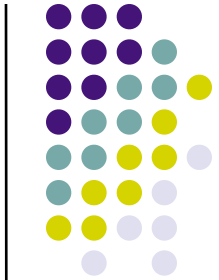
Cartographic Generalization

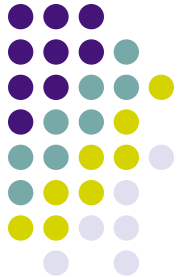


- Process of abstraction which react on change of map purpose or scale
- Process is influenced by symbolics and character of displayed area
- Process encompasses
  - Reduction of complexity
  - Emphasis of essential and suppress unimportant
  - Maintenance of relationship among map objects
  - Preservation of aesthetic quality

Definitions (ICA'73–McMaster'92–Ruas'95)

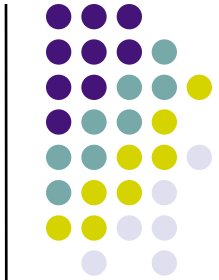
- Selection and simplified representation of detail appropriate scale and/or purpose of map
- Process of deriving from data source through the application of transformations, where derivation objectives are to reduce data in scope of amount, type and cartographic portrayal with maintenance of consistency and clarity of presentation
- Process of thematic and geometric resolution reduction

Automated Generalization



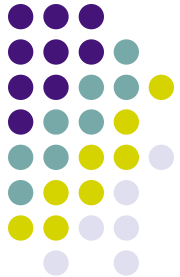
- Algorithmisation of transformations
- Three main types
  - Computer aided generalization – cartographic generalization provided by humans with computer based procedures
  - Multiple representation – to design adaptable cartographic visualization of geodata
  - Real-time generalization – automated map derivation from geodata

Roles of Generalization



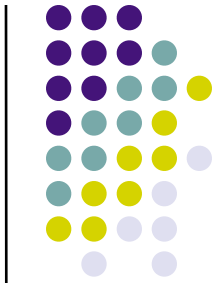
- Map production
- Electronic map design
- Web cartography
- Mobile cartography
- Geodata integration
- GIS

Map Production



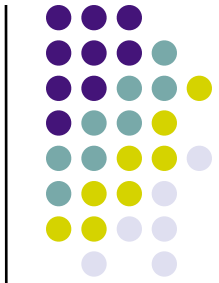
- Classical task (purpose oriented universal maps)
- Off-line processing
- Computer aided generalization
- Reduce time of map compilation
- Reduce map inconsistency
- Ability of creation of new special purpose maps

Electronic Map Design



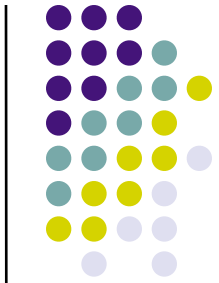
- Adaptive zoom – smooth change of map face and legend according to scale
- Adaptive visualization - change map face and legend according to purpose and/or context
  - Audience
  - Position
  - Time
  - Conditions
- Multiple representation/real-time
- Less importance of annotations

Web & Mobile Cartography



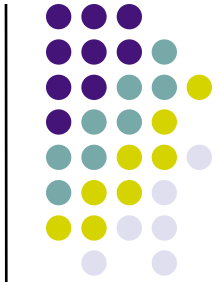
- Reduction of amount of transferred data
- To generate more individual maps
- Often opposition to map production – as less data as is possible
- Client/server distribution of tasks
- Multi-scale map-face
- Homogenize geo-data from various sources

Data Integration



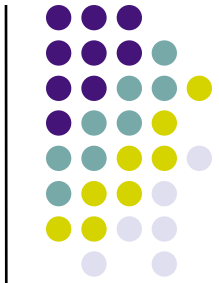
- To update geodatabase from various resources
- To find identical features in different scales
- Reverse engineering
- Harmonize geodata creation
- Homogenize existing geodata
- To support geoprocessing based on various resources

GIS



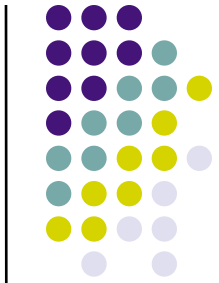
- To save geoprocessing time
- Iterative geoprocessing
- Identification of spatial patterns
- To eliminate random errors
- Support for cartographic analysis of geodata
- Visual interface support for GIS
- To avoid redundancy and save storage space

Models of generalization



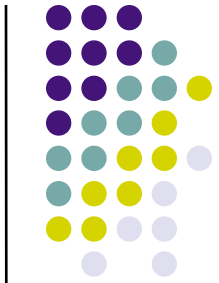
- Framework how to generalize
- From holistic process to procedures sequence
- From map compilation to geodatabase processing
- From empiricism to analytics
- Separation of generalization into two parts
  - Model generalization
  - Visual generalization

Ratajski model '67



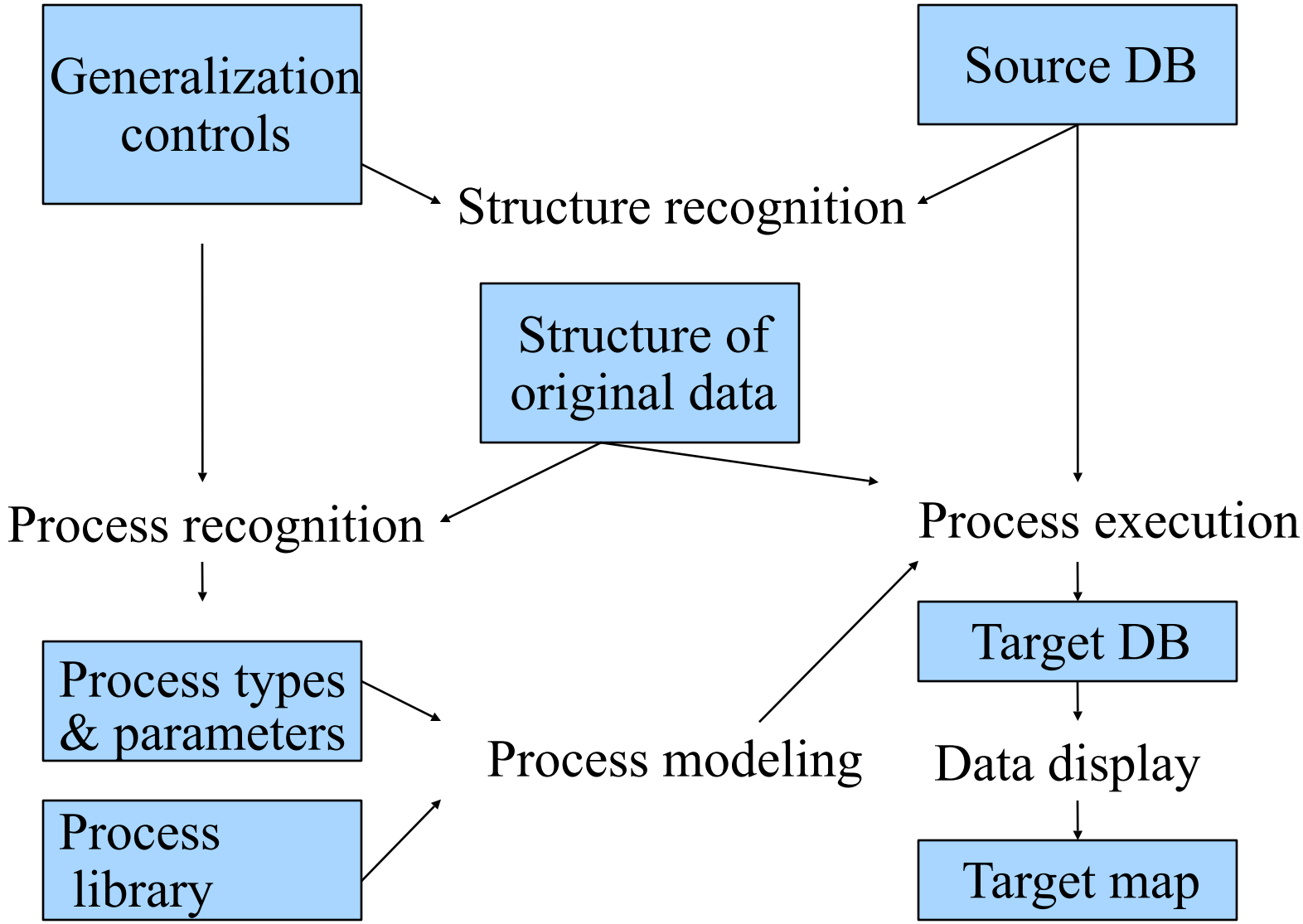
- Quantitative processes
  - Reduction of map content according scale
- Qualitative processes
  - Transform form representation to more abstract forms
- Generalization point – scale which map capacity is decreased to the level where qualitative change is necessary

Bertin model '83

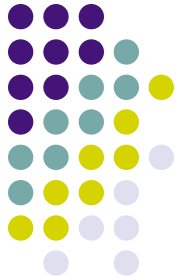


- Similar to Ratajski
- Conceptual generalization
  - New conceptualization of phenomena
- Structural generalization
  - Simplify phenomenon reperesentation (shape, symbol or distribution)
- Structural = Quantitative, Conceptual extending qualitative

Brassel-Weibel Model '88

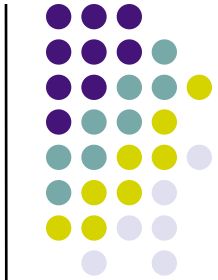


Brassel-Weibel Model '88



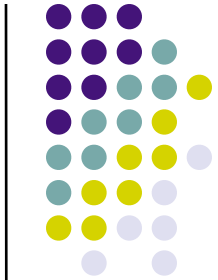
- Structure recognition – through cartometric analysis
  - Identification object or aggregates
  - Their spatial and semantic relations
  - Their importance
- Generalization controls
  - Purpose
  - Scale difference between source and target
  - Source quality
  - Symbols specifications
- Process recognition
  - Data modification
  - Parameters setup
- Process modeling
  - Compile rules and procedures

McMaster-Shea model '92



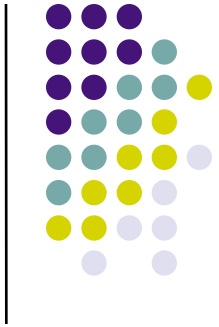
- Why to generalize
  - Theoretical issues
    - Reducing complexity
    - Maintaining accuracy, consistency, logical hierarchy
    - Maintaining aesthetic quality
  - Application issues
    - Scale
    - Audience
    - Clarity
  - Computational issues
    - Algorithm cost
    - Maximum data reduction

McMaster-Shea model '92



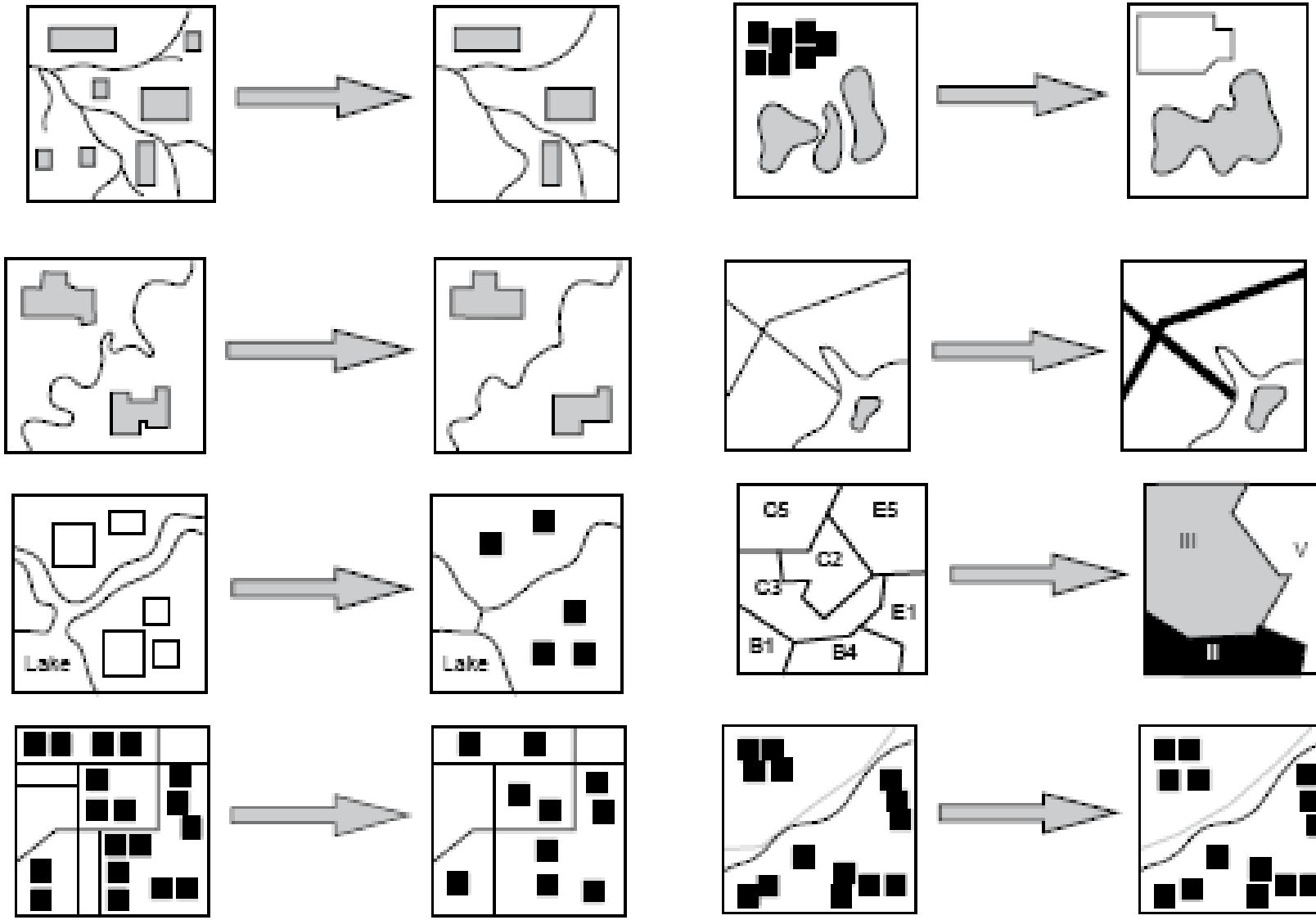
- When to generalise
  - Geometric conditions
    - Congestion
    - Coalescence
    - Complication
    - Inconsistency
    - Imperceptibility
  - Controls
    - Operators
    - Algorithms
    - Parameters
  - Measures
    - Density
    - Distribution
    - Length and sinusoity
    - Shape
    - Distance
    - Gestalt

McMaster-Shea model '92

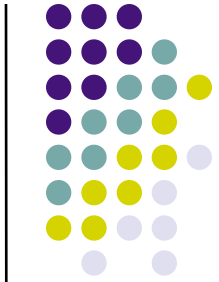


- How to generalize
  - Simplification
  - Smoothing
  - Aggregation
  - Amalgamation
  - Merging
  - Collapse
  - Refinement
  - Exaggeration
  - Enhancement
  - Displacement
  - Classification
  - Symbolisation
  - Typification (added later)

Operations (source ESRI)

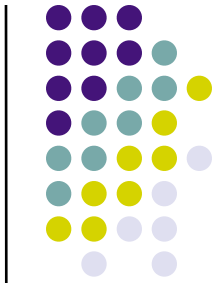


Kilpelainen(Sarjakoski) model '94



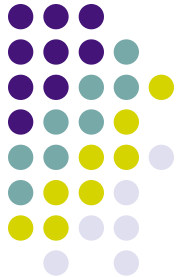
- Model generalization separation
- Incremental generalization
  - Generalization task is divided into modules which represent separable part of processed geodatabase
  - Generalization operations are divided into
    - increasing conflict (displacement, exaggeration) and non increasing conflict (rest)
    - Content (selection, aggregation,amalgamation and reclassification) and graphic (rest) ones

Contemporary approaches



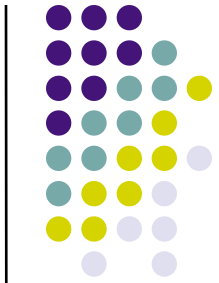
- rule based
- constraint based
  - agent based
  - combinatorial optimalisation based
  - continuous optimalisation based
- amplified intelligence

Rule based



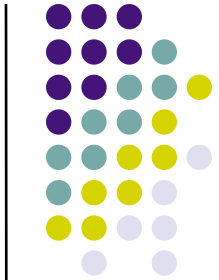
- expert systems legacy
- **If** something **then** action
- blind end ?
  - generalization is too complex
  - not easy to identify rules
  - rigidity
- not exactly !
  - generalized modus ponens
  - reverse engineering
  - non-inventory objects

Constraint based approach



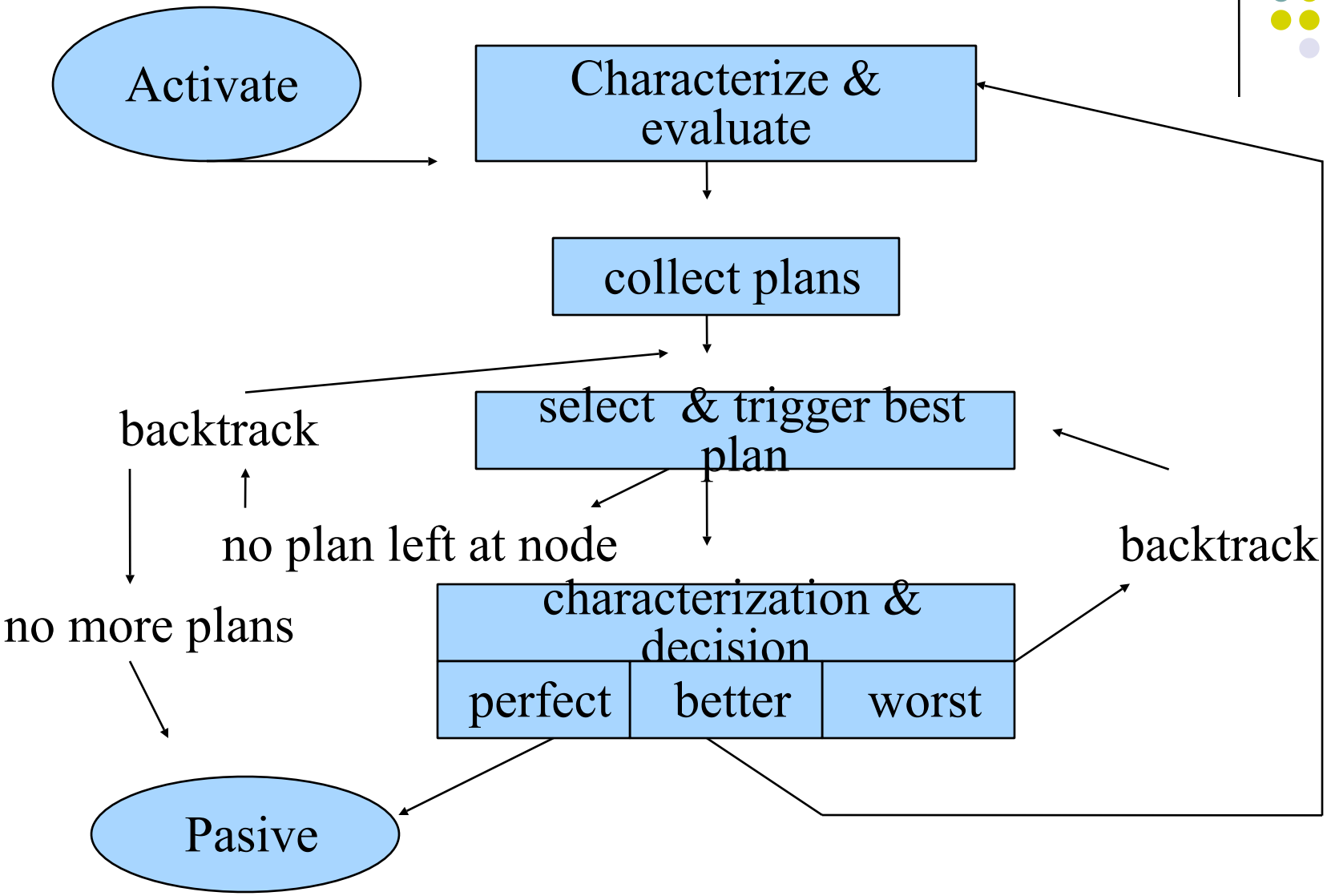
- set of conditions
  - for example : size, min. distance...
  - is impossible to satisfy all
  - optimization
- synthesis of conditions
- flexibility of method choice
- results oriented

Agents

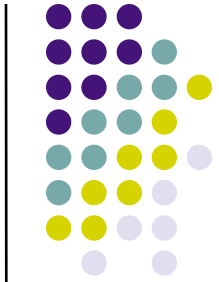


- communicating objects
- have plans how to reach better status
- perceive environment
- collaborate
- combine local and global view
- explicitly define map objects and its relations
- follows incremental model
- but too complex

"hill climbing" (source Weibel '05)



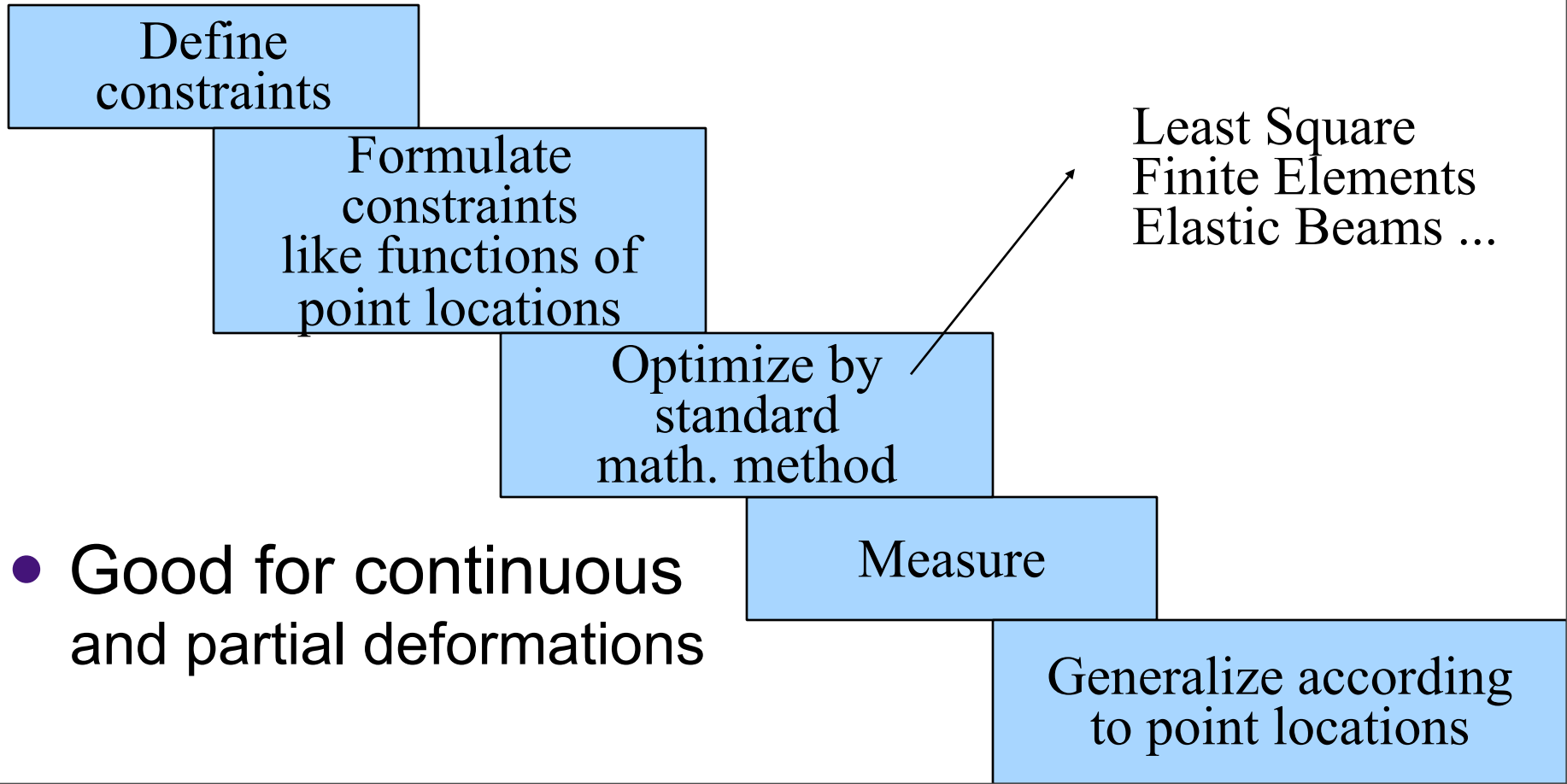
Combinatorial Optimization



- generate trial solutions
- test against criterion (a)
- trials are combination of methods
- cost of constraint violation
- discrete search space
- complicated tuning of parameters
- sometimes leads to deformations

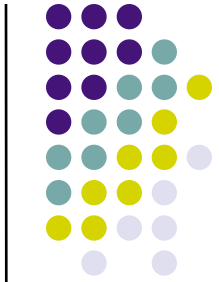
Continuous Optimization

- To find min. or max. of function defined in continuous space



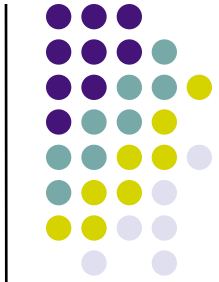
- Good for continuous and partial deformations

Amplified Intelligence



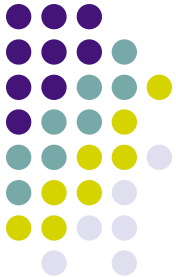
- Improvement of computer aided generalization
- Computer offer possible solutions
- WYSIWYG conflicts display
- Parameters are transformed in “human readable” form
- Holistic
- Strongly depend on user

Implementations



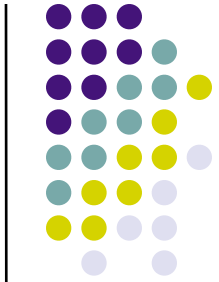
- more computer aided generalization
- Intergraph first
  - MGE MapGeneralizer
  - DynaGen
  - Geomedia extension (???)
- McMaster Model
- various simple functions
- WYSIWYG parameters tuning

Implementations



- ESRI in last years
  - simplification support
  - big plans in future
- Laser - Scan is most developed
  - related to AGENT and MAGNET
  - CLARITY environment
- Various NMA's products
  - CartACom - IGN
- Change – roads and buidings complex generalisation, Univ. of Hannover

Implementations



- Open Source world
  - JTS is heavy used
  - Plug-ins
  - web services
  - ICA working group for algorithms sharing