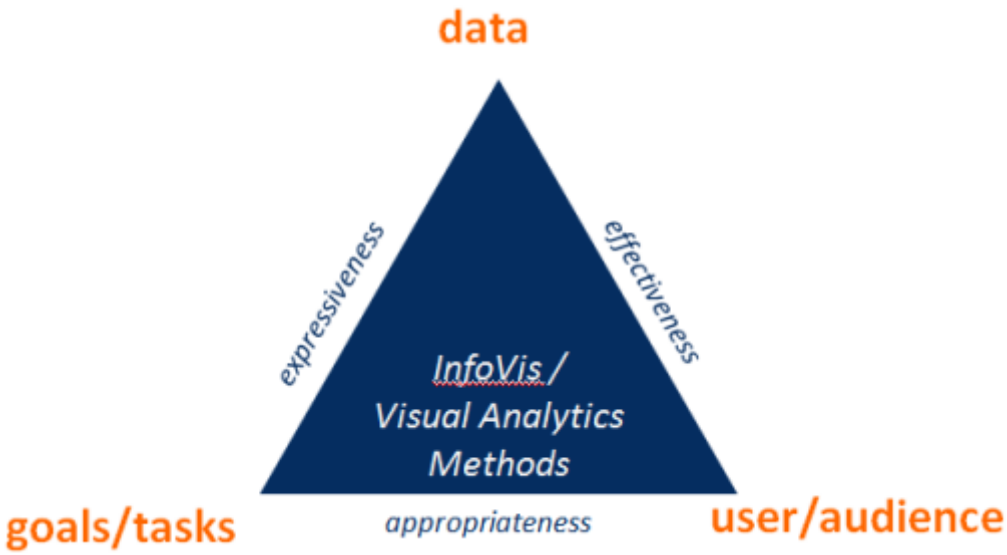



**Goal of InfoVis**

- insight – learning / knowledge extraction
- discovery
- explanation
- decision making

**Visualization Definitions**

- Using computer-supported, interactive, visual representations of data to amplify cognition
- --> insights, not pictures

**When is Vis needed**

- when human capabilities need to be augmented
  - when problem is not well defined
  - not clear which questions will need to be asked
- not when humans can be fully replaced by some automated system

**What does it do**

- increase cognitive ressources – extra working memory for humans
- reduce search time – represent data in small space
- improve pattern recognition – organize data in space by its time relationships
- support easy perceptual inference of relationships
- monitoring of large number of potential events
- provide manipulable medium – so user can explore data

**external representation**

- replaces cognition with perception
- --> answer is obvious once you look at the visualization

**Process**

1. Exploration
   1. search undirected – no hypotheses yet
   2. get insights + begin extracting relevant information
   3. come up with hypotheses
2. Confirmation
   1. search directed
   2. verify / reject hypotheses
3. Presentation of results

**Related**

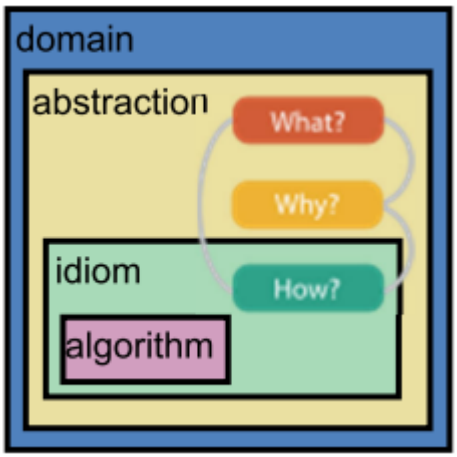
- Scientific Visualization – visualzies thing from the physical world
  - Volumes
  - Flow of Liquid / Energy / People
- Information Design – graphic design community based (infographics)
  - presents facts
  - no / less interactivity
  - less data

**Data**

- Variables
  - nominal
  - ordinal
  - quantitative
    - discrete
    - continous
  - binary
- Data Type Structures
  - univariat
  - multivariat
  - hierarchy / tree
  - graph / network
  - time-oriented
  - text / document
  - 2D map
  - 3D map

# Domain – Abstraction – Idiom – Algorithm
## What – Why – How

**Analysis Framework**




- levels
  - Domain
    - who are the users
    - possible problem: misunderstood the users
    - solution: observe users while they use existing tools
  - Abstraction
    - **what** is shown – data abstraction
    - **why** is the user looking – task abstraction
    - possible problem: showing the wrong thing
    - solution: observe users while they use your tool
  - Idiom
    - **how** is it shown
      - visual encoding – how to draw it
      - interaction – how to manipulate it
    - possible problem: show it in a bad way
    - solution: qualitative analysis / lab study
  - Algorithm
    - efficient computation
    - possible problem: code is too slow
    - solution: measure time / memory and analyse complexity

**Definitions**

- Data = input signal (to sensory / coginitive processes)
- Information = data with associated meaning
- Knowledge = all data + information + cognitive ability that allows people to make decicions

**How to handle complexity**

- change view over time
  - smooth transitions instead of jump cuts
- facet across multiple views
  - overlay 2 views onto one
  - present them side by side
  - split view into 2
  - also higlight item selected in one view in all other visible views
- reduce items / attributes within a view
  - filter
  - aggregate - boxplot
- derive new data to show within a view
  - original data: imports and exports over time
  - transform into: overall balance = exports – imports

## What

- Datasets
  - Data Types
  - Dataset Types
  - Data and Dataset Types
  - Dataset Availability
- Attributes
  - Attribute Types
  - Ordering Directions

## Why

- Actions
  - Analyze
    - Consume
    - Produce
  - Search
  - Query
- Targets
  - All data
  - Attributes
  - Network data
  - Spatial data

## How

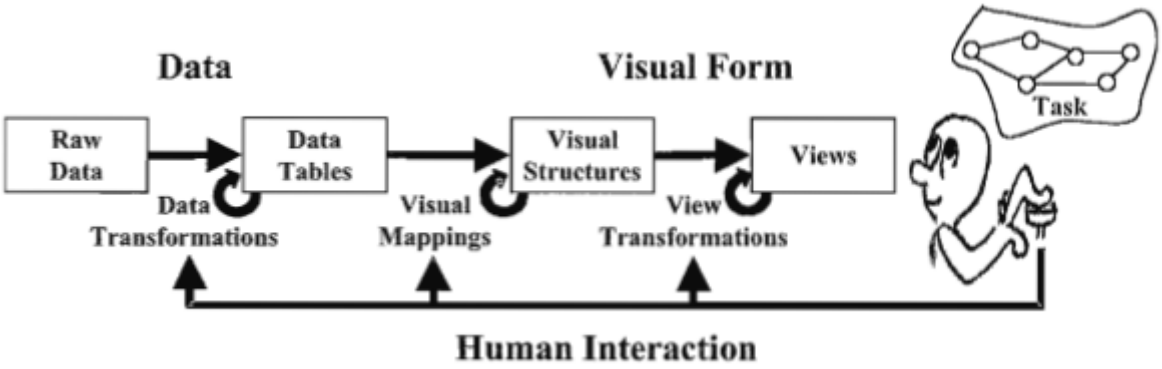
- Encode
  - Arrange
  - Map
- Manipulate
  - Change
  - Select
  - Navigate
- Facet
  - Juxtapose
  - Partition
  - Superimpose
- Reduce
  - Filter
  - Aggregate
  - Embed

# Card – Information Visualization

**Why does Visualization work**

- it makes the outside world a ressource for thought --> increases memory / processing
  - reduces search
  - improves pattern detection
  - enables perceptual inference operations --> solution obvious by looking at it
  - monitoring through perception
  - allows manipulation of informtion

**Visualization Reference Model**




**Data Structures**

- Nominal – things have names --> can only do = and != (Bernd, Alex, Franz)
- Ordinal – things have an order --> can also do < and > (Small, Medium, Large)
- Quantitative – can do arithmetic --> + - * etc. (0.5, 0.75, 1.25)

**Visual Structures**

- Spatial substrate – most powerful
  - most important variables encoded spatially -> easier to tell curves apart when drawn then when shown through color hues
- Marks
  - Points, Lines, Areas, Volumes
- Connections
  - Graphs, Trees
- Enclosure
  - Trees (like for File Size), Contour maps, Venn diagrams
- Retinal properties
  - color
- Temporal encoding
  - change view over time (like zooming)

**Expressive**

- if it encodes all intended data relations
- and no other data relations

**Effective**

- Position is most effective all-round representation
- Shape is only effective for Nominal data
- Gray scale is most effective for Ordinal data

**Techniques for Information Visualization**

- Dynamic queries
  - display needs to change within 0.1 sec of change made by user
- Magic lens (movable filter)
  - e.g. show population of city while the lens is over the city
- Overview + detail
  - magnified view + small view on the side that shows whole picture and where the magnification takes place
- Linking and brushing
  - multiple views – linked by using some color for same components
  - brushing: move cursor over object in one view highlights it in other view as well
- Extraction and comparison
  - comparse subsets with each other
- Attribute explorer
  - combination of techniques

**Focus + Context**

- user needs both overview (Context) and detail view (Focus) and different info in each
- Techniques
  - Data Based
    - Filtering – only display some of the data
    - Selective aggregation – aggregate some data where it makes sense
  - View Based
    - Micro-Macro readings – graph that shows both individual datapoints for close inspection and the broader outline of how things change over time
    - Highlighting
    - Visual transfer functions – show part of the screen distorted (like list where things to the bottom and top get smaller and smaller)
    - Perspective distortion – same but it 3D
    - Alternate geometries

**Knowledge Crystallization**

1. Acquire information
2. Make sense of it
   1. Extraction
   2. Fusing of information of different sources
   3. Find schema for compactly displaying important information
   4. Record instances into the schema
3. Create something new
4. Act on it

# Die visuelle Kodierung von Information

**Computer & Mensch**

- Computer
  - komplexe Berechnungen
  - genau + flexibel
  - dynamische Veränderung von Visualisierung basiert auf Parametern in Echtzeit
- Mensch
  - visuelle Wahrnehmung
  - kognitive Verarbeitung
  - Wissensassoziation und -konstruktion
  - leichte Erkennung von unscharfem Text / Formen

**Aspekte der Informationsvisualisierung**

- Zielgruppe – Fachwissen
- Aufgaben – warum wird es verwendet
- Daten – was / woher / wie kann man sie aufbereiten / reduzieren
- Representation – welche visuellen Mittel nützen
- Medium – Zeitschrift / Monitor mit Maus / Touchscreen

**Ziele**

- exploration – zB reflektierend
- discovery – finden neuer Zusammenhänge
- decision making
- explanation

**Stufen**

1. explorative Analyse
   - interakive ungerichtete Suche
   - Benutzer können nicht im Detail erklären was gesucht wird
   - es gibt noch keine Hypothesen über Daten / Strukturen / Eigenschaften
2. konfirmative Analyse
   - zielgerichtete Suche
   - basierend auf Hypothesen --> bestätigen / wiederlegen
3. Präsentation
   - Kommunikation von Erkenntnissen
   - Fakten so darstellen, dass andere sie leicht verstehen können

**Grundlegende Aufgaben von Informationsvisualisierungen (Tasks laut Intro Folien)**

- Overview
- Zoom
- Filter
- Details-on-demand
- Relate
- History (undo / repeat)
- Extract

**Mantra**

- Overview --> Zoom & Filter --> Details-on-demand

**Datentypen**

- Datenmodell – repräsentiert Auschnitt der realen Welt
  - Objekte mit Attributen und Relationen untereinander
- Attribute
  - quantitative
  - kategorisch (nominal / ordinal)
- konkrete Wert eines Attributes = Ausprägung
- Attribute von Daten = Metadaten