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*Ingenious Hackathon 7.0*

# Ingenious Hackathon 7.0

## Problem Statements

### Theme

# Building Trustworthy, Scalable, and Human-Centered Digital Systems for the Next Decade

# Hackathon Theme

# Trustworthy and Scalable Digital Systems

In the modern digital era, software systems form the backbone of critical societal, economic, and institutional functions. From governance and education to healthcare, agriculture, and urban infrastructure, digital platforms are expected to operate at unprecedented scale while remaining secure, reliable, transparent, and inclusive. However, as systems grow larger and more interconnected, challenges related to trust, scalability, resilience, privacy, and long-term sustainability become increasingly complex and consequential. Agriculture, Healthcare, and Smart Cities are identified as priority domains requiring urgent digital transformation.

The theme **"Trustworthy and Scalable Digital Systems"** emphasizes the design and engineering of next-generation software solutions that go beyond isolated applications and focus on system-level thinking. Participants are encouraged to explore how modern computing paradigms—such as distributed systems, cloud-native architectures, data platforms, cybersecurity engineering, human-centered design, and responsible use of intelligent technologies—can be combined to build digital ecosystems that people and institutions can rely upon.

This theme deliberately avoids restricting innovation to a single technology or domain. Instead, it invites interdisciplinary problem-solving that reflects real-world engineering practices, where performance, security, usability, ethics, and impact must coexist. Solutions may address challenges at the level of platforms, infrastructures, services, or large-scale digital interactions, and may be implemented using any appropriate combination of software technologies.

Through this theme, the Ingenious Hackathon aims to cultivate system thinkers—engineers and researchers who can design digital solutions that are not only innovative but also robust, future-ready, and socially responsible. Participants are expected to demonstrate architectural clarity, technical depth, and a clear understanding of how their systems

would function in real-world, high-stakes environments.

# Problem Statement 1

## Problem Title

National-Scale Digital Public Infrastructure for Seamless Service Delivery

### Background & Context

Across modern societies, critical public services such as healthcare (telemedicine, patient records), agriculture (farmer support, supply chain), smart cities (utilities, transportation), education, and welfare are increasingly delivered through digital platforms. However, most existing systems have evolved independently, resulting in fragmented architectures, duplicated data, inconsistent user experiences, and limited scalability. As the number of users and services grows, these disconnected systems struggle to meet performance, reliability, and interoperability requirements. There is a pressing need for a unified digital public infrastructure that can act as a common backbone for diverse services while remaining flexible enough to support regional, linguistic, and functional diversity.

### Detailed Problem Description

The challenge is to design a comprehensive digital infrastructure capable of supporting multiple public services through a shared, modular, and scalable architecture, with special consideration for agricultural extension services, healthcare delivery networks, and urban management systems. The proposed system should enable seamless integration of new services, standardized data exchange between departments, and consistent user experiences across platforms. Rather than focusing on a single application, participants are expected to think at the level of national-scale system design, addressing concerns such as service orchestration, fault tolerance, performance under heavy load, and long-term maintainability. The solution should demonstrate how such an infrastructure can evolve over time while ensuring continuity of critical public services.

### Objectives

Create a working prototype that demonstrates:

1. A core platform/service registry that allows different government services to register

and connect

2. At least 2-3 mock services (e.g., healthcare appointment booking, agricultural advisory service, city complaint system) that work through your platform
3. A data exchange mechanism between services
4. A dashboard showing system health, user traffic, and service performance
5. Implementation of at least one scalability feature (load balancing, caching, etc.)

## Expected Outcomes

- A functional backend system with APIs/services
- Frontend interfaces for different user types (citizen, government admin, service provider)
- Demonstration of how new services can be added to the platform
- Evidence of system handling concurrent users/simulated load
- Clear documentation of your architecture and APIs

## Judging Criteria

| Criterion | Description |
|---|---|
| **Technical Implementation:** | • Working, runnable code with clear setup instructions<br>• Code quality, architecture, and use of appropriate technologies<br>• Handling of scalability, security, and reliability concerns |
| **System Design:** | • Modularity and extensibility of your architecture<br>• Data flow and API design between components<br>• Error handling and fault tolerance mechanisms |
| **Impact & Practicality:** | • Relevance to healthcare, agriculture, and urban domains<br>• User experience and interface design<br>• Potential for real-world deployment |
| **AI-Driven Innovation (Bonus):** | • In recognition of the current AI-driven technological landscape, any technically sound implementation or feature leveraging Artificial Intelligence (AI), Machine Learning (ML), or data-driven intelligence to enhance system performance, automation, adaptability, or decision-making can be considered for additional bonus points, provided it is relevant, efficient, and well-justified. |

## Target Stakeholders / End Users

Government bodies, system administrators, policymakers, citizens, healthcare providers, agricultural communities, and urban residents.

## Suggested Solution Approaches

Participants may explore cloud-native architectures, microservices, API-driven systems, distributed databases, and platform engineering practices, with potential integration of IoT for agriculture, telemedicine platforms, and smart city sensors.

## Constraints & Considerations

Security, data protection, scalability, regional infrastructure limitations, and long-term sustainability must be addressed, with special attention to rural connectivity for agriculture, health data privacy, and urban digital divides.

# Problem Statement 2

## Problem Title

Privacy-Centric Digital Identity and Trust Management Platform

### Background & Context

Digital identity has become fundamental to accessing online services across critical sectors including healthcare, agriculture, and urban services, yet many identity systems are centralized, opaque, and vulnerable to misuse or breaches. Users often have little control over how their personal data is stored, shared, or monetized. As digital interactions increase across these sectors, the absence of privacy-preserving and user-controlled identity systems has become a critical concern for both individuals and organizations.

### Detailed Problem Description

This problem challenges participants to design a digital identity management platform that places privacy, transparency, and user control at its core, with applications in healthcare (patient identity), agriculture (farmer and land records), and smart cities (resident services). The system should enable secure authentication and authorization while allowing users to selectively share identity attributes based on context. The solution should explore mechanisms for trust establishment between entities without excessive reliance on centralized authorities. Emphasis should be placed on security architecture, governance models, and usability rather than merely implementing login functionality.

### Objectives

Develop a working identity platform that includes:

1. User registration and profile management with selective data sharing
2. Secure authentication system with multiple factors
3. Authorization mechanism that controls what data different services can access
4. Dashboard for users to see/control who accessed their data

5. At least 2-3 example applications (health portal, farm subsidy system, city service portal) being build up.

## Expected Outcomes

- Complete identity management system with frontend and backend
- Implementation of privacy controls (data minimization, consent management)
- Demonstration of secure data exchange between identity provider and services
- Working examples showing different access scenarios
- Security testing results/validation of your implementation

## Judging Criteria

| Criterion | Description |
|---|---|
| **Security Implementation:** | • Quality of cryptographic implementations and security practices<br>• Protection against common vulnerabilities (OWASP Top 10)<br>• Privacy preservation in data handling |
| **System Architecture:** | • Design of identity and access management components<br>• Scalability of the authentication/authorization system<br>• Integration capabilities with external services |
| **User Experience:** | • Ease of use for end-users<br>• Clarity of privacy controls and consent mechanisms<br>• Quality of documentation and developer experience |
| **AI-Driven Innovation (Bonus):** | • In recognition of the current AI-driven technological landscape, any technically sound implementation or feature leveraging Artificial Intelligence (AI), Machine Learning (ML), or data-driven intelligence to enhance system performance, automation, adaptability, or decision-making can be considered for additional bonus points, provided it is relevant, efficient, and well-justified. |

## Target Stakeholders / End Users

Citizens, enterprises, service providers, and regulatory authorities, including patients and healthcare providers, farmers and agricultural agencies, urban residents and municipal authorities.

## Suggested Solution Approaches

Cryptographic protocols, decentralized systems, secure access management, consent-based data sharing, with consideration for health information exchange standards, agricultural registry systems, and urban resident databases.

## Constraints & Considerations

Regulatory compliance (including health data regulations), interoperability, user experience, and scalability across diverse contexts including rural agricultural settings and complex urban environments.

# Problem Statement 3

## Problem Title

Holistic Academic and Professional Skill Intelligence System for Emerging Sectors

### Background & Context

Students and early-career professionals navigate complex academic pathways while attempting to align their skills with evolving industry expectations in critical sectors like healthcare technology, agricultural sciences, and urban/smart city planning. Current tools focus on isolated aspects such as grades, certifications, or resumes, failing to provide a unified understanding of an individual's learning journey and skill readiness for these priority domains.

### Detailed Problem Description

Design a digital platform that continuously captures, organizes, and analyzes academic performance, project experience, practical skills, and learning activities with special emphasis on healthcare informatics, agricultural technology, and urban/smart city systems. The system should generate meaningful insights that help users understand their progression, identify gaps, and plan future learning paths specifically for careers in these critical sectors. Rather than acting as a static profile, the platform should function as a living system that evolves with the user and supports long-term academic and professional growth.

### Objectives

Build a working platform that includes:

1. User profile system for entering skills, courses, projects, and achievements
2. Skill assessment and gap analysis algorithms
3. Recommendation engine for courses/projects based on career goals
4. Dashboard visualizing skill progression and career pathways

5. Integration with at least one external API (LinkedIn, course platforms, etc.)
6. Focus on healthcare, agriculture, and urban sector skill frameworks

## Expected Outcomes

- Functional web/mobile application with user accounts
- Working algorithms for skill analysis and recommendations
- Data visualization of career pathways and skill gaps
- Demonstration with sample users and career scenarios
- API documentation for potential integrations with learning platforms

## Judging Criteria

| Criterion | Description |
|---|---|
| **Technical Implementation:** | • Quality of data models and algorithms for skill analysis<br>• Working recommendation system with relevant suggestions<br>• Code organization and technical architecture |
| **User Experience:** | • Intuitive interface for users to manage their learning journey<br>• Clear visualizations of skill progression and gaps<br>• Practical value for students and early-career professionals |
| **Innovation:** | • Novelty in skill assessment or recommendation approaches<br>• Integration of healthcare/agriculture/urban domain knowledge<br>• Potential for scaling to different educational contexts |
| **AI-Driven Innovation (Bonus):** | • In recognition of the current AI-driven technological landscape, any technically sound implementation or feature leveraging Artificial Intelligence (AI), Machine Learning (ML), or data-driven intelligence to enhance system performance, automation, adaptability, or decision-making can be considered for additional bonus points, provided it is relevant, efficient, and well-justified. |

## Target Stakeholders / End Users

Students, educators, training institutions, employers in healthcare, agricultural technology, and urban development sectors.

## Suggested Solution Approaches

Data modeling, analytics platforms, dashboards, recommendation engines, integration with existing academic systems, with domain-specific modules for health, agriculture, and urban skills.

## Constraints & Considerations

Data accuracy, privacy, inclusivity, and adaptability across disciplines, with special consideration for interdisciplinary training needs in health-agri-urban nexus.

# Problem Statement 4

## Problem Title

Cyber-Resilient Infrastructure for Critical Sectors: Healthcare, Agriculture and Urban Systems

### Background & Context

As digital systems in healthcare (medical devices, patient records), agriculture (precision farming, supply chain), and smart cities (utilities, transportation) grow in complexity and scale, cyber threats have become more frequent, sophisticated, and damaging. Many organizations rely on reactive security measures that identify breaches only after significant harm has occurred. There is a growing need for proactive, resilient security infrastructures that can detect anomalies, respond to threats, and maintain system continuity in these critical sectors.

### Detailed Problem Description

Participants are tasked with designing a cyber-resilient infrastructure capable of monitoring system behavior, identifying potential threats, and supporting timely response mechanisms for healthcare networks, agricultural systems, and urban infrastructure. The focus should be on system-level security design, observability, and resilience rather than isolated tools. The solution should demonstrate how security can be embedded into system architecture as a continuous and adaptive process, with special consideration for the unique requirements of medical data protection, agricultural operational technology, and urban critical infrastructure.

### Objectives

Create a security monitoring and response system that includes:

1. Real-time monitoring of simulated systems (mock healthcare, agriculture, or urban systems)

2. Anomaly detection algorithms for identifying suspicious activities

3. Alerting and notification system
4. Automated or semi-automated response mechanisms
5. Dashboard showing security status, threats detected, and system health
6. Demonstration with simulated attack scenarios

## Expected Outcomes

- Working security monitoring system with data collection agents
- Implementation of anomaly detection algorithms
- Alerting system with different severity levels
- Response automation (blocking, isolation, notification)
- Clear evidence of detecting and responding to simulated threats
- Performance metrics of your monitoring system

## Judging Criteria

| Criterion | Description |
|---|---|
| **Security Effectiveness:** | • Accuracy of threat detection (minimizing false positives/negatives)<br>• Speed of detection and response<br>• Quality of automated response mechanisms<br>• Quality of your algorithm and efficiency of the same. |
| **System Architecture:** | • Scalability of monitoring infrastructure<br>• Integration capabilities with different systems<br>• Reliability and fault tolerance of security components |
| **Domain Relevance:** | • Adaptability to healthcare, agriculture, and urban contexts<br>• Handling of sector-specific security concerns<br>• Practicality for real-world deployment |
| **AI-Driven Innovation (Bonus):** | • In recognition of the current AI-driven technological landscape, any technically sound implementation or feature leveraging Artificial Intelligence (AI), Machine Learning (ML), or data-driven intelligence to enhance system performance, automation, adaptability, or decision-making can be considered for additional bonus points, provided it is relevant, efficient, and well-justified. |

## Target Stakeholders / End Users

Enterprises, infrastructure providers, security teams in healthcare institutions, agricultural organizations, and urban municipal bodies.

## Suggested Solution Approaches

Monitoring systems, anomaly detection, secure architectures, automated response workflows tailored for health IT systems, agricultural IoT networks, and urban SCADA systems.

## Constraints & Considerations

False positives, performance overhead, scalability, operational complexity, and sector-specific regulations for health data, agricultural operations, and urban infrastructure.

# Problem Statement 5

## Problem Title

Data-Driven Urban Systems for Sustainable, Healthy and Agriculturally-Supported Smart Cities

### Background & Context

Urban environments generate vast amounts of data from transportation, energy, waste management, and public services, while also depending on agricultural supply chains and healthcare systems for sustainability and resident well-being. However, much of this data remains underutilized and disconnected, limiting its potential to inform planning, sustainability efforts, and quality-of-life improvements that integrate urban, health, and agricultural considerations.

### Detailed Problem Description

Design a digital platform that integrates diverse urban data sources with agricultural supply data and public health indicators to support analysis, visualization, and decision-making for holistic city management. The system should help stakeholders understand patterns, anticipate challenges, and evaluate the impact of interventions across urban development, health outcomes, and food system sustainability. The emphasis should be on building a flexible, scalable data platform that supports long-term urban intelligence while considering health-agriculture-urban nexus.

### Objectives

Develop a data integration and visualization platform that includes:

1. Data ingestion from multiple simulated sources (traffic, weather, health, agriculture)
2. Data processing and storage pipeline
3. Dashboard with key metrics and visualizations
4. Predictive analytics or simulation capabilities

5. Tools for scenario planning (what-if analysis)
6. APIs for data access and integration
7. Can also implement machine learning if intended for any application upon this.

## Expected Outcomes

- Working data pipeline from ingestion to visualization
- Interactive dashboard with multiple data views
- Implementation of analytics/algorithms for insights
- Demonstration with sample/simulated data sets
- Evidence of handling real-time or near-real-time data
- Documentation of data models and API endpoints
- Working and efficiency of the algorithm implemented

## Judging Criteria

| Criterion | Description |
|---|---|
| **Data Integration:** | • Quality of data pipeline design and implementation<br>• Handling of diverse data types and formats<br>• Scalability and performance of data processing |
| **Analytics & Insights:** | • Usefulness of analytics and visualizations<br>• Innovation in data analysis approaches<br>• Quality of predictive models or simulations<br>• Quality and efficiency of algorithm implemented |
| **System Design:** | • Architecture for data processing and storage<br>• API design and integration capabilities<br>• User interface and experience of dashboard |
| **AI-Driven Innovation (Bonus):** | • In recognition of the current AI-driven technological landscape, any technically sound implementation or feature leveraging Artificial Intelligence (AI), Machine Learning (ML), or data-driven intelligence to enhance system performance, automation, adaptability, or decision-making can be considered for additional bonus points, provided it is relevant, efficient, and well-justified. |

## Target Stakeholders / End Users

Urban planners, municipal authorities, researchers, citizens, public health officials, agricultural suppliers, and community organizations.

## Suggested Solution Approaches

Data pipelines, analytics systems, visualization tools, cloud-based platforms with integration of health data streams, agricultural market data, and urban IoT networks.

## Constraints & Considerations

Data integration challenges, governance, scalability, ethical use, and balancing urban development needs with health priorities and agricultural sustainability.