AGILE METHODOLOGIES

ENCT 465

Lecture : 3 **Year : IV**
Tutorial : 2 **Part : II**
Practical : 1

Course Objectives:
The objective of this course is to provide students with a comprehensive understanding of the agile mindset, values, and principles, and to equip them with the practical skills required to manage product development using frameworks like Scrum, Lean, and Extreme Programming (XP).

1 Introduction to Agile project management (6 hours)

1.1 Project Management Makeover: Origins and the problem with the status quo
1.2 Introducing Agile Project Management: History and timeline
1.3 How Agile Projects Work: Empirical control, iterations (sprints), and transparency
1.4 Transitioning from Project Management to Product Management
1.5 Benefits of Agility: Improved quality, speed, and return on investment (ROI)

2 Agile manifesto and principles (6 hours)

2.1 Understanding the Agile Manifesto: History and the four core values
2.2 The 12 Agile Principles: Customer satisfaction, quality, teamwork, and development
2.3 Changes as a Result of Agile Values: Shifts in attitudes toward workers and change
2.4 The Agile Litmus Test: Evaluating process and behavior
2.5 Platinum Principles: Resisting formality, acting as a team, and visualization

3 Agile Approaches (8 hours)

3.1 The Umbrella of Agile Approaches: Broad overview
3.2 Lean Product Development: Principles (eliminate waste, amplify learning, fast delivery)
3.3 Kanban: Managing flow and limiting work in progress (WIP)
3.4 Scrum Framework: Roles (Scrum Master, Product Owner, Dev Team), artifacts, and events
3.5 Extreme Programming (XP): Engineering practices (TDD, refactoring, pair programming)

4 Agile Roles, Behaviors, and Team Dynamics (8 hours)

4.1 Establishing Agile Roles: Responsibilities of Product Owner, Team Member, and Scrum Master
4.2 Stakeholders and Agile Mentors: Their role in the product team
4.3 Key Agile Behaviors: Commitment, focus, openness, respect, and courage
4.4 Team Philosophy: Dedicated teams, cross-functionality, and self-organization
4.5 Team Development Phases: Forming, Storming, Norming, Performing, and Adjourning

5 Agile Planning: Vision to Release (8 hours)

5.1 Roadmap to Value: The seven stages of planning and execution
5.2 Defining the Product Vision: Developing objectives and vision statements
5.3 The Product Roadmap: Arranging features, themes, and timeframes
5.4 User Stories: Definition, creation (Three C's), and acceptance criteria
5.5 Effort Estimation: Relative estimation, planning poker, and affinity estimating
5.6 Release Planning: Goals, minimum marketable features, and deployment prep

6 Sprint Execution and Quality Management (9 hours)

6.1 Sprint Planning: Backlog creation, task identification, and timeboxing
6.2 Daily Scrum: Planning the day and identifying roadblocks
6.3 Tracking Progress: Task boards, burndown charts, and information radiators
6.4 Creating Shippable Functionality: Elaborating, developing, and verifying
6.5 Showcasing and Adapting: Sprint Review and Sprint Retrospective
6.6 Agile Quality and Risk: Automated testing, definition of done and failing fast

Tutorial (30 hours)

1. Introduction to Agile Project Management: Examine the origins of modern project management, the limitations of the traditional Waterfall model, and the empirical process control model built on transparency, inspection, and adaptation.
2. The Agile Manifesto and Principles: Conduct a deep dive into the four core values and principles of the 2001 Agile Manifesto while applying the Agile Litmus Test to evaluate process health.
3. Agile Approaches: Master the core practices of Lean, Kanban, Scrum, and Extreme Programming (XP) to manage workflow, roles, and software engineering excellence.
4. Agile Roles, Behaviors, and Team Dynamics: Define the responsibilities of Product Owners and Scrum Masters while building self-organizing, multi-skilled teams through Tuckman’s development phases.

5. Agile Planning (Vision to Release): Formulate strategic product visions and roadmaps, draft high-quality User Stories using the INVEST model, and estimate work for release planning.
6. Sprint Execution and Quality Management: Practice running sprint ceremonies, tracking progress with visual radiators, enforcing quality via the Definition of Done, and driving continuous improvement through reviews and retrospectives

Practical (15 hours)

1. The Agile Manifesto and Principles: Analyze the four core values and principles of the 2001 Agile Manifesto while applying Platinum Principles and the Agile Litmus Test to evaluate process health.
2. Agile Approaches: Implement Lean, Kanban, Scrum, and Extreme Programming (XP) practices to manage flow, define team roles, and ensure engineering excellence through continuous integration and TDD.
3. Agile Roles, Behaviors, and Team Dynamics: Practice establishing key roles such as Product Owner and Scrum Master while building self-organizing, multi-skilled teams through Tuckman's development stages.
4. Agile Planning (Vision to Release): Construct strategic product visions and roadmaps, draft User Stories using the INVEST criteria, and perform relative estimations using Planning Poker.
5. Sprint Execution and Quality Management: Execute sprint ceremonies including Daily Scrums, track progress using burndown charts and task boards, enforce quality via the Definition of Done, and gather feedback through reviews and retrospectives

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	6	8
2	6	8
3	8	10
4	8	10
5	8	10
6	9	14
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Beck, K., & Andres, C. (2004). Extreme programming explained: Embrace change (Lates ed.). Addison-Wesley Professional.
2. Cohn, M. (2004). User stories applied: For agile software development. Addison-Wesley Professional.

3. Cohn, M. (2005). Agile estimating and planning. Prentice Hall.
4. Poppendieck, M., & Poppendieck, T. (2003). Lean software development: An agile toolkit. Addison-Wesley Professional.
5. Rubin, K. S. (2012). Essential Scrum: A practical guide to the most popular Agile process. Addison-Wesley.
6. Sutherland, J., & Sutherland, J. J. (2014). Scrum: The art of doing twice the work in half the time. Crown Business.

MULTIMEDIA SYSTEM
ENCT 466

Lecture : 3 **Year: IV**
Tutorial : 2 **Part: II**
Practical : 1

Course Objectives:
The general objectives of this course are to provide theoretical as well as practical knowledge of Multimedia System, applications and tools to make students capable of implementing, managing and developing the issues of multimedia application in their personal as well professional life.

1. Introduction **(4 hours)**
- 1.1 Multimedia and its applications
- 1.2 Global structure of Multimedia
- 1.3 Medium
- 1.4 Multimedia system and properties
- 1.5 Characteristics of a Multimedia system
- 1.6 Challenges for Multimedia Systems
- 1.7 Components of Multimedia System
- 1.8 Multimedia building blocks
- 1.9 Scope of Multimedia

2. Sound/Audio System **(4 hours)**
- 2.1 Overview of sound system
- 2.2 Producing digital audio
- 2.3 Music and speech
- 2.4 Speech Generation
- 2.5 Speech Analysis
- 2.6 Speech Transmission
- 2.7 Representation of audio files
- 2.8 Computer Music –MIDI
- 2.9 MIDI versus Digital Audio

3. Images and Graphics **(4 hours)**
- 3.1 Uses of images and Graphics
- 3.2 Digital Image Representation
- 3.3 Image and graphics Format
- 3.4 Working with image and graphics
- 3.5 Image Synthesis, analysis and Transmission

4. Video and Animation **(6 hours)**
- 4.1 Digital Video
- 4.2 Video signal representation
- 4.3 Computer Video Format
- 4.4 Computer- Based animation
- 4.5 Animation Language
- 4.6 Timeline and frame based animation
- 4.7 Timeline and Tween-Based animation
- 4.8 Methods of controlling Animation

4.9 Display of Animation
4.10 Transmission of Animation

5. Data Compression (8 hours)

5.1 Need for Data Compression
5.2 Compression Basics
5.3 Storage Space
5.4 Coding Requirements
5.5 Lossless and Lossy Compression techniques
5.6 Source, Entropy and Hybrid Coding
5.7 Lossy Sequential DCT- based Mode
5.8 Expanded Lossy DCT-based Mode
5.9 JPEG and MPEG Compression

6. Abstractions for Programming (4 hours)

6.1 Abstractions Levels
6.2 Libraries
6.3 System Software
6.4 Toolkits
6.5 Higher Programming Languages
6.6 Object –oriented approaches

7. Multimedia Design (6 hours)

7.1 Development phases and development teams
7.2 Analysis phase
7.3 Design Phase
7.4 Development phase
7.5 Implementation Phase
7.6 Evaluation and testing phase
7.7 Multimedia User Interface Design

8. Multimedia Application (5 hours)

8.1 Media preparation and composition
8.2 Media integration and communication
8.3 Media Entertainment
8.4 Telemedicine
8.5 E-learning
8.6 Digital video editing and production systems
8.7 Video conferencing
8.8 Video-on-demand

9. Applications of AI in Multimedia (4 hours)

9.1 AI in audio and video generation
9.2 AI in images and graphics generation
9.3 AI in real time transcriptions, translation and captioning
9.4 Copyright issues and legal/ethical considerations
9.5 Case study using appropriate tool

Tutorial **(30 hours)**

1. Multimedia systems, components, and applications
2. Text, audio, image, video, and animation analysis
3. Sampling, quantization, and MIDI vs Digital Audio
4. Speech generation, analysis, and transmission
5. Raster vs Vector graphics and file formats
6. Resolution, RGB/CMYK, and optimization
7. Video formats, frame rate, and codecs
8. Timeline, tweening, and animation control
9. JPEG, MPEG, and lossless vs lossy compression
10. Design phases, AI tools, ethics, and copyright

Practical **(15 hours)**

1. Digital Audio Recording and Editing
2. Image editing and Optimization
3. Digital Video Editing
4. Basic Animation Development
5. Data Compression techniques
6. AI-Based Multimedia Mini Project

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks Distribution*
1	4	6
2	4	5
3	4	6
4	6	8
5	8	11
6	4	5
7	6	8
8	5	6
9	4	5
Total	**45**	**60**

*There may be minor deviation in marks distribution

References

1. Steinmetz, R., & Nahrstedt, K. (2012). *Multimedia: computing, communications and applications*. Pearson Education India.
2. Koegel Buford, J. F. (Ed.). (1994). *Multimedia systems*. ACM Press/Addison-Wesley Publishing Co..

ADVANCED ALGORITHMS

ENCT 467

Lecture : 3 **Year : IV**
Tutorial : 2 **Part : II**
Practical : 1

Course Objectives:

The primary objective of this course is to provide a comprehensive coverage of advanced algorithm concepts. The course encompasses advanced analysis techniques, advanced data structures, and a range of advanced algorithms together with their practical applications.

1 Advanced Analysis Techniques (5 hours)

1.1 Amortized analysis
1.2 Probabilistic analysis
1.3 Randomized algorithms
1.4 Smoothed analysis
1.5 Resource-aware analysis

2 Advanced Data Structures (7 hours)

2.1 Fibonacci heaps
2.2 Splay trees
2.3 Bloom filters
2.4 Segment trees
2.5 Disjoint set union

3 Advanced Graph Algorithms (8 hours)

3.1 Network flow problems
3.2 Maximum flow algorithms
3.3 Bipartite matching
3.4 Graph coloring
3.5 PageRank algorithm
3.6 Community detection algorithm

4 String and Pattern Matching Algorithms (5 hours)

4.1 String matching fundamentals
4.2 Knuth-Morris-Pratt algorithm
4.3 Rabin-Karp algorithm
4.4 Boyer-Moore algorithm
4.5 Suffix arrays and trees

5 Parallel and Distributed Algorithms (5 hours)

5.1 Introduction to parallel computing
5.2 Parallel divide-and-conquer
5.3 Map Reduce framework
5.4 Distributed graph processing

6 Approximation and Optimization Algorithms (5 hours)

6.1 Approximation algorithms
6.2 Vertex cover approximation
6.3 Set cover approximation
6.4 Linear programming concepts
6.5 Integer programming applications

7 Online and Streaming Algorithms (5 hours)

7.1 Online algorithms
7.2 Competitive analysis
7.3 Caching problems
7.4 Streaming algorithms
7.5 Sketching techniques

8 Algorithmic Applications and Emerging Topics (5 hours)

8.1 Algorithms for recommendation systems
8.2 Algorithms in search engines
8.3 Algorithms for large-scale data analytics
8.4 Green computing

Tutorial (30 hours)

1. Advanced Analysis Techniques
2. Advanced data structures
3. Advanced graph algorithms
4. String and pattern matching algorithms
5. Parallel and distributed algorithms
6. Approximation and optimization algorithms
7. Online and streaming algorithms
8. Algorithmic applications and emerging topics

Practical (15 hours)

1. Implementation and performance analysis of advanced data structures.
2. Implementation and performance analysis of advanced graph algorithms.
3. Implementation and performance analysis of string and pattern matching algorithms.
4. Implementation and performance analysis of parallel and distributed algorithms.

5. Implementation and performance analysis of approximation and optimization algorithms.

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	5	6
2	7	10
3	8	10
4	5	6
5	5	10
6	5	6
7	5	6
8	5	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2022). Introduction to algorithms (Latest ed.). MIT Press.
2. Gusfield, D. (1997). Algorithms on strings, trees, and sequences: Computer science and computational biology. Cambridge University Press.
3. Kleinberg, J., & Tardos, E. (2006). Algorithm design. Pearson Education.
4. Knuth, D. E. (1968–2022). The art of computer programming (Vols. 1–4B). Addison-Wesley.
5. Motwani, R., & Raghavan, P. (1995). Randomized algorithms. Cambridge University Press.
6. Vazirani, V. V. (2001). Approximation algorithms. Springer.

GEOGRAPHICAL INFORMATION SYSTEMS

ENCT 468

Lecture : 3 **Year : IV**
Tutorial : 2 **Part : II**
Practical : 1

Course Objectives:

The objective of this course is to provide fundamental concepts, principles and techniques of geographic information systems (GIS) and geospatial computing. The course also aims to equip students with the skills to design, build, analyze and deploy geospatial databases and location-aware applications using modern open-source tools, programming libraries and cloud platforms.

1 Introduction to Geographic Information Systems (4 hours)

1.1 GIS: definition, components (hardware, software, data, people and methods) and functions
1.2 GIS, GI Science and geospatial technologies; relationship with cartography, remote sensing, GNSS, CAD and DBMS
1.3 Historical development and evolution: desktop, enterprise, web, mobile and cloud GIS
1.4 Spatial and attribute (non-spatial) data; spatial queries versus conventional database queries
1.5 Applications of GIS: urban planning, disaster risk management, natural resources, transportation, utilities, public health, agriculture and location-based services

2 Geographic Phenomena and Spatial Data Models (5 hours)

2.1 Geographic phenomena: fields and objects, boundaries, scale and resolution
2.2 Attribute data and measurement scales: nominal, ordinal, interval and ratio
2.3 Raster data model: cells, resolution, encoding and compression (run-length, quadtree), multi-band rasters and pyramids
2.4 Vector data model: points, lines and polygons; Triangulated Irregular Network (TIN)
2.5 Topology and spatial relationships: topological rules, DE-9IM, OGC Simple Features geometry model
2.6 Raster versus vector comparison; temporal and spatio-temporal data representation

3 Spatial Referencing and Positioning (6 hours)

3.1 Shape of the earth: geoid, ellipsoid, horizontal and vertical datums (WGS 84, Everest 1830)
3.2 Coordinate systems: geographic, projected and local; coordinate reference systems
3.3 Map projections: classification and distortion properties; UTM, Lambert conformal conic and Web Mercator; Modified UTM (MUTM) system of Nepal
3.4 Coordinate transformations: datum transformation, affine and polynomial transformations; map scale
3.5 Satellite-based positioning: GNSS constellations (GPS, GLONASS, Galileo, BeiDou), working principle, sources of error and dilution of precision (DOP)

4 Spatial Data Acquisition and Data Quality (6 hours)

4.1 Data capture methods: primary (field survey, GNSS, remote sensing) and secondary (digitization, scanning, existing datasets)
4.2 Georeferencing, digitizing, vectorization and editing; topological cleaning
4.3 Remote sensing fundamentals: electromagnetic spectrum, sensors and platforms, spatial, spectral, radiometric and temporal resolution; overview of image classification
4.4 Modern data sources: UAV/drone photogrammetry, LiDAR, open satellite data (Landsat, Sentinel), OpenStreetMap and volunteered geographic information
4.5 Spatial data quality: positional, attribute and temporal accuracy, lineage, completeness and logical consistency
4.6 Metadata and standards (ISO); data conversion and integration

5 Spatial Databases and Data Management (6 hours)

5.1 Spatial database management systems: requirements, architecture and geodatabase concept
5.2 Spatial data types and operations: OGC Simple Features for SQL; PostGIS
5.3 Spatial queries: range, nearest-neighbor and spatial join queries; spatial SQL
5.4 Spatial indexing: grid index, quadtree, R-tree; space-filling curves (Z-order, Hilbert), geohash and hierarchical grids
5.5 Spatial query processing: minimum bounding rectangle and filter-and-refine strategy
5.6 Geospatial data formats: Shapefile, GeoJSON, KML, GeoPackage, GeoTIFF, Cloud Optimized GeoTIFF (COG) and GeoParquet; overview of big geospatial data management

6 Spatial Analysis (7 hours)

6.1 Classification of analytical capabilities: retrieval, measurement, classification and reclassification
6.2 Vector analysis: buffering, overlay (intersect, union, erase, clip), dissolve, spatial selection, proximity analysis and Thiessen (Voronoi) polygons
6.3 Raster analysis and map algebra: local, focal, zonal and global operations; resampling, distance and cost-distance surfaces
6.4 Network analysis: network data model, overview of shortest path (Dijkstra, A*), service area and location-allocation
6.5 Spatial interpolation: deterministic (Thiessen, IDW, splines) and geostatistical (semi-variogram) methods
6.6 Spatial statistics: spatial autocorrelation (Moran's I) and hot-spot analysis; multi-criteria decision analysis; error propagation

7 Geo-visualization and Cartography (4 hours)

7.1 Map elements, map design principles and visual variables
7.2 Thematic mapping: choropleth, graduated symbol, dot density and isarithmic maps; data classification methods (equal interval, quantile, natural breaks)
7.3 Visualization of time-series, 3D and multi-scale data; dashboards and story maps
7.4 Web map tiles: raster and vector tiles, tiling schemes and zoom levels

8 Web GIS, Spatial Data Infrastructure and Emerging Trends (7 hours)

8.1 Web GIS architecture: client-server, thin and thick clients; map servers (GeoServer, MapServer); web mapping libraries (Leaflet, OpenLayers, MapLibre)
8.2 OGC web services: WMS, WMTS, WFS, WCS, WPS, CSW and OGC API standards
8.3 Spatial data infrastructure (SDI): components, metadata, clearinghouse and geoportals, interoperability, legal and privacy aspects; national SDI of Nepal
8.4 Cloud and big-data geospatial computing: Google Earth Engine, distributed spatial processing (Apache Sedona)
8.5 GeoAI and emerging trends: deep learning for remote sensing image analysis, real-time IoT and sensor-based GIS, mobile location-based services, digital twins and 3D city models (CityGML)

Tutorial (30 hours)

1. Comparison of GIS with CAD, DBMS and remote sensing; identification of fields versus objects and attribute measurement scales for given datasets
2. Raster encoding exercises (run-length and quadtree); raster storage size and resolution calculations

3. Derivation of DE-9IM matrices for pairs of geometries; identification of topological errors
4. Coordinate system and projection problems: map scale, distortion, and selection of a suitable projection for given scenarios
5. Affine transformation parameters and RMSE calculation from ground control points for georeferencing
6. Spatial data quality assessment: positional accuracy (RMSE), error (confusion) matrix, overall accuracy and kappa coefficient
7. Construction of quadtree and R-tree for a given set of objects; Z-order and geohash encoding; writing spatial SQL queries
8. Buffer and vector overlay problems; local, focal and zonal map algebra computations on small raster grids
9. Network shortest path using Dijkstra and A* algorithms; IDW interpolation and Moran's I calculations
10. Data classification for thematic maps; design of a web GIS / SDI architecture for a given application scenario

Practical **(15 hours)**

1. Introduction to QGIS: loading vector and raster data, symbology, attribute tables, CRS assignment and reprojection; downloading open data (OpenStreetMap, Landsat/Sentinel, SRTM)
2. Georeferencing scanned topographic maps and on-screen digitization with topology rules; field data collection using a mobile GNSS application (QField or ODK) and integration into GIS
3. Spatial database development: creating a PostgreSQL/PostGIS database, importing data, building spatial indexes and executing spatial SQL queries (range, nearest neighbour, spatial join)
4. Vector analysis: buffer, overlay and spatial join; network analysis (shortest path, service area) using QGIS or pgRouting
5. Raster analysis: map algebra, reclassification, zonal statistics, interpolation (IDW, kriging) and multi-criteria site suitability analysis
6. Geospatial programming with Python (GDAL/OGR, GeoPandas, Shapely, Rasterio) for automated processing; NDVI computation and land-cover classification using Python or Google Earth Engine
7. Web GIS mini-project: publishing layers through GeoServer as WMS/WFS, developing an interactive web map using Leaflet or OpenLayers, and preparing a thematic map layout for export

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	4	6
2	5	6
3	6	8
4	6	8
5	6	8
6	7	10
7	4	6
8	7	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Huisman, O., de By, R.A. (Eds.) (2009). Principles of geographic information systems: An introductory textbook (Latest ed.). ITC, University of Twente, Enschede.
2. Chang, K.T. (2019). Introduction to geographic information systems (Latest ed.). McGraw-Hill.
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