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Data Science for Managerial Decisions (MB 511)

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Data Science for Managerial Decisions (MB 511)



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References/Literature

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- Cathy O’Neil and Rachel Schutt , “Doing Data Science”, O’Reilly, 2015.
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- Raj, Pethuru, “Handbook of Research on Cloud Infrastructures for Big Data Analytics”, IGI Global
- Management Information System, W.S Jawadekar, Tata Mc Graw Hill Publication.
- Management Information System, David Kroenke, Tata Mc Graw Hill Publication.
- MIS Management Perspective, D.P. Goyal, Macmillan Business Books.

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Online Resources



Software Resources



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Program Overview

- Introduction to Data Science
- Information Technology An Overview
- Applications of Data Science in various fields
- MIS and Control Systems
- Data Collection and Data Pre-Processing
- Building Information Systems
- Support Systems for Management Decisions



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Data Collection and Data Pre-Processing

- Introduction to Information Systems in Management
- Planning and Designing Information Systems
- Implementation and Integration of Information Systems
- Managing and Evaluating Information Systems



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Building Information Systems

Introduction to Information Systems in Management

Information systems (IS) play a pivotal role in modern organizations, providing essential tools and technologies to support managerial decision-making, streamline business processes, and facilitate communication and collaboration. Understanding the fundamentals of information systems is crucial for managers and decision makers to harness the power of technology effectively in achieving organizational goals and objectives.

Definition of Information Systems: An information system is a set of interconnected components that collect, process, store, and disseminate data and information within an organization. It encompasses hardware, software, networks, data, and people to support various organizational functions and activities.



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Introduction to Information Systems in Management



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Functions of Information Systems: Information systems in management serve several functions, including data collection and storage, data processing and analysis, decision support, communication and collaboration, and automation of routine tasks. These functions help organizations improve efficiency, productivity, and decision-making effectiveness.

Types of Information Systems: Information systems can be classified into different types based on their functionality and scope. Common types include transaction processing systems (TPS), management information systems (MIS), decision support systems (DSS), executive information systems (EIS), and enterprise resource planning (ERP) systems. Each type serves specific purposes and caters to different managerial needs.

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Introduction to Information Systems in Management



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Role of Information Systems in Management: Information systems play a crucial role in supporting managerial functions such as **planning, organizing, leading, and controlling**. They provide managers with timely and accurate information for **strategic planning, operational control, performance monitoring, and decision making** at various levels of the organization.

Challenges and Opportunities: While information systems offer numerous benefits, they also present challenges such as **data security and privacy concerns, technology obsolescence, and integration issues**. However, organizations can capitalize on the opportunities presented by information systems, including **improved competitiveness, innovation, and agility** in responding to market dynamics.

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Introduction to Information Systems in Management



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Strategic Importance: Information systems have become strategic assets for **organizations, driving innovation, competitive advantage, and business transformation**. Managers need to recognize the strategic importance of information systems and align their IT investments with organizational goals and objectives to achieve sustainable success.

Understanding the role and functions of information systems in management is essential for managers to leverage technology effectively in achieving organizational objectives. By harnessing the power of information systems, organizations can enhance their decision-making capabilities, streamline operations, and gain a competitive edge in today's digital economy.

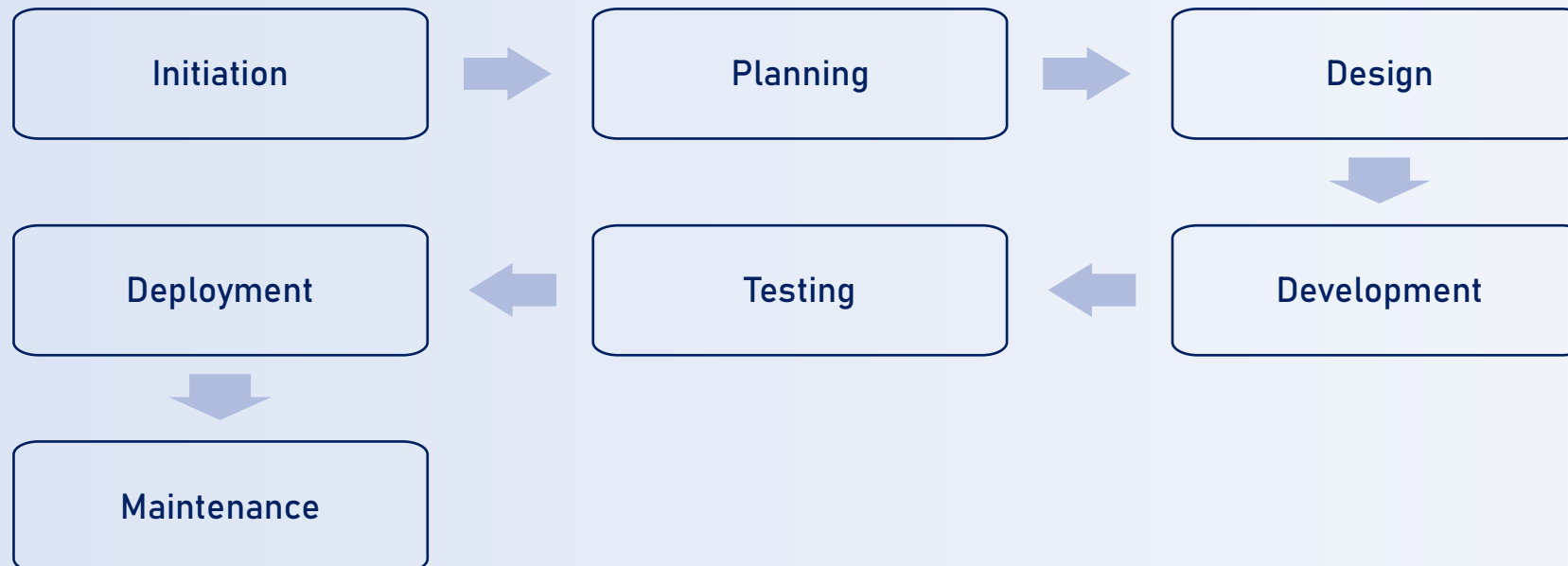
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Planning and Designing Information Systems - SDLC



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The System Development Life Cycle (SDLC) is a structured approach used by organizations to **design, develop, implement, and maintain** information systems and software applications. It consists of a series of **phases or stages** that guide the development process from inception to deployment and beyond.



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Planning and Designing Information Systems - SDLC



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- **Initiation:** The project is initiated, and the need for a new system or software application is identified. Stakeholders define the project scope, objectives, and requirements.
- **Planning:** A detailed project plan is developed, outlining the resources, timeline, budget, and deliverables. Risk assessment and mitigation strategies are also addressed in this phase.
- **Analysis:** Requirements gathering and analysis are conducted to understand the needs of end-users and stakeholders. Functional and non-functional requirements are documented to guide the design and development process.
- **Design:** Based on the requirements gathered, system architects and designers create a blueprint for the system's architecture, database structure, user interface, and functionality. This phase may include prototyping and user feedback sessions.
- References:
 - <https://theproductmanager.com/topics/software-development-life-cycle/>
 - <https://www.coursera.org/articles/software-development-life-cycle>

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Planning and Designing Information Systems - SDLC



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- **Development:** The actual coding and programming of the system or software application take place in this phase. Developers follow the design specifications to build the system's components and functionalities.
- **Testing:** Comprehensive testing is conducted to identify and fix defects, bugs, and errors in the system. Different types of testing, such as unit testing, integration testing, and user acceptance testing, are performed to ensure the system meets the requirements and functions correctly.
- **Deployment:** Once the system has been thoroughly tested and approved, it is deployed into the production environment. This may involve installing the software, configuring hardware, training end-users, and transitioning from old systems to the new one.
- **Maintenance:** After deployment, the system enters the maintenance phase, where it is monitored, updated, and enhanced to address issues, accommodate changes, and meet evolving user needs. Regular maintenance ensures the system remains effective and reliable over time.

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SDLC Models

SDLC (System Development Life Cycle) models are frameworks used by organizations to guide the development and management of software and information systems. These models define the stages and activities involved in the software development process.

- **Waterfall Model:** The Waterfall model follows a linear sequential approach, where each phase (requirements, design, implementation, testing, deployment, maintenance) is completed before moving to the next. It is simple and easy to understand but lacks flexibility for changes once the project is underway.
- **Iterative Model:** The Iterative model involves repeating the development process in cycles or iterations. Each iteration includes phases such as planning, requirements, design, implementation, testing, and deployment. It allows for incremental development and refinement of the software based on feedback.



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SDLC Models

- **Agile Model:** Agile is an iterative and incremental approach to software development that emphasizes flexibility, collaboration, and customer feedback. Agile teams work in short iterations called sprints, delivering working software incrementally and adapting to changing requirements throughout the project.
- **Scrum:** Scrum is a specific Agile framework that organizes development work into small, self-organized teams called Scrum teams. These teams work in short iterations called sprints, typically lasting 1-4 weeks, and follow a set of ceremonies (such as daily stand-ups, sprint planning, sprint review, and retrospective) to manage the development process.
- **Kanban:** Kanban is another Agile framework that visualizes the workflow and limits work in progress (WIP) to improve productivity and efficiency. Work items are represented on a Kanban board, with columns representing different stages of the development process. Teams pull work items from one stage to the next as capacity allows.



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SDLC Models

- **Spiral Model:** The Spiral model combines elements of both the waterfall and iterative models by incorporating risk analysis and prototyping. It involves multiple cycles of planning, risk analysis, engineering, and evaluation, with each cycle refining the product based on feedback and addressing identified risks.
- **V-Model:** The V-Model is a variation of the waterfall model that emphasizes the verification and validation of each stage of development. It aligns testing activities with corresponding development stages, with each stage's deliverables directly related to its corresponding testing activities.

These SDLC models offer different approaches to software development, each with its own strengths and weaknesses. Organizations choose the most appropriate model based on project requirements, timelines, budget, team expertise, and stakeholder preferences.



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Tools and Methodologies for System Design

System design involves creating a detailed blueprint for the **architecture, components, and functionality** of a software system or application. Various tools and methodologies are used in system design to facilitate the process and ensure the successful development of robust and scalable systems.

- **Unified Modeling Language (UML):** UML is a standardized modeling language used to visualize, specify, construct, and document the artifacts of a software system. It includes various diagrams such as use case diagrams, class diagrams, sequence diagrams, and activity diagrams, which help in representing different aspects of the system's structure and behavior.
- **Entity-Relationship Diagrams (ERDs):** ERDs are used to visualize and design the data model of a system by representing entities, their attributes, and the relationships between them. ERDs are particularly useful for database design and ensuring data integrity and consistency.



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Tools and Methodologies for System Design

- **Data Flow Diagrams (DFDs):** DFDs depict the flow of data within a system, showing how information moves between processes, data stores, and external entities. DFDs help in understanding the functional requirements of a system and identifying potential bottlenecks or inefficiencies.
- **Structured Systems Analysis and Design Method (SSADM):** SSADM is a traditional methodology for system analysis and design that divides the development process into stages, including feasibility study, requirements analysis, system design, implementation, and maintenance. It emphasizes a structured and rigorous approach to system development.
- **Rapid Application Development (RAD):** RAD is an iterative and incremental approach to system design that focuses on rapid prototyping and quick feedback from users. RAD emphasizes collaboration between developers and stakeholders, allowing for faster development and delivery of software systems.



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Tools and Methodologies for System Design

- **Design Patterns:** Design patterns are reusable solutions to common design problems in software development. By applying design patterns, developers can leverage proven solutions to design issues and improve the quality, scalability, and maintainability of their systems.
- **CASE Tools (Computer-Aided Software Engineering):** CASE tools provide software developers with automated support for various tasks in the system design process, such as modeling, code generation, and documentation. Examples of CASE tools include UML modeling tools, requirements management tools, and version control systems.

By utilizing these tools and methodologies, software developers can effectively design, develop, and maintain complex software systems that meet the requirements and expectations of stakeholders while adhering to best practices in system design and development.



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Implementation and Integration of Information Systems – Challenges

Implementing an information system can be a complex process, fraught with challenges but also opportunities for optimization and improvement. By addressing these challenges proactively and implementing best practices, organizations can increase the likelihood of successful information system implementation and achieve their desired outcomes.

- **Requirements Gathering:** Understanding and defining user requirements accurately can be challenging. Users might not always know what they need or may have difficulty articulating it.
- **Scope Creep:** As the project progresses, there might be a tendency for the scope to expand beyond the initial plan, leading to delays and budget overruns.
- **Resource Constraints:** Limited budget, time, and skilled personnel can pose significant challenges during implementation.



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Implementation and Integration of Information Systems – Challenges

- **Change Management:** Resistance to change among users or stakeholders can hinder adoption and success.
- **Integration Issues:** Integrating the new system with existing systems and processes can be complex, especially if there are compatibility issues or data migration challenges.
- **Data Security:** Ensuring the security of sensitive data is crucial but can be challenging, especially with the increasing sophistication of cyber threats.
- **Performance Optimization:** Optimizing system performance to meet user expectations, especially as the system scales or as workload patterns change, can be a continuous challenge.



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Implementation and Integration of Information Systems – Best Practices

- **Thorough Planning:** Invest time and effort in comprehensive planning, including defining clear objectives, scope, deliverables, timelines, and budget.
- **Stakeholder Involvement:** Engage stakeholders early and frequently throughout the process to ensure alignment of expectations and requirements.
- **Agile Methodology:** Adopting an agile approach allows for flexibility and iterative development, enabling faster adaptation to changing requirements and reducing the risk of scope creep.
- **Change Management:** Develop a robust change management strategy to address resistance and foster a culture of acceptance and adoption.
- **Data Management:** Prioritize data integrity, security, and quality throughout the implementation process, including data migration, integration, and ongoing maintenance.



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Implementation and Integration of Information Systems – Best Practices

- **Testing and Quality Assurance:** Implement thorough testing procedures to identify and address issues early in the development lifecycle, ensuring a stable and reliable system.
- **Training and Support:** Provide comprehensive training and ongoing support to users to facilitate adoption and maximize the benefits of the new system.
- **Documentation:** Maintain detailed documentation of the system architecture, processes, and configurations to facilitate troubleshooting, maintenance, and future upgrades.
- **Continuous Improvement:** Establish mechanisms for gathering feedback, monitoring performance, and implementing continuous improvements to the system and processes.



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Managing and Evaluating Information Systems

Importance of ongoing management and maintenance of information systems

- **Optimal Performance:** Regular maintenance ensures that the system continues to perform optimally.
This includes monitoring system health, identifying and addressing performance bottlenecks, and optimizing configurations to meet evolving needs.
- **Security:** Cyber threats are constantly evolving, making ongoing security management essential.
Regular updates, patches, and security audits help protect against vulnerabilities and ensure the confidentiality, integrity, and availability of data.
- **Data Integrity:** Information systems store and process vast amounts of data critical to business operations. Ongoing management ensures data integrity by implementing data backup and recovery processes, data validation checks, and data quality assurance measures.



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Building Information Systems

Managing and Evaluating Information Systems

Importance of ongoing management and maintenance of information systems

- **Compliance:** Regulatory requirements and industry standards often evolve over time. Ongoing management ensures that information systems remain compliant with relevant regulations and standards, reducing the risk of penalties and legal issues.
- **Scalability:** As business needs change and grow, information systems must be able to scale accordingly. Ongoing management involves assessing scalability requirements, implementing necessary upgrades or expansions, and optimizing system architecture to accommodate growth.
- **User Support and Training:** Providing ongoing user support and training is essential for ensuring that employees can effectively use the system to perform their tasks. This includes addressing user queries, providing training on new features or updates, and offering troubleshooting assistance.



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Building Information Systems

Monitoring and Evaluating the performance of Information Systems

Monitoring and evaluating the performance of information systems is crucial for ensuring that they meet organizational objectives, perform optimally, and deliver value.

- **System Health Monitoring:** Monitor key performance indicators (KPIs) such as response time, uptime, and system availability using monitoring tools or software. Alerts can be set up to notify administrators of any anomalies or issues.
- **Usage Metrics:** Track usage metrics such as user logins, transactions processed, and system throughput to understand how the system is being utilized and identify areas for improvement.
- **Resource Utilization:** Monitor resource utilization metrics such as CPU, memory, disk space, and network bandwidth to ensure that the system has sufficient resources to handle current and future demands.



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Building Information Systems

Monitoring and Evaluating the performance of Information Systems

Monitoring and evaluating the performance of information systems is crucial for ensuring that they meet organizational objectives, perform optimally, and deliver value.

- **Security Monitoring:** Implement security monitoring tools to detect and respond to security threats such as unauthorized access attempts, malware infections, and data breaches.
- **Feedback Mechanisms:** Establish feedback mechanisms such as surveys, user feedback forms, or support tickets to gather feedback from users about their experience with the system.



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Building Information Systems

Monitoring and Evaluating the performance of Information Systems



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Evaluation

- **Define Evaluation Criteria:** Establish clear criteria for evaluating the performance of the information system, aligned with organizational goals and objectives. This may include factors such as efficiency, effectiveness, reliability, scalability, and security.
- **Data Analysis:** Analyze the data collected through monitoring activities to identify trends, patterns, and areas of concern. Compare performance metrics against predefined benchmarks or targets to assess performance against expectations.
- **User Feedback Analysis:** Analyze user feedback to identify common issues, pain points, and areas for improvement. Prioritize feedback based on its impact on user satisfaction and business objectives.
- **Root Cause Analysis:** Investigate the root causes of any performance issues or discrepancies identified during monitoring activities. This may involve conducting detailed diagnostics, troubleshooting, and system audits to identify underlying problems.

Building Information Systems

Monitoring and Evaluating the performance of Information Systems



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Evaluation

- **Benchmarking:** Compare the performance of the information system against industry standards, best practices, or competitor benchmarks to identify areas where the system can be improved or optimized.
- **Recommendations for Improvement:** Based on the findings of the evaluation, develop recommendations for improving the performance of the information system. These recommendations may include infrastructure upgrades, software updates, process improvements, or user training initiatives.
- **Continuous Improvement:** Implement the recommended improvements and monitor their impact on system performance over time. Continuously iterate on the evaluation process to identify new areas for improvement and ensure that the information system remains aligned with organizational goals and objectives.

Building Information Systems

Addressing security and privacy concerns in information systems

Security Measures

- **Risk Assessment:** Conduct regular risk assessments to identify potential security threats, vulnerabilities, and risks to the information system. This involves evaluating factors such as system architecture, data sensitivity, access controls, and external threats.
- **Access Control:** Implement robust access control mechanisms to ensure that only authorized users have access to sensitive data and system resources. This includes user authentication, role-based access control (RBAC), and least privilege principles.
- **Encryption:** Encrypt sensitive data both in transit and at rest to protect it from unauthorized access or interception. Use strong encryption algorithms and secure key management practices to ensure the confidentiality and integrity of data.



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Building Information Systems

Addressing security and privacy concerns in information systems

Security Measures

- **Security Patching and Updates:** Regularly apply security patches and updates to operating systems, software, and firmware to address known vulnerabilities and mitigate the risk of exploitation by attackers.
- **Network Security:** Implement firewalls, intrusion detection and prevention systems (IDPS), and network segmentation to protect the information system from unauthorized access, malware, and other network-based attacks.
- **Security Training and Awareness:** Provide security training and awareness programs to educate users and employees about common security threats, best practices for safeguarding sensitive information, and how to recognize and respond to security incidents.
- **Incident Response Plan:** Develop and maintain an incident response plan outlining procedures for detecting, responding to, and recovering from security incidents. This includes incident triage, containment, eradication, and recovery steps.



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Building Information Systems

Addressing security and privacy concerns in information systems

Privacy Measures

- **Data Minimization:** Collect and retain only the minimum amount of personal data necessary to fulfill the intended purpose. Avoid unnecessary data collection and implement data anonymization or pseudonymization techniques where possible.
- **Privacy by Design:** Incorporate privacy considerations into the design and development of information systems from the outset. This involves implementing privacy-enhancing technologies, such as data encryption, access controls, and anonymization features, into the system architecture.
- **Transparency and Consent:** Clearly communicate to users how their personal data will be collected, used, and shared, and obtain explicit consent before collecting any personal information. Provide users with options to control their privacy settings and preferences.



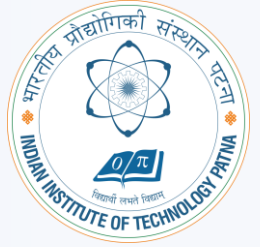
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Building Information Systems

Addressing security and privacy concerns in information systems

Privacy Measures

- **Data Access Controls:** Implement controls to restrict access to personal data to only those users who have a legitimate need to access it for authorized purposes. Monitor and audit data access to detect and prevent unauthorized or inappropriate use of personal information.
- **Data Breach Notification:** Develop procedures for promptly notifying affected individuals and regulatory authorities in the event of a data breach involving personal information. Comply with legal requirements for data breach notification and take appropriate steps to mitigate the impact of the breach.
- **Privacy Impact Assessments:** Conduct privacy impact assessments (PIAs) to evaluate the potential privacy risks and implications of new information systems or changes to existing systems. Use the findings of the PIA to implement mitigating controls and address privacy concerns.



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Addressing security and privacy concerns in information systems

Privacy Measures

- **Compliance with Privacy Regulations:** Stay informed about relevant privacy regulations and compliance requirements, such as the General Data Protection Regulation (GDPR), California Consumer Privacy Act (CCPA), and Health Insurance Portability and Accountability Act (HIPAA). Ensure that information systems adhere to applicable privacy laws and regulations.

By implementing security and privacy measures, organizations can mitigate risks, protect sensitive information, and demonstrate their commitment to maintaining the security and privacy of their information systems.



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Data Science Use Cases

Supervised ML:

- <https://www.kaggle.com/code/mariamezzathamam/obesity-or-cvd-risk>
- <https://www.kaggle.com/code/tohidyousefi/classification-and-regression-tree-mla-cart>
- <https://www.kaggle.com/code/motsimaslam/titanic-basic-random-forest-technique>
- <https://www.kaggle.com/code/fahadmehfooz/credit-analysis-with-knn-dtree-rf-bagging-ann>
- <https://www.kaggle.com/code/kaushikholla/eda-feature-engineering-and-machine-learning>
- <https://www.kaggle.com/code/kritidoneria/responsible-ai-model-explainability>
- <https://www.kaggle.com/code/wstofu/logistic-regression-model-prediction>
- <https://www.kaggle.com/code/rosaaestrada/natural-disasters-as-predictor-for-loan-default>



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Data Science Use Cases

Unsupervised ML:

- <https://www.kaggle.com/code/victorambonati/unsupervised-anomaly-detection>
- <https://www.kaggle.com/code/fazilbtopal/popular-unsupervised-clustering-algorithms>
- <https://www.kaggle.com/code/kashnitsky/topic-7-unsupervised-learning-pca-and-clustering>
- <https://www.kaggle.com/code/rgaddati/unsupervised-fraud-detection-isolation-forest>
- <https://www.kaggle.com/code/fatmakursun/supervised-unsupervised-learning-examples>
- <https://www.kaggle.com/code/efeergun96/unsupervised-learning-on-iris>
- <https://www.kaggle.com/code/frankmollard/a-story-about-unsupervised-learning>



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Data Science Use Cases

Artificial Neural Network:

- <https://www.kaggle.com/code/kanncaa1/deep-learning-tutorial-for-beginners>
- <https://www.kaggle.com/code/kanncaa1/pytorch-tutorial-for-deep-learning-lovers>
- <https://www.kaggle.com/code/tanulsingh077/deep-learning-for-nlp-zero-to-transformers-bert>
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- <https://www.kaggle.com/code/toregil/welcome-to-deep-learning-cnn-99>



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Quiz and Assignment 4

- Quiz 4 : April 20, 2024
- Assignment 3 : April 30, 2024



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Have a question?

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