:** To cope with various processes, artificial intelligence-based solutions are needed. Early in the design process, artificial intelligence technologies, especially machine learning algorithms can be used to help with requirement elicitation, suggestions, and consistency checks. Artificial intelligence and machine learning will be used to improve analysis and support operations at a subsequent stage in the development process, as well as earlier requirement papers will be integrated into the elicitation process. Artificial intelligence approaches will also be used to provide suggestions for (types of) demands based on the information that is now accessible to the public domain.

Be aware that this paper does not particularly address some key operations such as deployment [12]. The Core Infrastructure and its AI-augmented Toolkit will assist them, however. application domain and the standards and norms that are connected with that domain. Core Infrastructure. To automatically evaluate if a standard or guideline has been satisfied, tools based on artificial intelligence (AI) will be created, in particular AR techniques. A formal framework will be used to profit from the development of understandable results from AI-based systems and technologies can be investigated in this framework as well as Knowledge Representation (KR) techniques [12]. The criterion for consistency will be verified, which is an important problem to deal with. The project will develop artificial intelligence-based solutions that use augmented reality to deliver an easily interpretable and verifiable response to a pool of demands or technical requirements that are not consistent. By using artificial intelligence-based solutions, we mean creating and implementing new ways of managing demands. Furthermore, it is important to create artificial intelligence approaches that make use of natural language processing (NLP), notably for translating natural language into the formal languages necessary for requirements specification, like validating the requirement formulation against guidelines, and for the interpretation of formal languages into natural language [12,13].

**AI for monitoring:** With artificial intelligence (AI) as a foundation, we will focus on run-time property verification, failure detection, and forecasting for predictive maintenance, among other things. AI for monitoring. Using artificial intelligence and machine learning techniques, these responsibilities may be accomplished by detecting performance and system defects using trace analysis and accompanying historical data [14].

**AI for modeling:** It will be possible to make better decisions, design strategies, and generate suggestions with the help of artificial intelligence-based tools and techniques developed throughout the modeling phase. It is expected that an artificial intelligence-based assistant will be created to support researchers in the development of complicated mixed-criticality systems by identifying applicable qualities that will permit realistic implementations based on previously stated multiple performance parameters, as well as by offering new model-based ideas relevant to the system now under development [14]. Artificial intelligence and machine learning technologies are also being developed to make it easier to generate and/or update big and intricate model views utilizing diverse (design time and runtime) modelling in a semi-automated manner. To help with model improvement and verification, many artificial intelligence-based approaches will be created. Design consistency checks, automated attributes confirmation, outlier detection, and underlying cause identification in temporal behaviour, especially for security application areas, and automated attributes validations will all benefit from AR techniques being developed in the future [14].

**AI for coding:** When it comes to computer programming and artificial intelligence, code may be seen as an executable textual model. Although ideograms and associated symbols will be used throughout the project, I-based coding tools will be developed to let persons with little or no programming skills construct applications. These approaches will mostly be used to learn code generation patterns from samples using machine learning and artificial intelligence [15].

**AI for testing:** Finally, it is necessary to develop AI-based tools and methods for testing at different levels. The use of artificial intelligence and machine learning technologies are recommended for acquiring, evaluating, and monitoring data models to develop reliable unit tests [15,16]. Pattern recognition algorithms will be developed to identify high-quality test suites, such as a collection of tests with a greater failure probability.

## IV. FUTURE IN THE U.S

The future of AI augmentation in the U.S is increasing considering that the recent technological trends represent a push behind the advent of CPS. Because of recent technological developments that have brought us closer to the adoption of CPS, the future of artificial intelligence augmentation in the United States seems promising. It is possible to use a broad range of sensors with sizes ranging from macro to micro and even Nano, to detect a wide range of natural phenomena, including the state of physical variables as well as a variety of chemical, fluid, solid, and biological materials. Batteries-operated motors and enormous construction equipment are examples of actuators [16]. Alternative energy sources and energy collection methods are multiplying like mushrooms. Almost everything on the globe has access to satellite or wireless communications. The number of people with access to the internet is rapidly increasing. The capabilities of computers and storage devices are increasing at a virtually exponential pace, and they are becoming more affordable in smaller and more compact form forms [16,17]. A trained workforce and solid CPS foundations are driving growth, with some demands acting as a pushback. Fully self-driving automobiles will provide the safest and most efficient transportation for their passengers. Afterward, they'll be able to serve the people who have already asked about their availability. Facilitating elderly citizens' mobility will increase their sense of independence and self-worth. In 2007 Carnegie Mellon University's self-driving car took first place in the DARPA Urban Challenge, traveling 60 miles in urban driving conditions while avoiding other cars and obeying traffic laws [17,18]. With the use of a wide range of sensors including lidars, radars, cameras, and a strong computer base, it was able to operate wirelessly. Artificial intelligence-powered DevOps systems will analyze corporate goals and provide recommendations on infrastructure designs and regulations in the future. Eventually, as the number of CPSs increases, engineers will have to completely redesign their instructional programs. An entirely new field of engineering will be created to take over from traditional but highly specialized engineering fields, with a focus on both cyber and physical components, with fundamental disciplines like control theory and physical/mechanical properties as well as software becoming essential learning outcomes for engineers.

## V. ECONOMIC BENEFITS IN THE UNITED STATES

Because of this reliance on foreign suppliers for cutting-edge semiconductor manufacture that powers artificial intelligence algorithms crucial to military systems and nearly everything else, the United States used to dominate the world in the microelectronics sector for decades. Artificial intelligence (AI) has the potential to alter almost every element of how CEOs conduct business, according to the majority of them. Deploying AI-augmentation for DevOps and modeling complicated predictive systems is predicted to provide the greatest economic benefits for the technology and industrial sectors (CPSs). Robots are on the verge of replacing humans as the primary industrial labor. Globally, the usage of robots in the manufacturing business has grown by an average of 13% per year since 2011, with most of the increase happening in the automotive and electronic/electric manufacturing industries. Compared to the previous year, sales increased by 6% in the United States. The need for digitally linked machines in smart factories is always expanding in combination with the new notion of CPS revolutions [18] Product development time is reduced, items may be reused more quickly, product failures are reduced, and machine downtime is reduced, among other advantages, in smart factories. Smart factories use a continuous stream of data from networked operations and production systems to provide seamless communication across all levels of high automation. This adaptive system can learn and adapt to new demands. MIT Sloan Management Review and Boston Consulting Group recently performed a poll of over 3,000 company leaders and found that pioneering businesses like Chevron, Allianz, and Daimler are prioritizing revenue-generating uses of artificial intelligence above cost-saving ones [18]. Due to the shrinking gap between the United States and other nations in terms of technical superiority, as well as international initiatives to get American know-how and dual-purpose technology.

## VI. CONCLUSION

This paper explored how AI augmentation can be applied in DevOps as a model for developing Cyber-Physical Systems (CPS). A growing desire for intelligent devices that can interact with the world around them is being driven by developments in analytics, artificial intelligence (AI), and communications. Examples include autonomous automobiles that analyze and interact with their environments and smart applications that reduce energy use to save money. In addition to improving quality of life, CPS is laying the groundwork for smart infrastructure, goods, and services that will revolutionize the world. The use of artificial intelligence in DevOps. The AI-augmented toolkit component's AIOps operations will assist several common engineering tasks, such as requirements gathering, monitoring, modeling, coding, and testing, as well as other related ones. It is possible to create a model-based framework with the help of Model-Driven Engineering (MDE) ideas and methodologies. This framework will make it possible to look at and analyze data acquired during both the design and runtime phases, resulting in AI-enhanced solutions that can be tested in real-world scenarios involving complicated CPSs. These activities provide feedback, insights, or actions that may be put to use at various points in the DevOps lifecycle.

## REFERENCES


1) S. Chien, G. Rabideau, J. Willis and T. Mann, "Automating planning and scheduling of shuttle payload operations", Artificial Intelligence, vol. 114, no. 1-2, pp. 239-255, 1999.
2) M. Egerstedt, "From algorithms to architectures in cyber-physical networks", Cyber-Physical Systems, vol. 1, no. 2-4, pp. 67-75, 2015.
3) F. Glover, "Future paths for integer programming and links to artificial intelligence", Computers & Operations Research, vol. 13, no. 5, pp. 533-549, 1986.
4) S. Hansson, "Knowledge-level analysis of belief base operations", Artificial Intelligence, vol. 82, no. 1-2, pp. 215-235, 1996.
5) M. Kim, "A framework for context immersion in mobile augmented reality", Automation in Construction, vol. 33, pp. 79-85, 2013.
6) S. Kumar and M. Abdul Qadeer, "Application of AI in Home Automation", International Journal of Engineering and Technology, vol. 4, no. 6, pp. 803-807, 2012.
7) N. Liberati, "Augmented reality and ubiquitous computing: the hidden potentialities of augmented reality", AI & SOCIETY, vol. 31, no. 1, pp. 17-28, 2014.
8) H. Lou and Y. Huang, "Hierarchical decision making for proactive quality control: system development for defect reduction in automotive coating operations", Engineering Applications of Artificial Intelligence, vol. 16, no. 3, pp. 237-250, 2003.
9) N. Cuong and X. Qafmolla, "Model Transformation in Web Engineering and Automated Model Driven Development", *International Journal of Modeling and Optimization*, pp. 7-12, 2011.
10) V. Torres, P. Giner and V. Pelechano, "Developing BP-driven web applications through the use of MDE techniques", *Software & Systems Modeling*, vol. 11, no. 4, pp. 609-631, 2010.
11) S. Ontañón and P. Meseguer, "Speeding up operations on feature terms using constraint programming and variable symmetry", Artificial Intelligence, vol. 220, pp. 104-120, 2015.
12) V. Rudtsch, J. Gausemeier, J. Gesing, T. Mittag and S. Peter, "Pattern-based Business Model Development for Cyber-Physical Production Systems", Procedia CIRP, vol. 25, pp. 313-319, 2014.

13) T. Zhang, J. Frédéric, A. Christian, B. Jean and X. LI, "MDE-Based Mode Transformation: From MARTE Model to FIACRE Model", *Journal of Software*, vol. 20, no. 2, pp. 214-233, 2009.

14) I. Stojmenovic and F. Zhang, "Inaugural issue of 'cyber-physical systems'", Cyber-Physical Systems, vol. 1, no. 1, pp. 1-4, 2014.

15) C. Sun, V. Uraikul, C. Chan and P. Tontiwachwuthikul, "An integrated expert system/operations research approach for the optimization of natural gas pipeline operations", Engineering Applications of Artificial Intelligence, vol. 13, no. 4, pp. 465-475, 2000.

16) K. Thramboulidis, "An RTSJ-based framework for model-driven development in distributed control and automation", International Journal of Industrial and Systems Engineering, vol. 7, no. 4, p. 518, 2011.

17) J. Wang, L. Cheng and J. Liu, "A New Spatio-temporal Event Model based on Multi-tuple for Cyber-Physical Systems", International Journal of Control and Automation, vol. 6, no. 6, pp. 51-62, 2013.

18) G. Schirner, D. Erdogmus, K. Chowdhury and T. Padir, "The Future of Human-in-the-Loop Cyber-Physical Systems", *Computer*, vol. 46, no. 1, pp. 36-45, 2013.

19) L. C. Briand, "Novel applications of machine learning in software testing," in 2008 The Eighth International Conference on Quality Software,pp. 3–10, 2008.