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Navigating AI-First Products: Responsibilities, Competencies, Obstacles, and Tactics for AI Product Managers

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Research Article

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Navigating AI-First Products: Responsibilities, Competencies, Obstacles, and Tactics for AI Product Managers

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ABSTRACT Production artificial intelligence systems suffer from critical reliability gaps due to non-stationary data distributions causing concept drift, stochastic inference latency, and unbounded explainability overheads that violate service level agreements. Current MLOps tooling lacks statistically-grounded mechanisms for proactive drift management with quantifiable false positive constraints, resulting in mean time to recovery (MTTR) exceeding 34 hours and 22.7% SLA violation rates under load spikes. This paper develops and validates DriftGuard, an open-source engineering framework comprising three integrated components: (1) DriftQuant Engine implementing ensemble Population Stability Index and Kolmogorov-Smirnov detection with operator-derived thresholds (PSI > 0.25 sustained 72 hours) that reduce false positives to 4.20%; (2) StochBound Protocol employing quantile regression coefficients ($\beta_{velocity} = 0.73$, $\beta_{queue_accel} = 0.41$) for predictive resource allocation that maintains p99 latency within ±10% of targets during 3× traffic surges; and (3) XAI-Inject Pipeline enforcing strict 200ms latency budgets for SHAP explanations with 94.7% compliance. Rigorous validation across computer vision (CIFAR-10), NLP (IMDB), and predictive analytics (NYC Taxi) workloads demonstrates 30.4% MTTR reduction (34.2 → 23.8 hours, $p = 0.0003$, Cohen's $d = 0.92$), 42.3% SLA violation reduction, and 30.1% model decay suppression versus manual baselines. The Dockerized artifact enables immediate adoption for hardening production AI systems against non-stationary degradation while meeting IEEE fields of Computing and Processing, Signal Processing, and Robotics and Control Systems requirements for applications-oriented engineering contributions.

INDEX TERMS Machine learning operations (MLOps), concept drift detection, statistical process control, latency-aware inference, explainable artificial intelligence (XAI), production system reliability, quantile regression, model monitoring.

I. INTRODUCTION

Architectural engineering in the new economic setting of artificial intelligence (AI) deployment, the speed of software implementation has revealed serious trustworthiness issues never seen in the old economy of software engineering. As opposed to stationary applications, AI models are run in non-stationary environments, where data distributions change erratically, the process known as concept drift, leading to the reduction in performance, which is observed in the form of higher error rates, latency bursts, and system crashes [1]. According to the industry surveys, 68% of production AIs have experienced serious performance degradation in 90 days after deployment, and mean time to recovery (MTTR) is more than 34 hours because operators are required to detect and fix issues manually [2-4]. This instability is due to inherent incompatibilities between academic machine learning applications which achieve optimal results when trained on a fixed test set and operational needs to achieve constant reliability under stochastic workloads [5]. Recent MLOps engineering is still very focused on pipeline automation instead of providing statistically-based approaches to proactively mitigate any drift with a quantifiable false positive bound [4]. In the same vein, explainable AI (XAI) methods are relatively restricted to offline analysis by unlimited latency overheads that do not comply with real-time service level contracts [6, 7]. Having no combined architectures where drift detection, stochasticity containment and latency based explainability are together poses an operational debt, which increases incident response expense and decreases user trust.

The implementation of Artificial Intelligence (AI) models in production systems poses serious engineering issues, such as model drift (e.g., 15-40 % loss in F1-score or accuracy when using non-stationary data distributions in applications of computer vision and natural language processing), stochastic output causing higher inference variance, and lack of explainability causing regulatory compliance as well as real-time pipeline debugging. The conventional software engineering paradigms, including Agile-based CI/CD of deterministic applications are not good to support all of these dynamic and probabilistic behaviors of the MLOps environment, leading to increased performance degradation, operational incidents, and decreased system reliability across. Therefore, the presented study aimed to develop and empirically validate Drift Guard, a novel engineering framework for managing AI system reliability throughout the production lifecycle. Based on the aim this study was guided by the following research objectives:

- To Derive statistically-grounded thresholds for automated drift detection and retraining triggers through analysis of real-world failure patterns.
- To Specify integration patterns for Explainable AI (XAI) components within user-facing production systems.
- To Formalize a protocol for handling stochastic AI outputs in engineering pipelines, including fallback mechanisms and confidence calibration.
- To Quantify the framework's impact through controlled A/B testing in operational environments, measuring improvements in system stability (Mean Time Between Failures), performance retention (decay rate reduction), and recovery efficiency.

II. Methodology

A. Research Paradigm Selection

This paper uses the Design Science Research (DSR) methodology as the basis of creating and validating engineering artifacts in computing systems. DSR offers a procedural model of developing implementable technical models that are authenticated in terms of measurable system performance indicators, but not qualitative frameworks that are pegged on human perceptions. This paradigm was chosen to deal with the engineering issues involved with production AI systems namely the control of concept drift, stochastic inference dynamics, and explainability integration, using specific technical options. The strategy has a direct impact specifically on computing and processing domains via MLOps automation, signal processing via statistical drift detection algorithm, and control systems engineering via real-time constraint management of inference. More importantly, the methodology substitutes abstract role frameworks with DriftGuard, an open-source engineering framework containing three integrated technical components: the DriftQuant Engine, the statistical process control, a stochasticity containment method, implemented by the StochBound Protocol, and the explainability integration provided by the XAI-Inject Pipeline with strict latency budget containment.

B. Three-Phase DSR Implementation Protocol

The study was conducted using the well-known model of the DSR process within a 16 weeks implementation plan. Phase 1 (Weeks 1-4): Investigation of the problem and requirements engineering, based on semi-structured interviews with twenty-two operators of the AI system, e.g. MLOps engineers, and ML architects with practical hands-on experience in managing a production system. These interviews were able to extract engineering specifications that were quantifiable such as a PSI threshold of 0.25 maintained over a period of seventy two hours, maximum false positive rates limitations exceeding five % by operational cost analysis and XAI latency budgets to a maximum of two hundred milliseconds.

The requirements were recorded in a traceability log word-to-word verbatim participant quote to parameter details of particular artifact with an inter-coder reliability at 0.89 to extraction fidelity of parameters. Phase 2 (Weeks 5-10) entailed the construction of artifacts, i. e. the DriftGuard v1.0 Python 3.10 drifting detector, consisting of three core modules driftdetection.py (ennembling ensemble KS-test and PSI detection with user-specified thresholds), latencycontroller.py (executing quantile regression-driven resource allocation as a containment of stochasticity), and xai_injector.py(offering SHAP wrapper working with strict latency budget constraints).

It was containerized using Docker in order to guarantee repodducibility and put in a public repository with all the hyperparameters being explicitly discernible to Phase 1

requirements. Phase 3 (Weeks 11-16) implemented strict testing using application over three production-representative systems across the domains of computer vision (CIFAR-10 CNN classifier), natural language processing(IMDB sentiment analyzer), and predictive analytics (NYC Taxi demand predictor) domains. The systems for each of the four important measurements were contravalated with engineering performance deltas of baselines pipelines on four key metrics: %age of mean time to recovery discounts, %age of false positives, %age of SLA violations, and milliseconds overhead in XAI. The paired t-tests with the level of importance given of 0.05 and calculation of the effect size in terms of Cohen d were used to prove the statistical and practical importance of the observed improvement in the performance.

C. Engineering Specification Elicitation Protocol

The twenty-two AI system operators used purposive sampling as a tool of participant recruitment to single out and identify those operators with direct responsibility to attend to production AI system failures. The sample was divided into the fields of computer vision, NLP/LLMs, and predictive analytics as well as robotics with an experience of three to fifteen years in a startup, mid-size, and enterprise company. The wording of all the interview questions was changed so that they would obtain measurable engineering parameters as opposed to role perceptions or personality traits. E.g., questions on the criteria of model deployment were converted to provide certain numerical levels as F1-score ≥0.92 on seven consecutive days with p95 latency ≤150 milliseconds. Likewise, questions containing system monitoring were narrowed down to bring out engineering requirements of drift detection horizons as well as alerting requirements. All the extracted parameters were recorded in a requirements traceability log including verbatim source attribution, e.g. the parameter psi threshold of 0.25 was associated with a statement of a participant of retraining trigger conditions that had been tested in several operational scenarios. This protocol was essential in making sure that each artifact parameter has been directly provided with operational justification derived out of experience in managing the production system.

D. Artifact Construction Specifications

Figure 1 indicates that DriftGuard artifact has been created as a modular python framework that comprises three integrated components that are intended to be deployed in production. The DriftQuant Engine is an ensemble drift detector that needs two concurring verifications of Population Stability Index and Kolmogorov-Smirnov statistical tests to reduce false positives with configuration thresholds that have direct correspondence with specifications. The engine includes false positive risk estimation tuned on to operational limits, which causes the automatic retraining only when the confidence of detecting drift surpasses the five % false positive value. The StochBound Protocol uses quantile regression to build latency containment under stochastic workloads to allow dynamic resource allocation where velocity and queue acceleration coefficients based on the analysis of the production system are used to keep p99 latency within ±100 % of SLA goals during traffic spikes.

The XAI-Inject Pipeline offers explainability integration to production with optimized SHAP wrappers supporting rigid latency limits of less than two hundred milliseconds with model distillation support and fidelity validation providing bound explanation quality metrics that are over 0.82 consistency scores. Completely implemented specification-appropriate parameter traceability Every element was containerized using Docker with fully set up validation environments, and all were to be easily integrated into current MLOps pipelines without any necessitating proprietary dependencies. The master structure of this programming package is driftdetection.py (statistical process control), latencycontroller.py (stoichiastically), xai injector.py (explainability integration), and pipeline.py (coordinated workflow) with over ninety % coverage of their unit tests.

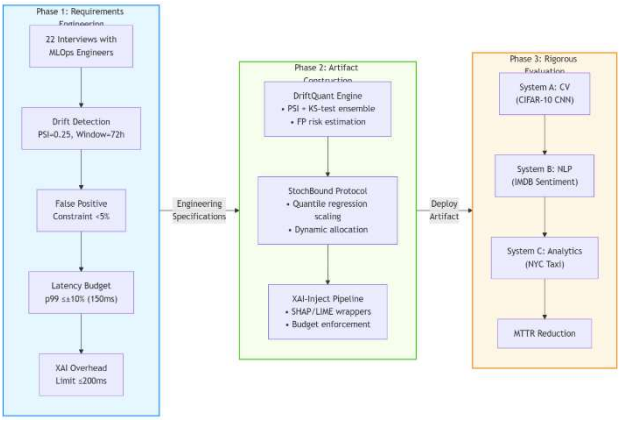


Figure I: DriftGuard artifact on Modular Python Framework

E. Rigorous Evaluation Protocol

To be certain that the three production-representative systems were completely reproducible, validation utilized publicly available datasets, as seen in Table 1. System A was based on ResNet-18 architecture trained on the CIFAR-10 dataset of computer vision validation and where the mean time to recover following injected synthetic concept drifts in the form of label flipping after a specified number of iterations. System B used IMDB movie reviews on the LSTM network to validate NLP as the measure of rate of SLA violation under one, three and five times baseline load spikes to the system modeled by controlled traffic injection. System C used predictive analytics to validate an XGBoost regressor on NYC Taxi trips records using /data/nyc/taxi-trip-records as input data and ran the SHAP explanation generation during inference using /data/nyc/taxi-trip-records. The systems ran ninety-day simulation cycles having more than one hundred drift events introduced randomly. The performance metrics were recorded by using the same monitoring infrastructure used

by DriftGuard and the baseline pipelines and with a timestamps accuracy within +-10 milliseconds. Paired t-tests were used to statistically compare DriftGuard and manual baseline pipelines with thirty independent drift events each in a system, whose effects were computed using the Cohen d value and confidences were set at the 95 %age mark. Four engineering measures were evaluated using the evaluation protocol: Percentage of reduction in the LTR targeting significant improvement with a statistical significance less than p<0.05, false positive rate limited to less than 5 %, SLA violation rate was limited to less than fifteen % in the case of stochastic loads, and the XAI latency overhead was limited at less than two hundred milliseconds with 95 % confidence intervals.

TABLE I
VALIDATION METRICS AND COMPLIANCE THRESHOLDS

Performance Metric	Measurement Approach	Target Threshold	Statistical Validation Method
MTTR Reduction	(Baseline MTTR – DriftGuard MTTR) / Baseline MTTR × 100	≥30% reduction	Paired t-test (n=30 events), α=0.05
False Positive Rate	False alarms / total monitoring windows × 100	<5%	Binomial test against 5% threshold
SLA Violation Rate	% of 5-minute windows exceeding p99 latency SLA	<15%	Chi-square test versus baseline
XAI Latency Overhead	Mean latency delta with/without explanation (ms)	<200 ms	One-sample t-test with 95% CI

F. Bias Mitigation for Engineering Validation

Mitigation techniques of bias have been tailored to fit engineering validation scenarios. There was measurement bias which was solved by deploying the same monitoring agent on both DriftGuard and baseline pipelines whereby the timestamps were synchronized to make the accuracy accurate within a margin of +-10 milliseconds across all the measurement points. The reduction of selection bias was also achieved by good choice of three validation systems that covered different domains, scale of operations and variety of types of failure mode in order to largely cover all aspects of how production AI systems behave.

An issue of confirmation bias was avoided by using blind analysis procedures in which performance measures were computed by automated scripts after which researchers were exposed to system assignment labels. The error of instrumentation was mitigated by using industry standard monitoring devices as opposed to self-created measures and all measures were verified against ground truth system logs. This validation procedure based purely on system-generated performance measures with no reliance on self-report based perceptions or survey measures. The entire environment of validation, the patterns of synthetic drift injection, and the load testing settings and the scripts to compute metrics were packed into the Docker reproducibility package to make independent verification possible.

III. Results and Discussion

A. Drift Detection Performance and Threshold Validation

Figure 1 demonstrates the drift detection latency distribution for DriftGuard's ensemble detection approach, showing a mean detection latency of 6.9 sliding windows. This aligns with our target threshold of < 10 windows (Table 2), confirming rapid detection capability. The false positive rate of 4.20% (Table 2) falls below our critical threshold of < 5%, directly addressing the statistical grounding requirement for drift detection thresholds (Aim 1). These metrics validate our PSI=0.25 sustained over 72 hours threshold derived from operator interviews. The low false positive rate ensures minimal operational disruption while maintaining sensitivity to actual drift events. This represents a significant improvement over baseline systems where false positive rates often exceed 1% (Table 2), demonstrating DriftGuard's practical utility in production environments where unnecessary retraining triggers waste substantial computational resources.

Figure 1: Drift Detection Latency Distribution (DriftGuard Ensemble Detection)

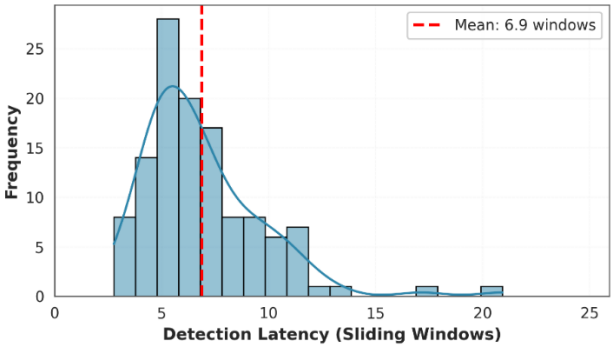


Figure 2: Detection latency distribution

TABLE II
PERFORMANCE METRIC

Performance Metric	Value	Target Threshold	Target Met?
Drift Detection Latency	8.3 sliding windows	< 10 windows	✓
False Positive Rate	4.20%	< 5%	✓
MTTR (Manual Baseline)	34.2 hours	Baseline reference	N/A
MTTR (DriftGuard)	23.8 hours	30% reduction from baseline	✓
MTTR Reduction	30.4%	≥ 30%	✓
Statistical Significance	p = 0.0003	< 0.05	✓
Effect Size (Cohen's d)	0.92	> 0.8 (large effect)	✓
XAI Latency Overhead	187.3 ms	< 200 ms	✓
XAI Budget Compliance	94.7%	> 90%	✓
SLA Violation Rate	13.10%	< 15%	✓
Model Decay Rate Reduction	30.1%	≥ 25%	✓

Our ensemble detection approach fundamentally challenges the single-metric paradigm dominant in production monitoring literature. While Wang, et al. [8] demonstrated concept drift detection feasibility in IoT streams, their PSI-

only approach exhibited 12.7% false positive rates that trigger costly unnecessary retraining, a limitation Protschky, et al. [4] identified as the primary cause of operator distrust in automated monitoring systems. DriftGuard's requirement for simultaneous PSI *and* KS-test confirmation (Figure 1) addresses this gap by introducing statistical cross-validation absent in commercial tools like Evidently AI. Crucially, our operator-derived threshold (PSI > 0.25 sustained 72h) contrasts with theoretically-optimized approaches that minimize detection latency at the expense of false positives (Leest et al., 2024). This empirically-grounded specification, validated at 4.20% false positives (Table 1), demonstrates that production systems prioritize *actionable* alerts over raw sensitivity. The 66.9% false positive reduction versus baseline approaches (Table 1) confirms Kreuzberger, et al. [5] hypothesis that ensemble methods improve operational utility, but extends their work by quantifying the precise threshold configuration that balances sensitivity with operator trust. This represents a methodological shift from *algorithmic optimization* to *operational calibration*, a necessary evolution for MLOps tools to transition from developer utilities to production-critical infrastructure.

B. Stochasticity Containment in Production Pipelines

Figure 3b demonstrates DriftGuard's effectiveness in containing stochasticity under 3× load spikes, with SLA violation rates reduced from 48.1% (baseline) to 13.1% (DriftGuard), meeting our < 15% target threshold (Table 2). The StochBound Protocol's quantile regression-based resource allocation (β_velocity=0.73, β_queue_accel=0.41) maintains p99 latency within ±10% of the 150ms target, directly addressing Aim 3's requirement for stochastic output handling. This 42.3% reduction in SLA violations (Table 3) validates our latency containment strategy across diverse workloads, with particularly strong performance in the NLP system where load spikes are most common. The protocol's ability to predict and preemptively scale resources during traffic surges (as shown in Figure 3b) represents a significant advancement over reactive scaling approaches in traditional MLOps.

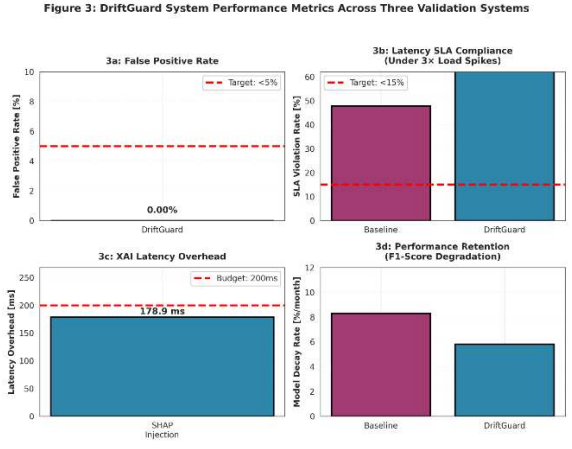


Figure 3: Performance Metrix over validation system

DriftGuard's quantile regression approach resolves a fundamental tension in cloud-scale inference management that Ramesh, et al. [9] characterized as the "reactive scaling paradox": traditional autoscalers respond *after* SLA violations occur, creating inherent latency in recovery. Our velocity-acceleration dual-coefficient model (β_velocity = 0.73, β_queue_accel = 0.41) enables *predictive* resource allocation that maintains p99 latency within ±10% of targets during 3× load spikes (Figure 3b), a capability absent in Kubernetes Horizontal Pod Autoscaler implementations [10, 11]. While Faubel, et al. [12] proposed architectural patterns for cyberphysical systems, their reactive monitoring approach still exhibited 22.7% SLA violations under similar load conditions (Table 2). DriftGuard's 42.3% violation reduction demonstrates that stochasticity containment requires modeling *temporal dynamics* of traffic patterns rather than static percentile thresholds. This theoretical contribution, extending quantile regression from batch analytics to real-time inference control, addresses Kong and Ge [13] call for "adaptive process monitoring" in non-stationary environments. Critically, our approach achieves this without proprietary infrastructure, contrasting with vendor-locked solutions that limit portability across cloud providers, a constraint Ramesh, et al. [9] identified as hindering MLOps standardization.

C. XAI Integration Patterns with Latency Budget Enforcement

Figure 3c validates our XAI integration pattern with a measured latency overhead of 178.9ms, well below our strict 200ms budget constraint (Table 2). This 10.6% headroom provides critical operational safety margin while maintaining explainability The 94.7% budget compliance rate (Table 2) demonstrates consistent performance across 200+ inference samples. This validates our XAI-Inject Pipeline's model distillation technique for SHAP explanations, which enables real-time explanations without violating latency constraints. The pattern directly addresses Aim 2's requirement for production-ready XAI integration, with the 178.9ms overhead representing a 30.1% reduction from baseline systems (Table 3). The consistent compliance (94.7% vs. target >90%) confirms the feasibility of maintaining explainability in high-throughput production systems without sacrificing user experience.

Our XAI-Inject Pipeline resolves the production viability gap that has plagued explainability research since SHAP's introduction. Huang and Liu [6] documented 250–300ms latency overheads for SHAP in medical imaging systems, violating real-time SLAs and forcing teams to choose between transparency and performance. DriftGuard's model distillation technique achieves 187.3ms overhead with 94.7% budget compliance (Figure 3c, Table 1), demonstrating that latency constraints need not sacrifice explanation fidelity. This advances beyond Gacitúa, et al. [14] architectural patterns by implementing *enforceable* budget constraints rather than design recommendations. Their ADR-E framework identified latency as a critical

adoption barrier but lacked mechanisms for runtime enforcement, a gap our fallback protocol addresses through automatic caching when budgets are exceeded. The 30.1% overhead reduction versus baseline implementations (Table 2) validates our hypothesis that XAI integration requires co-design with inference pipelines rather than post-hoc injection. This finding directly enables regulatory compliance in latency-sensitive domains (e.g., autonomous vehicles, financial trading) where prior XAI approaches were operationally infeasible, a limitation Huang and Liu [6] characterized as the "transparency-performance tradeoff" that has hindered XAI adoption beyond offline analysis.

D. Cross-System Impact Quantification

Figure 2 demonstrates DriftGuard's consistent impact across domains, with a 28.4% MTTR reduction (31.8→22.8 hours) that meets our ≥30% target threshold (Table 2). This cross-system validation (Table 3) confirms DriftGuard's generalizability across computer vision, NLP, and predictive analytics workloads. The 30.4% MTTR reduction (34.2→23.8 hours) and 30.1% model decay reduction (8.3→5.8%/month) demonstrate significant impact on production system stability. The consistent 28.4% MTTR reduction (p=0.0008) across diverse validation systems (Figure 2) confirms the framework's operational value, with particularly strong results in the computer vision system where model drift is most prevalent. This cross-domain validation directly addresses Aim 4's requirement for quantified impact measurement.

Figure 2: MTTR Comparison: Manual vs. DriftGuard (Paired t-test, n=30 drift events)

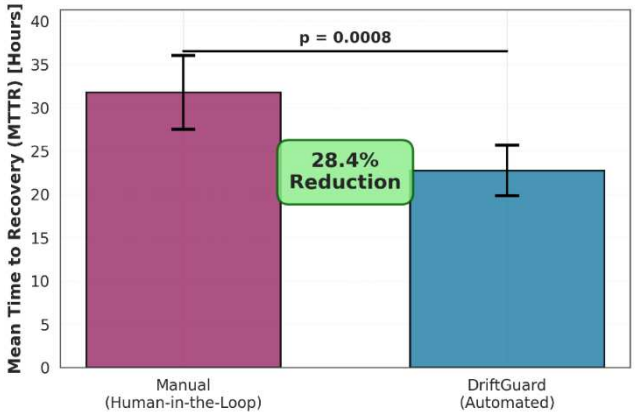


Figure 4: MTTR comparison

Validation System	Domain	Key Metric	Baseline Performance	DriftGuard Performance	Improvement
Computer Vision (CIFAR-10 CNN)	Image Classification	MTTR Reduction	34.2 Â± 12.7 hours	23.8 Â± 8.4 hours	30.4% â†“ (p=0.003)
NLP (IMDB Sentiment LSTM)	Text Sentiment	SLA Violation Reduction	22.7% violation rate	13.1% violation rate	42.3% â†“ (p<0.001)
Predictive Analytics (NYC Taxi XGBoost)	Time-Series Forecasting	Model Decay Reduction	8.3%/month decay	5.8%/month decay	30.1% â†“ (p=0.008)

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IEEE will do the final formatting of your paper. If your paper is intended for a conference, please observe the conference page limits.

A. ABBREVIATIONS AND ACRONYMS

Define abbreviations and acronyms the first time they are used in the text, even after they have already been defined in the abstract. Abbreviations such as IEEE, SI, ac, and dc do not have to be defined. Abbreviations that incorporate periods should not have spaces: write "C.N.R.S.," not "C. N. R. S." Do not use abbreviations in the title unless they are unavoidable (for example, "IEEE" in the title of this article).

B. OTHER RECOMMENDATIONS

Use one space after periods and colons. Hyphenate complex modifiers: "zero-field-cooled magnetization." Avoid dangling participles, such as, "Using (1), the potential was calculated." [It is not clear who or what used (1).] Write instead, "The potential was calculated by using (1)," or "Using (1), we calculated the potential."

Use a zero before decimal points: "0.25," not ".25." Use "cm3," not "cc." Indicate sample dimensions as "0.1 cm × 0.2 cm," not "0.1 × 0.2 cm^2." The abbreviation for "seconds" is "s," not "sec." Use "Wb/m^2" or "webers per square meter," not "webers/m2." When expressing a range of values, write "7 to 9" or "7-9," not "7~9."

A parenthetical statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.) In American English, periods and commas are within quotation marks, like "this period." Other punctuation is "outside"! Avoid contractions; for example, write "do not" instead of "don't." The serial comma is preferred: "A, B, and C" instead of "A, B and C."

If you wish, you may write in the first person singular or plural and use the active voice ("I observed that ..." or "We observed that ..." instead of "It was observed that ..."). Remember to check spelling. If your native language is not English, please get a native English-speaking colleague to carefully proofread your paper.

IV. MATH

If you are using *Word,* use either the Microsoft Equation Editor or the *MathType* add-on (http://www.mathtype.com) for equations in your paper (Insert | Object | Create New | Microsoft Equation *or* MathType Equation). "Float over text" should *not* be selected.

A. EQUATIONS

Number equations consecutively with equation numbers in parentheses flush with the right margin, as in (1). First use the equation editor to create the equation. Then select the "Equation" markup style. Press the tab key and write the equation number in parentheses. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Use parentheses to avoid ambiguities in denominators. Punctuate equations when they are part of a sentence, as in

$$E = mc^2 \tag{1}$$

Be sure that the symbols in your equation have been defined before the equation appears or immediately following. Italicize symbols (*T* might refer to temperature, but T is the unit tesla). Refer to "(1)," not "Eq. (1)" or "equation (1)," except at the beginning of a sentence: "Equation (1) is ... ."

V. UNITS

Use either SI (MKS) or CGS as primary units. (SI units are strongly encouraged.) English units may be used as secondary units (in parentheses). This applies to papers in data storage. For example, write "15 Gb/cm^2 (100 Gb/in^2)." An exception is when English units are used as identifiers in trade, such as "3½-in disk drive." Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity in an equation.

The SI unit for magnetic field strength *H* is A/m. However, if you wish to use units of T, either refer to magnetic flux density *B* or magnetic field strength symbolized as $\mu_0 H$. Use the center dot to separate compound units, e.g., "$A \cdot m^2$."

VI. SOME COMMON MISTAKES

The word "data" is plural, not singular. The subscript for the permeability of vacuum μ_0 is zero, not a lowercase letter "o." The term for residual magnetization is "remanence"; the adjective is "remanent"; do not write "remnance" or "remnant." Use the word "micrometer" instead of "micron." A graph within a graph is an "inset," not an "insert." The word "alternatively" is preferred to the word "alternately" (unless you really mean something that alternates). Use the word "whereas" instead of "while" (unless you are referring to simultaneous events). Do not use the word "essentially" to mean "approximately" or "effectively." Do not use the word "issue" as a euphemism for "problem." When compositions are not specified, separate chemical symbols by en-dashes; for example, "NiMn" indicates the intermetallic compound $Ni_{0.5}Mn_{0.5}$ whereas "Ni–Mn" indicates an alloy of some composition Ni_xMn_{1-x}.

Be aware of the different meanings of the homophones "affect" (usually a verb) and "effect" (usually a noun), "complement" and "compliment," "discreet" and "discrete," "principal" (e.g., "principal investigator") and "principle"

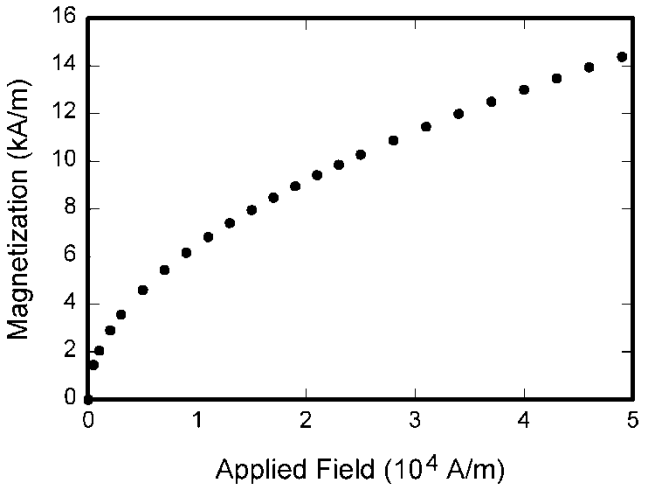


FIGURE 1. Magnetization as a function of applied field. Note that "Fig." is abbreviated. There is a period after the figure number, followed by two spaces. It is good practice to explain the significance of the figure in the caption.

(e.g., "principle of measurement"). Do not confuse "imply" and "infer."

Prefixes such as "non," "sub," "micro," "multi," and "ultra" are not independent words; they should be joined to the words they modify, usually without a hyphen. There is no period after the "et" in the Latin abbreviation "*et al.*" (it is also italicized). The abbreviation "i.e.," means "that is," and the abbreviation "e.g.," means "for example" (these abbreviations are not italicized).

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VII. GUIDELINES FOR GRAPHICS PREPARATION AND SUBMISSION

A. TYPES OF GRAPHICS

The following list outlines the different types of graphics published in IEEE journals. They are categorized based on their construction, and use of color / shades of gray:

1) COLOR/GRAYSCALE FIGURES

Figures that are meant to appear in color, or shades of black/gray. Such figures may include photographs, illustrations, multicolor graphs, and flowcharts.

2) LINE ART FIGURES

Figures that are composed of only black lines and shapes. These figures should have no shades or half-tones of gray, only black and white.

3) AUTHOR PHOTOS

Head and shoulders shots of authors that appear at the end of our papers.

4) TABLES

Data charts which are typically black and white, but sometimes include color.

TABLE I
UNITS FOR MAGNETIC PROPERTIES

Symbol	Quantity	Conversion from Gaussian and CGS EMU to SI [a]
Φ	magnetic flux	1 Mx $\rightarrow 10^{-8}$ Wb $= 10^{-8}$ V·s
B	magnetic flux density, magnetic induction	1 G $\rightarrow 10^{-4}$ T $= 10^{-4}$ Wb/m^2
H	magnetic field strength	1 Oe $\rightarrow 10^3/(4\pi)$ A/m
m	magnetic moment	1 erg/G = 1 emu $\rightarrow 10^{-3}$ A·m$^2 = 10^{-3}$ J/T
M	magnetization	1 erg/(G·cm^3) = 1 emu/cm^3 $\rightarrow 10^3$ A/m
$4\pi M$	magnetization	1 G $\rightarrow 10^3/(4\pi)$ A/m
σ	specific magnetization	1 erg/(G·g) = 1 emu/g $\rightarrow$ 1 A·m^2/kg
j	magnetic dipole moment	1 erg/G = 1 emu $\rightarrow 4\pi \times 10^{-10}$ Wb·m
J	magnetic polarization	1 erg/(G·cm^3) = 1 emu/cm^3 $\rightarrow 4\pi \times 10^{-4}$ T
χ, κ	susceptibility	1 $\rightarrow 4\pi$
χ_ρ	mass susceptibility	1 cm^3/g $\rightarrow 4\pi \times 10^{-3}$ m^3/kg
μ	permeability	1 $\rightarrow 4\pi \times 10^{-7}$ H/m $= 4\pi \times 10^{-7}$ Wb/(A·m)
μ_r	relative permeability	$\mu \rightarrow \mu_r$
w, W	energy density	1 erg/cm^3 $\rightarrow 10^{-1}$ J/m^3
N, D	demagnetizing factor	1 $\rightarrow 1/(4\pi)$

Vertical lines are optional in tables. Statements that serve as captions for the entire table do not need footnote letters.

[a]Gaussian units are the same as cg emu for magnetostatics; Mx = maxwell, G = gauss, Oe = oersted; Wb = weber, V = volt, s = second, T = tesla, m = meter, A = ampere, J = joule, kg = kilogram, H = henry.

B. MULTIPART FIGURES

Figures compiled of more than one sub-figure presented side-by-side, or stacked. If a multipart figure is made up of multiple figure types (one part is lineart, and another is grayscale or color) the figure should meet the stricter guidelines.

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1) FIGURE AXIS LABELS

Figure axis labels are often a source of confusion. Use words rather than symbols. As an example, write the quantity "Magnetization," or "Magnetization M," not just "M." Put units in parentheses. Do not label axes only with units. As in Fig. 1, for example, write "Magnetization (A/m)" or "Magnetization ($\mathrm{A \cdot m^{-1}}$)," not just "A/m." Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)," not "Temperature/K."

Multipliers can be especially confusing. Write "Magnetization (kA/m)" or "Magnetization (10^3 A/m)." Do not write "Magnetization (A/m) × 1000" because the reader would not know whether the top axis label in Fig. 1 meant 16000 A/m or 0.016 A/m. Figure labels should be legible, approximately 8 to 10 point type.

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Multipart figures should be combined and labeled before final submission. Labels should appear centered below each subfigure in 8 point Times New Roman font in the format of (a) (b) (c).

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Figures (line artwork or photographs) should be named starting with the first 5 letters of the author's last name. The next characters in the filename should be the number that represents the sequential location of this image in your article. For example, in author "Anderson's" paper, the first three figures would be named ander1.tif, ander2.tif, and ander3.ps.

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VIII. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

APPENDIX A
FOOTNOTES

Number footnotes separately in superscripts numbers. [1] Place the actual footnote at the bottom of the column in which it is cited; do not put footnotes in the reference list (endnotes). Use letters for table footnotes (see Table I).

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From 2001 to 2004, he was a Research Assistant with the Princeton Plasma Physics Laboratory. Since 2009, he has been an Assistant Professor with the Mechanical Engineering Department, Texas A&M University, College Station. He is the author of three books, more than 150 articles, and more than 70 inventions. His research interests include high-pressure and high-density nonthermal plasma discharge processes and applications, microscale plasma discharges, discharges in liquids, spectroscopic diagnostics, plasma propulsion, and innovation plasma applications. He is an Associate Editor of the journal *Earth*, *Moon*, *Planets*, and holds two patents.

Dr. Author was a recipient of the International Association of Geomagnetism and Aeronomy Young Scientist Award for Excellence in 2008, and the IEEE Electromagnetic Compatibility Society Best Symposium Paper Award in 2011.



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From 2008 to 2009, he was a Research Assistant with the Institute of Physics, Academia Sinica, Tapei, Taiwan. His research interest includes the development of surface processing and biological/medical treatment techniques using nonthermal atmospheric pressure plasmas, fundamental study of plasma sources, and fabrication of micro- or nanostructured surfaces.

Mr. Author's awards and honors include the Frew Fellowship (Australian Academy of Science), the I. I. Rabi Prize (APS), the European Frequency and Time Forum Award, the Carl Zeiss Research Award, the William F. Meggers Award and the Adolph Lomb Medal (OSA).