

Next Steps for the *GIS&T Body of Knowledge*

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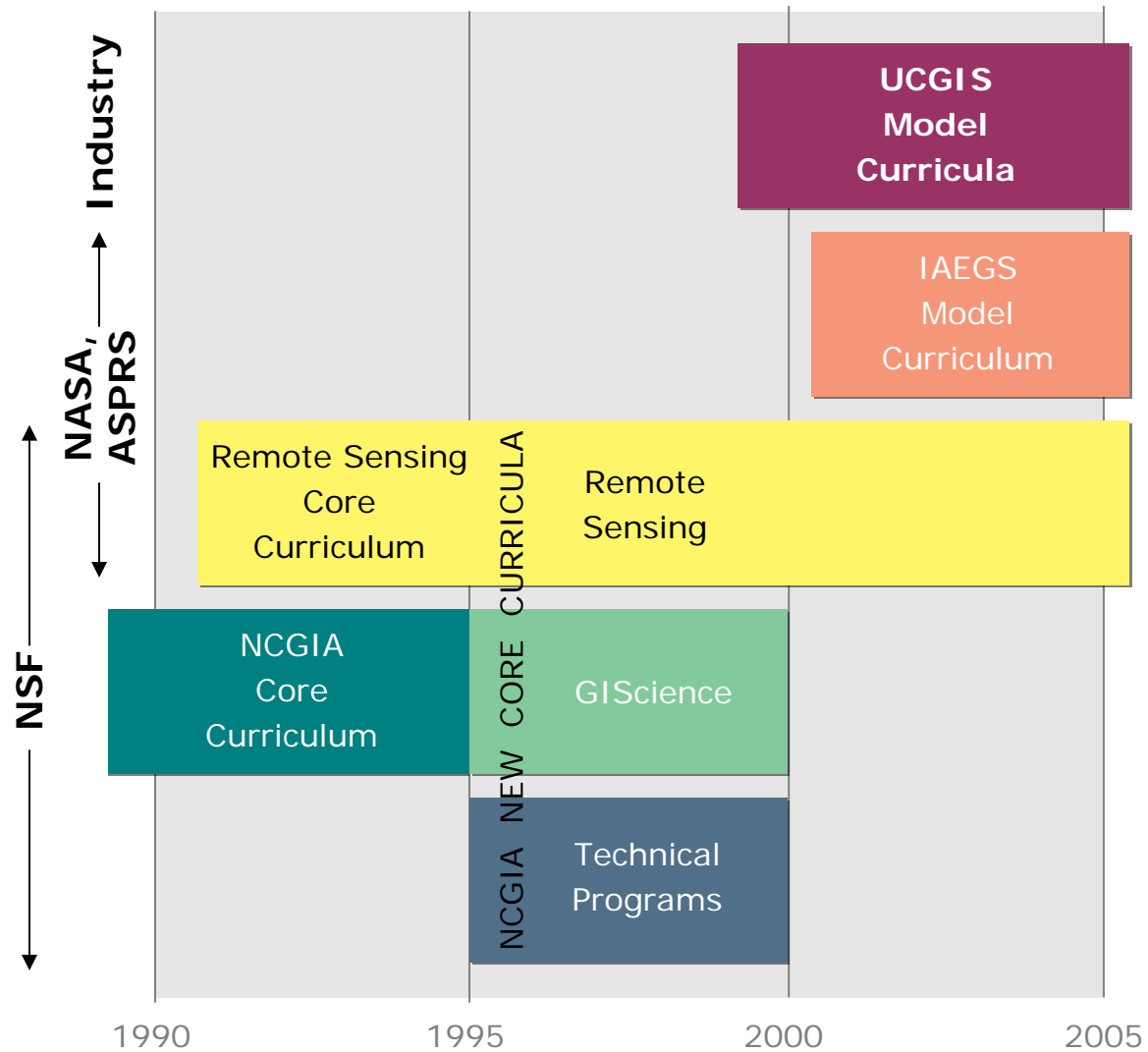
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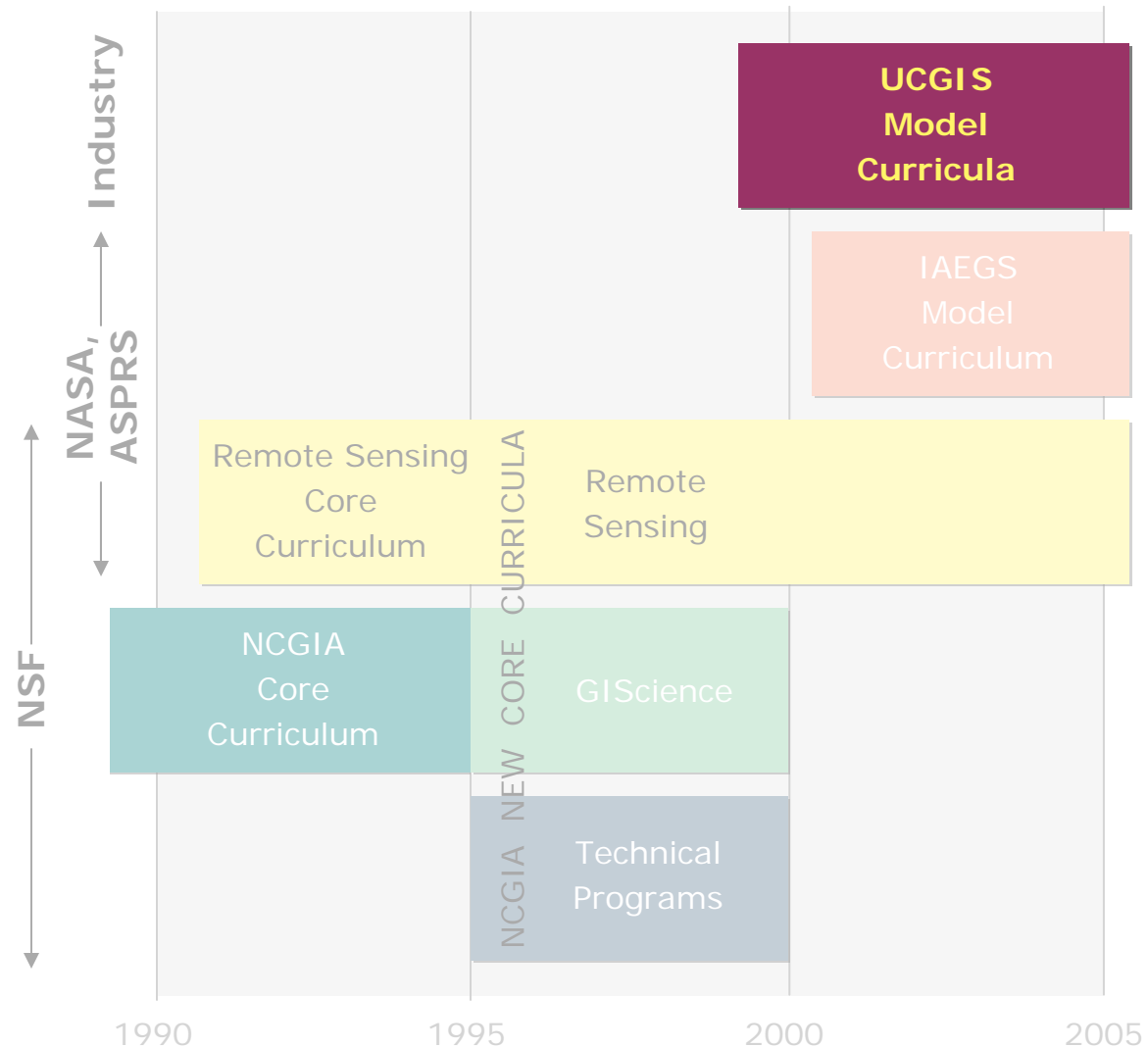
GIS&T Body of Knowledge, 1st Edition

<h2 style="text-align: center;">Geographic Information Science & Technology Body of Knowledge</h2> <p style="text-align: center; font-size: small;">Edited by David DeHaene, Michael DeMaio, Ann Johnson, Karen Kemp, Ann Taylor Lock, Brandon Pines, and Elizabeth Wente</p> <p style="text-align: center; font-weight: bold;">UNIVERSITY CONSORTIUM FOR GEOGRAPHIC INFORMATION SCIENCE</p>			
<h3>Analytical Methods</h3> <p>AM1 Academic and analytical origins</p> <ul style="list-style-type: none"> 1.1 Academic foundations 1.2 Analytical approaches <p>AM2 Query operations and query languages</p> <ul style="list-style-type: none"> 2.1 SQL theory 2.2 Structured Query Language (SQL) and spatial queries 2.3 Spatial queries <p>AM3 Geometric measures</p> <ul style="list-style-type: none"> 3.1 Distance and length 3.2 Direction 3.3 Shape 3.4 Area 3.5 Perimeter and distance decay 3.6 Adjacency and connectivity <p>AM4 Basic analytical operations</p> <ul style="list-style-type: none"> 4.1 Buffers 4.2 Overlay 4.3 Neighborhoods 4.4 Map algebra <p>AM5 Basic analytical methods</p> <ul style="list-style-type: none"> 5.1 Point pattern analysis 5.2 Lengths and density estimation 5.3 Spatial cluster analysis 5.4 Spatial interaction 5.5 Analyzing multidimensional attributes 5.6 Cartographic modeling 5.7 Multi-criteria evaluation 5.8 Spatial process models <p>AM6 Analysis of surfaces</p> <ul 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Geospatial curriculum initiatives



Geospatial curriculum initiatives



UCGIS Model Curricula project

Geographic Information Science & Technology Body of Knowledge
UNIVERSITY CONSORTIUM FOR GEOGRAPHIC INFORMATION SCIENCE

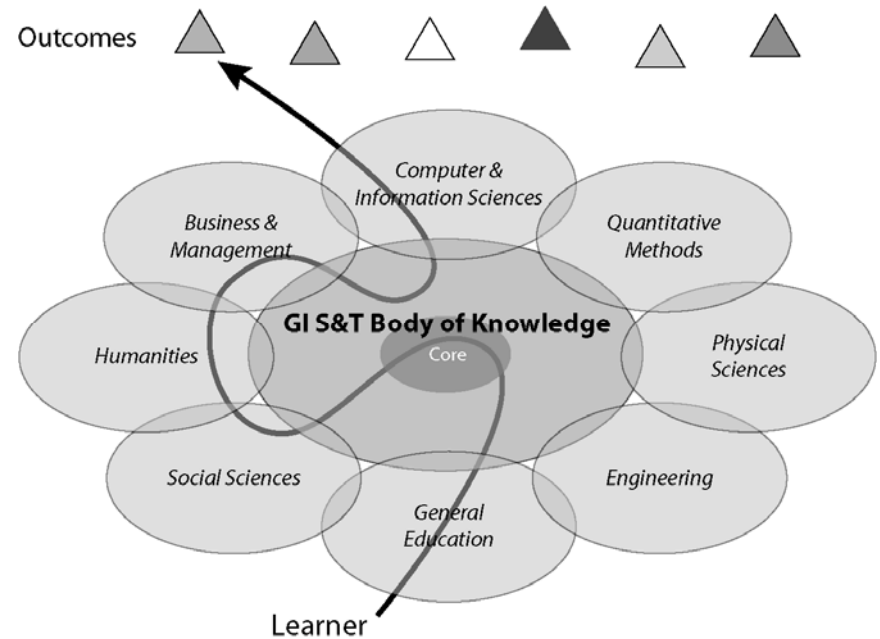
Analytical Methods	Cartography and Visualization
AM1 Academic and analytical cartography	CV1 Theory and methods
AM2 Spatial operations and analysis	CV2 Graphic representation techniques
AM3 Geographic information systems	CV3 Design and production
AM4 Geographic information science	CV4 Map production
AM5 Spatial data management	CV5 Map use and evaluation
AM6 Spatial data integration	CV6 Map design and evaluation
AM7 Spatial data visualization	CV7 Map design and evaluation
AM8 Spatial data visualization	CV8 Map design and evaluation
AM9 Spatial data visualization	CV9 Map design and evaluation
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AM12 Spatial data visualization	CV12 Map design and evaluation
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AM16 Spatial data visualization	CV16 Map design and evaluation
AM17 Spatial data visualization	CV17 Map design and evaluation
AM18 Spatial data visualization	CV18 Map design and evaluation
AM19 Spatial data visualization	CV19 Map design and evaluation
AM20 Spatial data visualization	CV20 Map design and evaluation

Conceptual Foundations

CF1 Philosophical foundations	CF2 History of geographic information science
CF3 Geographic information science	CF4 Geographic information science
CF5 Geographic information science	CF6 Geographic information science
CF7 Geographic information science	CF8 Geographic information science
CF9 Geographic information science	CF10 Geographic information science
CF11 Geographic information science	CF12 Geographic information science
CF13 Geographic information science	CF14 Geographic information science
CF15 Geographic information science	CF16 Geographic information science
CF17 Geographic information science	CF18 Geographic information science
CF19 Geographic information science	CF20 Geographic information science

Data Modeling

DM1 Data storage and retrieval	DM2 Data storage and retrieval
DM3 Data storage and retrieval	DM4 Data storage and retrieval
DM5 Data storage and retrieval	DM6 Data storage and retrieval
DM7 Data storage and retrieval	DM8 Data storage and retrieval
DM9 Data storage and retrieval	DM10 Data storage and retrieval
DM11 Data storage and retrieval	DM12 Data storage and retrieval
DM13 Data storage and retrieval	DM14 Data storage and retrieval
DM15 Data storage and retrieval	DM16 Data storage and retrieval
DM17 Data storage and retrieval	DM18 Data storage and retrieval
DM19 Data storage and retrieval	DM20 Data storage and retrieval



GIS&T BoK

+ Pathways

+ Curriculum Development Support Plan

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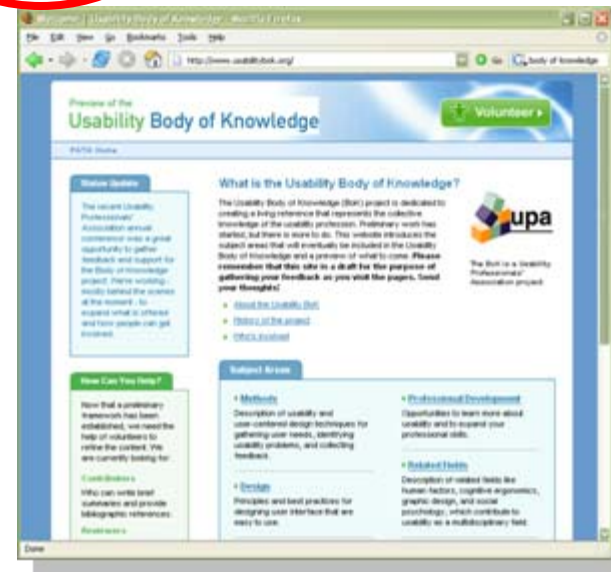
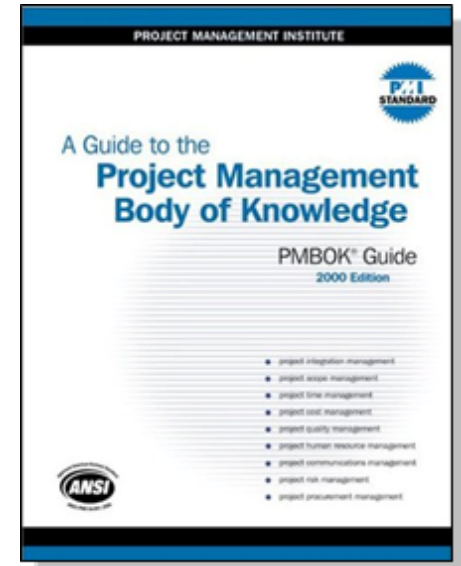
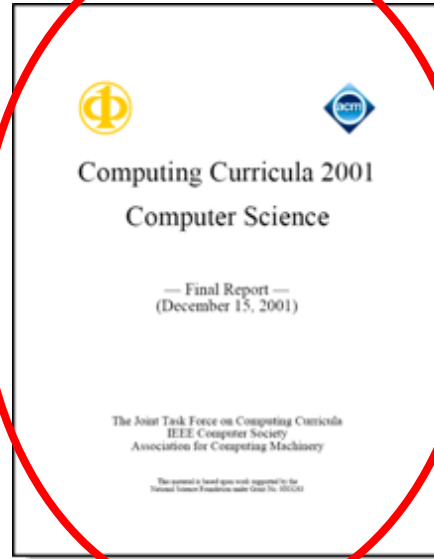
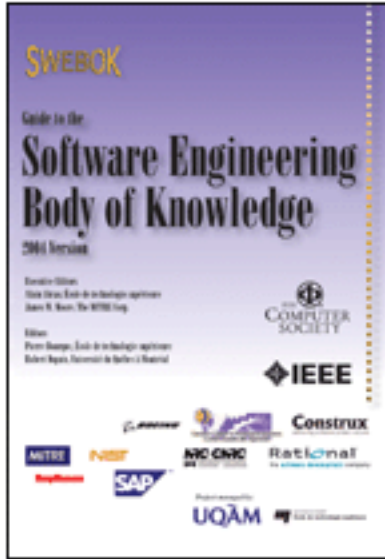
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GIS&T Body of Knowledge

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Bodies of Knowledge in other domains



GIS&T Body of Knowledge

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DA1 The scope of GIS&T system design 1.1 Why maps to represent information and decisions 1.2 Components of multiple data structures and datasets DA2 Project definition 2.1 Problem definition 2.2 Planning for design 2.3 Application/requirements assessment 2.4 Requirements analysis 2.5 Social, political, and cultural issues DA3 Resource planning 3.1 Feasibility analysis 3.2 Software systems 3.3 Data entry 3.4 Labor and management 3.5 Spatial facilities and equipment 3.6 Funding DA4 Database design 4.1 Modeling tools 4.2 Conceptual model 4.3 Logical models 4.4 Physical models DA5 Analysis design 5.1 Identifying analytical components 5.2 Identifying and designing analytical procedures 5.3 Coding analytical models into GIS 5.4 Analyzing procedure design DA6 Application design 6.1 Software analysis and design 6.2 User interface 6.3 Development considerations for geographic applications 6.4 Computer-Aided Software Engineering (CASE) tools DA7 System implementation 7.1 Implementation planning 7.2 Implementation, testing, and training 7.3 System testing 7.4 System deployment	DA8 Database design 8.1 Modeling tools 8.2 Conceptual model 8.3 Logical models 8.4 Physical models DA9 Analysis design 9.1 Identifying analytical components 9.2 Identifying and designing analytical procedures 9.3 Coding analytical models into GIS 9.4 Analyzing procedure design DA10 Application design 10.1 Software analysis and design 10.2 User interface 10.3 Development considerations for geographic applications 10.4 Computer-Aided Software Engineering (CASE) tools DA11 System implementation 11.1 Implementation planning 11.2 Implementation, testing, and training 11.3 System testing 11.4 System deployment	DA12 Database design 12.1 Modeling tools 12.2 Conceptual model 12.3 Logical models 12.4 Physical models DA13 Analysis design 13.1 Identifying analytical components 13.2 Identifying and designing analytical procedures 13.3 Coding analytical models into GIS 13.4 Analyzing procedure design DA14 Application design 14.1 Software analysis and design 14.2 User interface 14.3 Development considerations for geographic applications 14.4 Computer-Aided Software Engineering (CASE) tools DA15 System implementation 15.1 Implementation planning 15.2 Implementation, testing, and training 15.3 System testing 15.4 System deployment	DA16 Database design 16.1 Modeling tools 16.2 Conceptual model 16.3 Logical models 16.4 Physical models DA17 Analysis design 17.1 Identifying analytical components 17.2 Identifying and designing analytical procedures 17.3 Coding analytical models into GIS 17.4 Analyzing procedure design DA18 Application design 18.1 Software analysis and design 18.2 User interface 18.3 Development considerations for geographic applications 18.4 Computer-Aided Software Engineering (CASE) tools DA19 System implementation 19.1 Implementation planning 19.2 Implementation, testing, and training 19.3 System testing 19.4 System deployment
Data Modeling			
DM1 Basic storage and retrieval structures 1.1 Basic data structures 1.2 File-based structures DM2 Database management systems 2.1 Evolution of DBMS and GIS 2.2 Basic DBMS 2.3 Evolution of the relational model DM3 Transaction data models 3.1 Relational model 3.2 The raster model 3.3 Hierarchical models of response 3.4 The hexagonal model 3.5 The hexagonal/irregular Triangular (HIT) model 3.6 Evolution 3.7 Non-spatial data models	DM4 Vector and object data models 4.1 The geographic model 4.2 The object-oriented model 4.3 Basic raster data models 4.4 Object-oriented model 4.5 Object-oriented model 4.6 Object-oriented model DM5 Modeling 3D, uncertain, and temporal phenomena 5.1 Temporal data 5.2 Uncertainty 5.3 Modeling three-dimensional entities	DM6 Basic storage and retrieval structures 6.1 Basic data structures 6.2 File-based structures DM7 Database management systems 7.1 Evolution of DBMS and GIS 7.2 Basic DBMS 7.3 Evolution of the relational model DM8 Transaction data models 8.1 Relational model 8.2 The raster model 8.3 Hierarchical models of response 8.4 The hexagonal model 8.5 The hexagonal/irregular Triangular (HIT) model 8.6 Evolution 8.7 Non-spatial data models	DM9 Vector and object data models 9.1 The geographic model 9.2 The object-oriented model 9.3 Basic raster data models 9.4 Object-oriented model 9.5 Object-oriented model 9.6 Object-oriented model DM10 Modeling 3D, uncertain, and temporal phenomena 10.1 Temporal data 10.2 Uncertainty 10.3 Modeling three-dimensional entities
Data Manipulation			
DM1 Representation 1.1 Types of representation 1.2 Data models and formal constraints 1.3 Data models and formal constraints 1.4 Data models and formal constraints 1.5 Data models and formal constraints 1.6 Data models and formal constraints 1.7 Data models and formal constraints 1.8 Data models and formal constraints 1.9 Data models and formal constraints 1.10 Data models and formal constraints	DM2 Generalization and aggregation 2.1 Generalization 2.2 Data, line, and area generalization 2.3 Classification of generalization methods 2.4 Aggregation of spatial entities DM3 Transaction management 3.1 Modeling database change 3.2 Modeling database change 3.3 Modeling temporal geographic databases	DM4 Representation 4.1 Types of representation 4.2 Data models and formal constraints 4.3 Data models and formal constraints 4.4 Data models and formal constraints 4.5 Data models and formal constraints 4.6 Data models and formal constraints 4.7 Data models and formal constraints 4.8 Data models and formal constraints 4.9 Data models and formal constraints 4.10 Data models and formal constraints	DM5 Generalization and aggregation 5.1 Generalization 5.2 Data, line, and area generalization 5.3 Classification of generalization methods 5.4 Aggregation of spatial entities DM6 Transaction management 6.1 Modeling database change 6.2 Modeling database change 6.3 Modeling temporal geographic databases
Geocomputation			
GC1 Emergence of geocomputation 1.1 Origins GC2 Computational aspects and multi-representation 2.1 High performance computing 2.2 Computational models 2.3 Data structure and visualization 2.4 Data structure and visualization 2.5 Data structure and visualization 2.6 Data structure and visualization 2.7 Data structure and visualization 2.8 Data structure and visualization 2.9 Data structure and visualization 2.10 Data structure and visualization	GC3 Cellular Automata (CA) 3.1 CA Model Structure 3.2 CA Transition Rule 3.3 CA Simulation and Control 3.4 Impact of uncertainty 3.5 Typical CA applications	GC4 Hierarchies 4.1 Hierarchical structures 4.2 Hierarchical structures 4.3 Hierarchical structures 4.4 Hierarchical structures 4.5 Hierarchical structures 4.6 Hierarchical structures 4.7 Hierarchical structures 4.8 Hierarchical structures 4.9 Hierarchical structures 4.10 Hierarchical structures	GC5 Genetic algorithms (GA) 5.1 GA and global optimization 5.2 Genetic algorithms and spatial optimization GC6 Agent-based models 6.1 Evolution of agent-based models 6.2 Agent-based models 6.3 Agent-based models 6.4 Agent-based models 6.5 Agent-based models 6.6 Agent-based models 6.7 Agent-based models 6.8 Agent-based models 6.9 Agent-based models 6.10 Agent-based models
GIS&T and Society			
GS1 Legal aspects 1.1 The legal system 1.2 Liability law 1.3 Liability law 1.4 Liability law 1.5 Liability law 1.6 Liability law 1.7 Liability law 1.8 Liability law 1.9 Liability law 1.10 Liability law	GS2 Economic aspects 2.1 Economic and the role of information 2.2 Valuing and measuring benefits 2.3 Market of benefits 2.4 Agency, institutions, and industry perspectives 2.5 Innovation	GS3 Use of geospatial information in the public sector 3.1 Use of geospatial information in the public sector 3.2 Use of geospatial information in the public sector 3.3 Use of geospatial information in the public sector 3.4 Use of geospatial information in the public sector 3.5 Use of geospatial information in the public sector 3.6 Use of geospatial information in the public sector 3.7 Use of geospatial information in the public sector 3.8 Use of geospatial information in the public sector 3.9 Use of geospatial information in the public sector 3.10 Use of geospatial information in the public sector	GS4 Dissemination of geospatial information 4.1 Innovation and barriers to sharing geospatial information 4.2 Data sharing among organizations and individuals 4.3 Legal considerations for sharing geospatial information 4.4 Building capacity and open access to geospatial information GS5 Ethical aspects 5.1 Ethical and geospatial information 5.2 Codes of ethics for geospatial professionals
Organizational & Institutional Aspects			
OI1 Origins of GIS&T 1.1 Public sector origins 1.2 Private sector origins 1.3 Academic origins 1.4 Learning from experience 1.5 Future trends	OI2 Managing the GIS system operation and infrastructure 2.1 Managing the GIS system operation and infrastructure 2.2 Managing the GIS system operation and infrastructure 2.3 Managing the GIS system operation and infrastructure 2.4 Managing the GIS system operation and infrastructure 2.5 Managing the GIS system operation and infrastructure 2.6 Managing the GIS system operation and infrastructure 2.7 Managing the GIS system operation and infrastructure 2.8 Managing the GIS system operation and infrastructure 2.9 Managing the GIS system operation and infrastructure 2.10 Managing the GIS system operation and infrastructure	OI3 Organizational structure and providers 3.1 Organizational models for GIS systems 3.2 Organizational models for GIS systems 3.3 Organizational models for GIS systems 3.4 Organizational models for GIS systems 3.5 Organizational models for GIS systems 3.6 Organizational models for GIS systems 3.7 Organizational models for GIS systems 3.8 Organizational models for GIS systems 3.9 Organizational models for GIS systems 3.10 Organizational models for GIS systems	OI4 GIS&T workforce themes 4.1 GIS&T self-development 4.2 GIS&T positions and qualifications 4.3 GIS&T training and education 4.4 Increasing GIS&T self-awareness job satisfaction

Knowledge Area (10)

GIS&T Body of Knowledge

**Geographic Information Science & Technology
Body of Knowledge**

Edited by David Dillman, Michael Goodchild, Alan Johnston, Karen Kruger, Ann Taylor-Lock, Brandon Phares, and Elizabeth Wentz
UNIVERSITY OF CONSORTIUM FOR GEOGRAPHIC INFORMATION SCIENCE

<p>Analytical Methods</p> <p>AM1 Academic and analytical origins</p> <p>AM2 Query operations and query languages</p> <p>AM3 Geometric measures</p> <p>AM4 Basic analytical operations</p> <p>AM5 Basic analytical methods</p> <p>AM6 Analysis of surfaces</p> <p>Conceptual Foundations</p> <p>CF1 Philosophical foundations</p> <p>CF2 Cognitive and social foundations</p> <p>CF3 Domains of geographic information</p>	<p>AM7 Spatial statistics</p> <p>AM8 Geostatistics</p> <p>AM9 Spatial regression and econometrics</p> <p>AM10 Data Mining</p> <p>AM11 Network analysis</p> <p>AM12 Optimization and location-allocation modeling</p>	<p>Cartography and Visualization</p> <p>CV1 History and trends</p> <p>CV2 Data considerations</p> <p>CV3 Principles of map design</p> <p>CV4 Graphic representation techniques</p> <p>CV5 Map production</p> <p>CV6 Map use and evaluation</p> <p>Design Aspects</p> <p>DA1 The scope of GIS&T system design</p> <p>DA2 Project definition</p> <p>DA3 Resource planning</p> <p>Data Modeling</p> <p>DM1 Basic storage and retrieval strategies</p> <p>DM2 Database management systems</p> <p>DM3 Transaction data models</p> <p>DM4 Vector and object data models</p> <p>DM5 Modeling 3D, uncertain, and temporal phenomena</p>	<p>Unit (73)</p> <p>Core Unit (26)</p> <p>Topics (329)</p>
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Analytical Methods

AM1 Academic and analytical origins

- 1-1 Academic foundations
- 1-2 Analytical approaches

AM2 Query operations and query languages

- 2-1 Set theory
- 2-2 Structured Query Language (SQL) and attribute queries
- 2-3 Spatial queries

AM3 Geometric measures

- 3-1 Distances and lengths
- 3-2 Direction
- 3-3 Shape
- 3-4 Area
- 3-5 Proximity and distance decay
- 3-6 Adjacency and connectivity

AM4 Basic analytical operations

- 4-1 Buffers
- 4-2 Overlay
- 4-3 Neighborhoods
- 4-4 Map algebra

AM5 Basic analytical methods

- 5-1 Point pattern analysis
- 5-2 Kernels and density estimation
- 5-3 Spatial cluster analysis
- 5-4 Spatial interaction
- 5-5 Analyzing multidimensional attributes
- 5-6 Cartographic modeling
- 5-7 Multi-criteria evaluation
- 5-8 Spatial process models

AM6 Analysis of surfaces

- 6-1 Calculating surface derivatives
- 6-2 Interpolation of surfaces
- 6-3 Surface features
- 6-4 Intervisibility
- 6-5 Friction surfaces

AM7 Spatial statistics

- 7-1 Graphical methods
- 7-2 Stochastic processes
- 7-3 The spatial weights matrix
- 7-4 Global measures of spatial association
- 7-5 Local measures of spatial association
- 7-6 Outliers
- 7-7 Bayesian methods

AM8 Geostatistics

- 8-1 Spatial sampling for statistical analysis
- 8-2 Principles of semi-variogram construction
- 8-3 Semi-variogram modeling
- 8-4 Principles of kriging
- 8-5 Kriging variants

AM9 Spatial regression and econometrics

- 9-1 Principles of spatial econometrics
- 9-2 Spatial autoregressive models
- 9-3 Spatial filtering
- 9-4 Spatial expansion and Geographically Weighted Regression (GWR)

AM10 Data Mining

- 10-1 Problems of large spatial databases
- 10-2 Data mining approaches
- 10-3 Knowledge discovery
- 10-4 Pattern recognition and matching

AM11 Network analysis

- 11-1 Networks defined
- 11-2 Graph theoretic (descriptive) measures
- 11-3 Least-cost (shortest) path
- 11-4 Flow modeling
- 11-5 The Classic Transportation Problem
- 11-6 Other classic network problems
- 11-7 Accessibility Modeling

AM12 Optimization and location-allocation modeling

- 12-1 Operations research modeling and location modeling principles
- 12-2 Linear programming
- 12-3 Integer programming
- 12-4 Location-allocation modeling and

Knowledge Area (10)

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**Geographic Information Science & Technology
Body of Knowledge**

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UNIVERSITY CONSORTIUM FOR GEOGRAPHIC INFORMATION SCIENCE

Analytical Methods		Cartography and Visualization	
AM1 Academic and analytical origins	AM7 Spatial statistics	CV1 History and trends	CV4 Graphic representation techniques
AM2 Query operations and query languages	AM8 Geostatistics	CV2 Data considerations	CV5 Map production
AM3 Geometric measures	AM9 Spatial regression and econometrics	CV3 Principles of map design	CV6 Map use and evaluation
AM4 Basic analytical operations	AM10 Data Mining	Design Aspects	
AM5 Basic analytical methods	AM11 Network analysis	DA1 The scope of GIS/ET system design	
AM6 Analysis of surfaces	AM12 Optimization and location-allocation modeling	DA2 Project definition	
Conceptual Foundations		DA3 Business planning	
CF1 Philosophical foundations	CF4 Elements of geographic information	DA4 Database design	
CF2 Cognitive and social foundations	CF5 Relationships	DA5 Analysis	
CF3 Domains of geographic information	CF6 Implications for geographic information	DA6 Application design	
		DA7 System implementation	
		Data Modeling	
		DM1 Basic storage and retrieval strategies	DM4 Vector and object data models
		DM2 Database management	DM5 Modeling 3D, uncertain, and temporal phenomena
		DM3 Terrestrial data models	

Unit AM4

Analytical Methods

AM1 Academic and analytical origins

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- 12-1 Operations research modeling and location modeling principles
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- 12-3 Integer programming
- 12-4 Location-allocation modeling and

Example Unit, Topics, and Objectives

Unit AM4 Basic analytical operations (*core unit*)

This small set of analytical operations is so commonly applied to a broad range of problems that their inclusion in software products is often used to determine if that product is a “true” GIS. Concepts on which these operations are based are addressed in Unit CF3 Domains of geographic information and Unit CF5 Relationships.

Topic AM4-3 Neighborhoods

- Discuss the role of Voronoi polygons as the dual graph of the Delaunay triangulation
- Explain how Voronoi polygons can be used to define neighborhoods around a set of points
- Outline methods that can be used to establish non-overlapping neighborhoods of similarity in raster datasets
- Create proximity polygons (Thiessen/Voronoi polygons) in point datasets
- Write algorithms to calculate neighborhood statistics (minimum, maximum, focal flow) using a moving window in raster datasets

Topic AM4-4 Map algebra

- Describe how map algebra performs mathematical functions on raster grids
- Describe a real modeling situation in which map algebra would be used (e.g., site selection, climate classification, least-cost path)
- Explain the categories of map algebra operations (i.e., local, focal, zonal, and global functions)
- Explain why georegistration is a precondition to map algebra
- Perform a map algebra calculation using command line, form-based, and flow charting user interfaces

Example Unit, Topics, and Objectives

Unit GS6 Ethical aspects (*core unit*)

Ethics provide frameworks that help individuals and organizations make decisions when confronted with choices that have moral implications. Most professional organizations develop codes of ethics to help their members do the right thing, preserve their good reputation in the community, and help their members develop as a community.

Topic GS6-1 Ethics and geospatial information

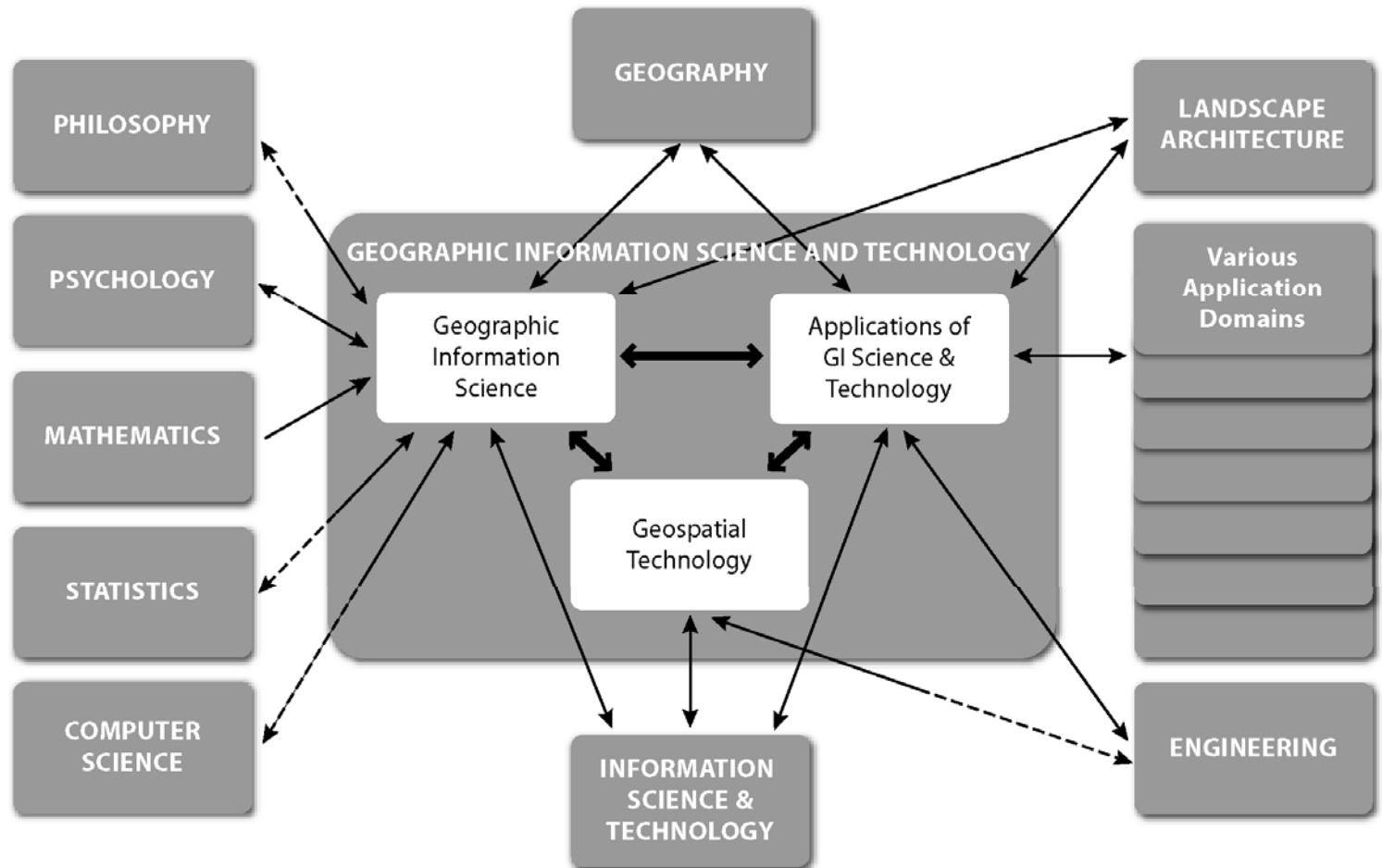
- Describe a variety of philosophical frameworks upon which codes of professional ethics may be based
- Discuss the ethical implications of a local government's decision to charge fees for its data
- Describe a scenario in which you would find it necessary to report misconduct by a colleague or friend
- Describe the individuals or groups to which GIS&T professionals have ethical obligations

Topic GS6-2 Codes of ethics for geospatial professionals

- Compare and contrast the ethical guidelines promoted by the GIS Certification Institute (GISCI) and the American Society for Photogrammetry and Remote Sensing (ASPRS)
- Describe the sanctions imposed by ASPRS and GISCI on individuals whose professional actions violate the Codes of Ethics
- Explain how one or more obligations in the GIS Code of Ethics may conflict with organizations' proprietary interests
- Propose a resolution to a conflict between an obligation in the GIS Code of Ethics and organizations' proprietary interests

Questionnaire page 2

Defining the GIS&T field



Questionnaire page 3

Defining geospatial competence

TABLE 3
Geospatial Technology Core Competencies

(Note: Core competencies are shown in bold)

<p><u>Technical Competencies</u> Ability to Assess Relationships Among Geospatial Technologies Cartography Computer Programming Skills Environmental Applications GIS Theory and Applications Geology Applications Geospatial Data Processing Tools Photogrammetry Remote Sensing Theory and Applications Spatial Information Processing Technical Writing Technological Literacy Topology</p>	<p><u>Business Competencies</u> Ability to See the “Big Picture” Business Understanding Buy-in/Advocacy Change Management Cost Benefit Analysis/ROI Ethics Modeling Industry Understanding Legal Understanding Organization Understanding Performance Analysis and Evaluation Visioning</p>
<p><u>Analytical Competencies</u> Creative Thinking Knowledge Management: Model Building Skills Problem-Solving Skills Research Skill Systems Thinking</p>	<p><u>Interpersonal Competencies</u> Coaching Communication Conflict Management: Feedback Skills Group Process Understanding Leadership Skills Questioning Relationship Building Skills Self-Knowledge/Self-Management</p>

Gaudet, C., Annulis, H., & Carr, J. (2003). Building the geospatial workforce. *URISA Journal* 15(1): 21-30.

Defining geospatial competence

TABLE I
Geospatial Technology Role Definitions

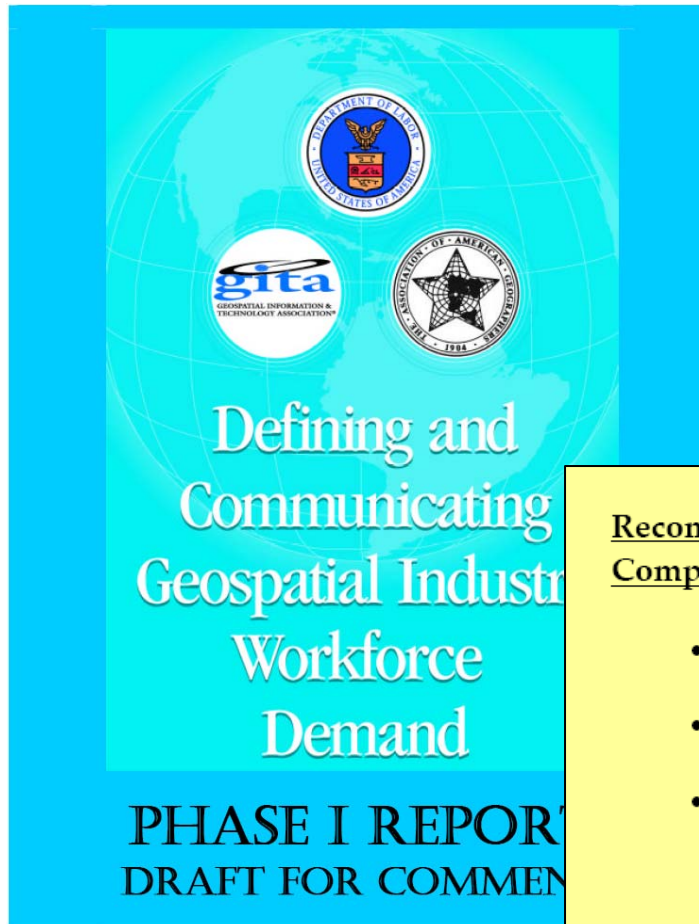
Applications Development	Identify and develop tools and instruments to satisfy customer needs
Data Acquisition	Collect geospatial and related data
Coordination	Interorganizational facilitation and communication
Data Analysis and Interpretation	Process data and extract information to create products, drive conclusions, and inform decision-making reports
Data Management	Catalog, archive, retrieve, and distribute geospatial data
Management	Efficiently and effectively apply the company's mission using financial, technical, and intellectual skills and resources to optimize the end products
Marketing	Identify customer requirements and needs, and effectively communicate those needs and requirements to the organization, as well as promote geospatial solutions
Project Management	Effectively oversee activity requirements to produce the desired outcomes on time and within budget
Systems Analysis	Assess requirements for system capacities including inputs, outputs, processes, timing, and performance, as well as recommend necessary additions or adaptations
Systems Management	Integrate resources and develop additional resources to support spatial and temporal user requirements
Training	Analyze, design, and develop instructional and non-instructional interventions to provide transfer of knowledge and evaluation for performance improvement
Visualization	Render data and information into visual geospatial representations

Geospatial Technology Competency Model

Table 4
Geospatial Technology Competency Model®

		ROLES												
		Applications Development	Coordination	Data Acquisition	Data Analysis	Data Management	Management	Marketing	Project Management	Systems Analysis	Systems Management	Training	Visualization	
COMPETENCIES	Technical	Ability to Assess Relationships Among Geospatial Technologies		●				●	●		●	●	●	●
		Cartography			●	●								●
		Computer Programming Skills	●		●		●				●			●
		Environmental Applications	●			●								●
		GIS Theory and Applications	●			●	●	●		●		●	●	●
		Geology Applications				●								●
		Geospatial Data Processing Tools			●	●					●	●	●	●
		Photogrammetry	●		●	●								●
		Remote Sensing Theory and Applications	●		●	●						●		●
		Spatial Information Processing	●		●	●								●
	Business	Technical Writing	●	●		●		●	●	●	●	●	●	●
		Technological Literacy	●		●	●	●	●	●	●	●	●	●	●
		Topology				●								●
		Ability to see the "Big Picture"	●	●			●	●	●		●	●	●	
		Business Understanding		●				●		●				
		Buy-in/Advocacy		●				●	●		●			●
		Change Management	●	●		●	●	●	●	●	●	●	●	●
		Cost Benefit Analysis / ROI	●	●			●	●	●	●		●	●	●
		Ethics Modeling				●		●	●	●		●	●	●
		Industry Understanding	●	●				●	●				●	●
Analytical	Legal Understanding		●											
	Organization Understanding		●				●				●			
	Performance Analysis and Evaluation			●			●	●	●	●	●	●		
	Visioning		●				●	●	●	●	●	●		
	Creative Thinking	●	●	●	●	●	●	●	●	●	●	●	●	
	Knowledge Management		●		●		●		●			●	●	
	Model Building Skills	●				●	●				●	●	●	
	Problem-Solving Skills	●	●	●	●	●	●	●	●	●	●	●	●	
	Research Skill	●			●							●	●	
	Systems Thinking	●					●			●	●	●	●	
Interpersonal	Coaching		●				●					●		
	Communication	●	●	●	●	●	●	●	●	●	●	●	●	
	Conflict Management	●	●				●	●	●		●	●	●	
	Feedback Skills	●	●	●	●	●	●	●	●	●	●	●	●	
	Group Process Understanding		●				●		●		●	●	●	
	Leadership Skills		●			●	●	●	●		●	●	●	
	Questioning		●				●	●	●	●	●	●	●	
	Relationship Building Skills		●				●	●	●	●	●	●	●	
Self-Knowledge/Self-Management		●				●	●		●	●	●	●		

Critiquing the GTCM



62% of survey respondents agreed that Technical Competencies specified in the GTCM are inadequate.

Recommendations for Modifications to the Geospatial Competency Model

- The University of Southern Mississippi's Geospatial Workforce Competency Model should be refined and updated.
- It would be helpful to clarify the differences between the terms "roles," "competencies," "occupations," and "job titles."
- A fifth group of competencies may be added to include discipline-specific application competencies such as "environmental applications," "geological applications," "demographic applications," or "sociological applications."
- "Standards" and "interoperability" may be added to the existing technical competencies.
- The level of competency may also be incorporated into the model in conjunction with the type of competency.

Applications of *GIS&T BoK*

- › Curriculum planning
- › Program accreditation
- › Program evaluation and assessment
- › Program articulation
- › Professional certification
- › Employee screening
- › Defining the GIS&T field

Questionnaire page 4

Analytical Methods

- Unit AM1 Academic and analytical origins
- Unit AM2 Query operations and query languages
- Unit AM3 Geometric measures**
- Unit AM4 Basic analytical operations**
- Unit AM5 Basic analytical methods**
- Unit AM6 Analysis of surfaces
- Unit AM7 Spatial statistics
- Unit AM8 Geostatistics
- Unit AM9 Spatial regression and econometrics
- Unit AM10 Data mining
- Unit AM11 Network analysis
- Unit AM12 Optimization and location-allocation modeling

Conceptual Foundations

- Unit CF1 Philosophical foundations
- Unit CF2 Cognitive and social foundations
- Unit CF3 Domains of geographic information**
- Unit CF4 Elements of geographic information**
- Unit CF5 Relationships
- Unit CF6 Imperfections in geographic information

Cartography and Visualization

- Unit CV1 History and trends
- Unit CV2 Data considerations**
- Unit CV3 Principles of map design**
- Unit CV4 Graphic representation techniques
- Unit CV5 Map production
- Unit CV6 Map use and evaluation**

Design Aspects

- Unit DA1 The scope of GIS&T system design
- Unit DA2 Project definition
- Unit DA3 Resource planning
- Unit DA4 Database design**
- Unit DA5 Analysis design
- Unit DA6 Application design
- Unit DA7 System implementation

Data Modeling

- Unit DM1 Basic storage and retrieval structures
- Unit DM2 Database management systems**
- Unit DM3 Tessellation data models**
- Unit DM4 Vector and object data models**
- Unit DM5 Modeling 3D, temporal, and uncertain phenomena

Data Manipulation

- Unit DN1 Representation transformation**
- Unit DN2 Generalization and aggregation**
- Unit DN3 Transaction management of geospatial data

Geocomputation

- Unit GC1 Emergence of geocomputation
- Unit GC2 Computational aspects and neurocomputing
- Unit GC3 Cellular Automata (CA) models
- Unit GC4 Heuristics
- Unit GC5 Genetic algorithms (GA)
- Unit GC6 Agent-based models
- Unit GC7 Simulation modeling
- Unit GC8 Uncertainty
- Unit GC9 Fuzzy sets

Geospatial Data

- Unit GD1 Earth geometry**
- Unit GD2 Land partitioning systems
- Unit GD3 Georeferencing systems**
- Unit GD4 Datums**
- Unit GD5 Map projections**
- Unit GD6 Data quality**
- Unit GD7 Land surveying and GPS**
- Unit GD8 Digitizing
- Unit GD9 Field data collection
- Unit GD10 Aerial imaging and photogrammetry**
- Unit GD11 Satellite and shipboard remote sensing**
- Unit GD12 Metadata, standards, and infrastructures**

GIS&T and Society

- Unit GS1 Legal aspects
- Unit GS2 Economic aspects
- Unit GS3 Use of geospatial information in the public sector
- Unit GS4 Geospatial information as property
- Unit GS5 Dissemination of geospatial information
- Unit GS6 Ethical aspects of geospatial information and technology**
- Unit GS7 Critical GIS

Organizational and Institutional Aspects

- Unit OI1 Origins of GIS&T
- Unit O2 Managing the GI system operations and infrastructure
- Unit OI3 Organizational structures and procedures
- Unit OI4 GI S&T workforce themes
- Unit OI5 Institutional and inter-institutional aspects**
- Unit OI6 Coordinating organizations (national and international)**

Questionnaire page 5

Next steps for UCGIS Model Curricula

1. Priorities for future development
2. Staffing of future *GIS&T BoK*
3. Format of future *GIS&T BoK*

Next steps for UCGIS Model Curricula

Thanks for your contribution!