



*Visualization, DD2257*  
*Prof. Dr. Tino Weinkauff*

## ***Data Description***

Variables

*semantics: real-world meaning*

Basil

7

S

Pear

*type:*  
*categorical*

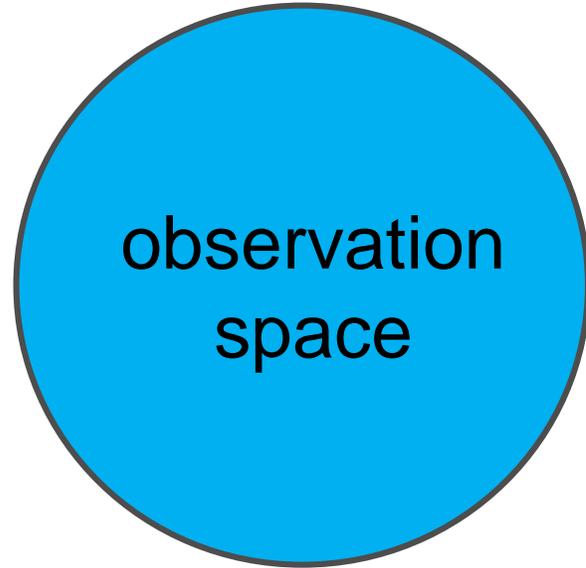
*type:*  
*quantitative*

*type:*  
*ordinal*

*type:*  
*categorical*

very important

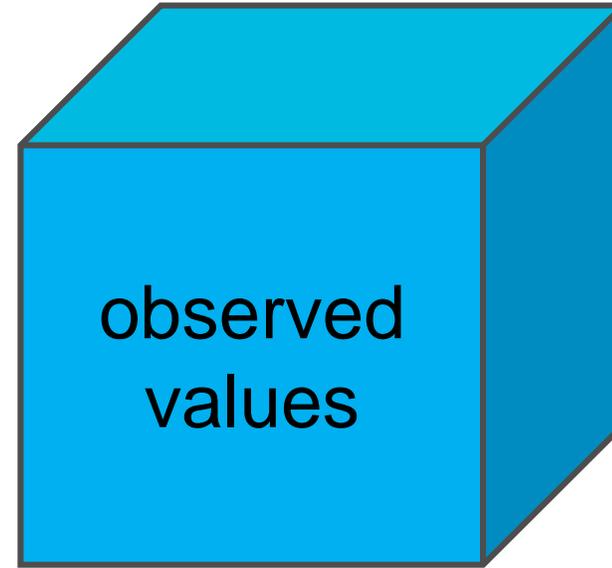
$R^n$



independent  
variables

X

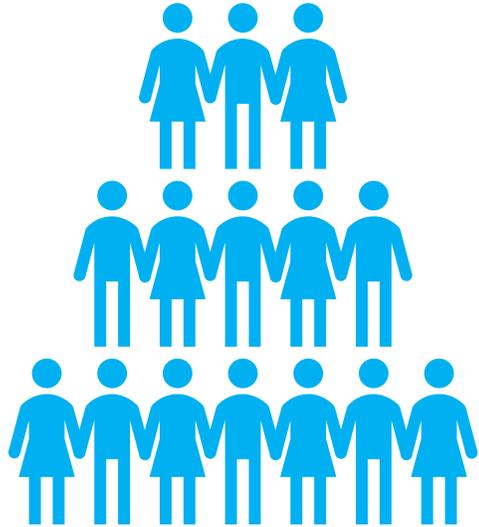
$R^m$



dependent  
variables

observation space:

students



independent  
variables

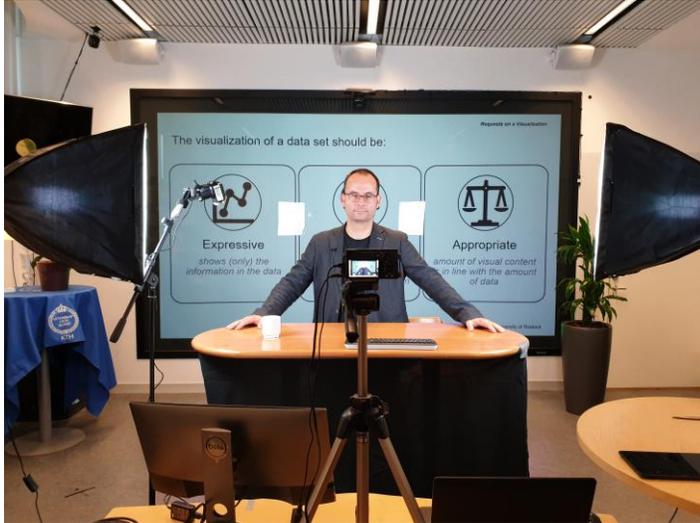
X

observed values:

name  
height  
field of study

dependent  
variables

observation space:  
room (x,y,z-coordinates)



independent  
variables

observed values:

temperature  
material  
(wood, glass, metal, air)

dependent  
variables

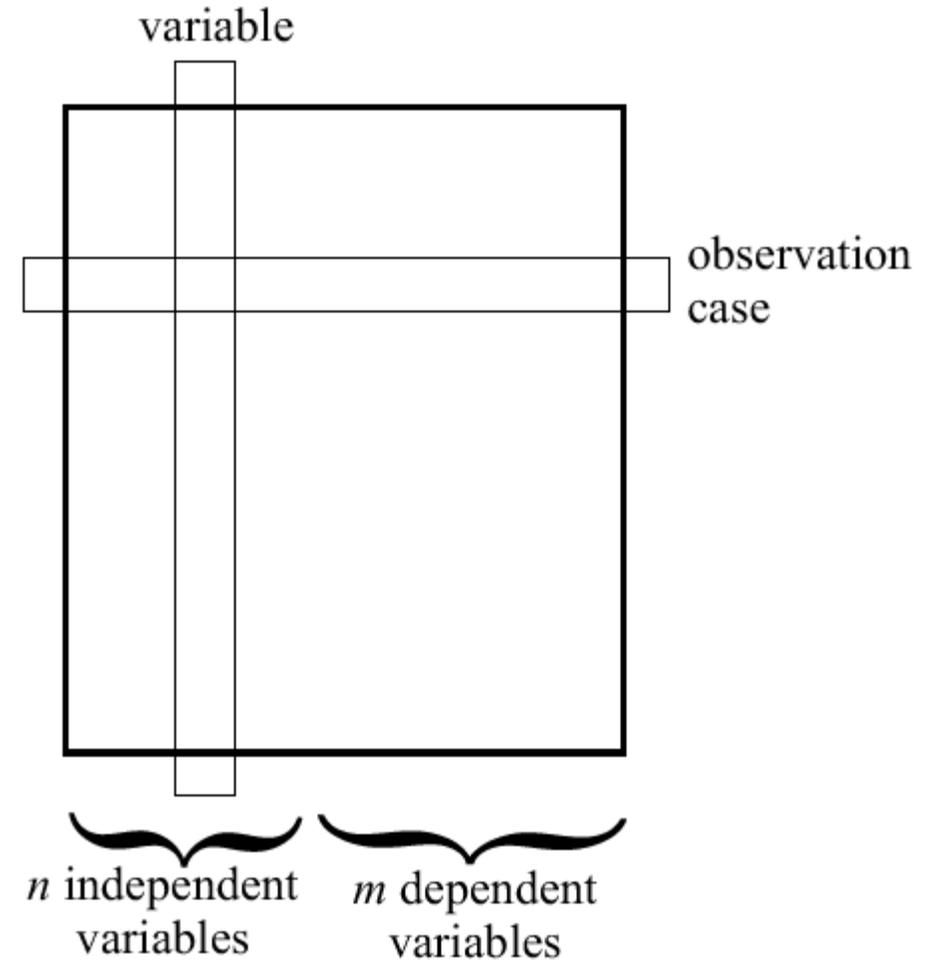
X

- **Scientific data are [Brodlie 92], [Bergeron 93], [Wong 97]**
  - $m$ -dimensional data, which are gathered in an
  - $n$ -dimensional observation space.
- **We distinguish between:**
  - **independent variables:** dimensions which define the observation space
    - “multidimensional data“
  - **dependent variables:** the parameters observed in the observation space
    - “multivariate data“
- “Multiparameter data” is the general term for multidimensional and multivariate data.

- Observation space is actual space & time
  - Often the case in physics, medicine, chemistry, geology, ...
  - Many numerical methods available (derivatives, interpolation, ...)
  - *The class will concentrate on visualization methods for that kind of data.*
  
- No specific prior on observation space
  - Often the case with business data, data bases, abstract spaces, ...
  - Few general methods exist
  - Many guidelines exist
  - *We discuss only few methods for this kind of data in this course. Otherwise, see Information Visualization course.*

Common way of describing multiparameter data:

table in which independent and dependent variables are marked.



Variables have different properties such as:

- quantitative / qualitative
- ordering
- metric
- discrete / continuous
- ...

# Quantitative versus qualitative variables

## *quantitative variable*

The values are numeric and some mathematical operations\* are defined.

- height of people
- positions in space
- movie ratings on a 1-10 integer scale

## *qualitative variable*

The values come in other forms than numbers.

- names of people
- food: fruit, vegetable, meat, other
- t-shirt sizes: small, medium, large

\* addition, multiplication, comparison, ...

# Subtypes of quantitative variables

## *quantitative variable*

- scalar

- height of people
- movie ratings on a 1-10 integer scale

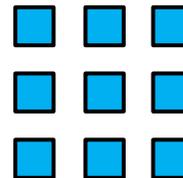


- vector

- positions in space



- tensor

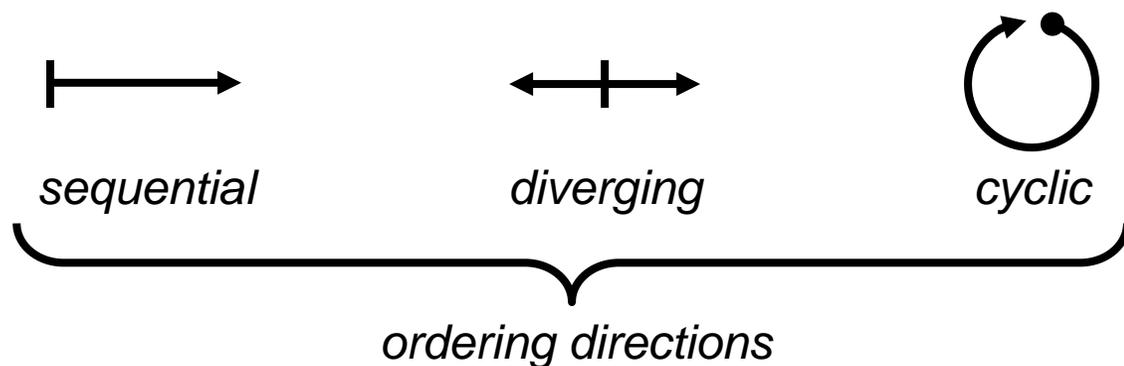


# Association with an ordering

## *ordering defined*

We can order any two values, and consequently, any number of values.

- height of people
- t-shirt sizes: small, medium, large
- movie ratings on a 1-10 integer scale



## *ordering not defined*

An ordering between values is not intrinsically defined.

- names of people
- food: fruit, vegetable, meat, other
- positions in space

## Association with a metric (distance function)

### *metric defined*

We can compute the distance between any two values.

- height of people
- positions in space
- movie ratings on a 1-10 integer scale

### *metric not defined*

A distance between values is not intrinsically defined.

- names of people
- food: fruit, vegetable, meat, other
- t-shirt sizes: small, medium, large

## Discrete versus continuous for quantitative variables with metrics

### *discrete variable*

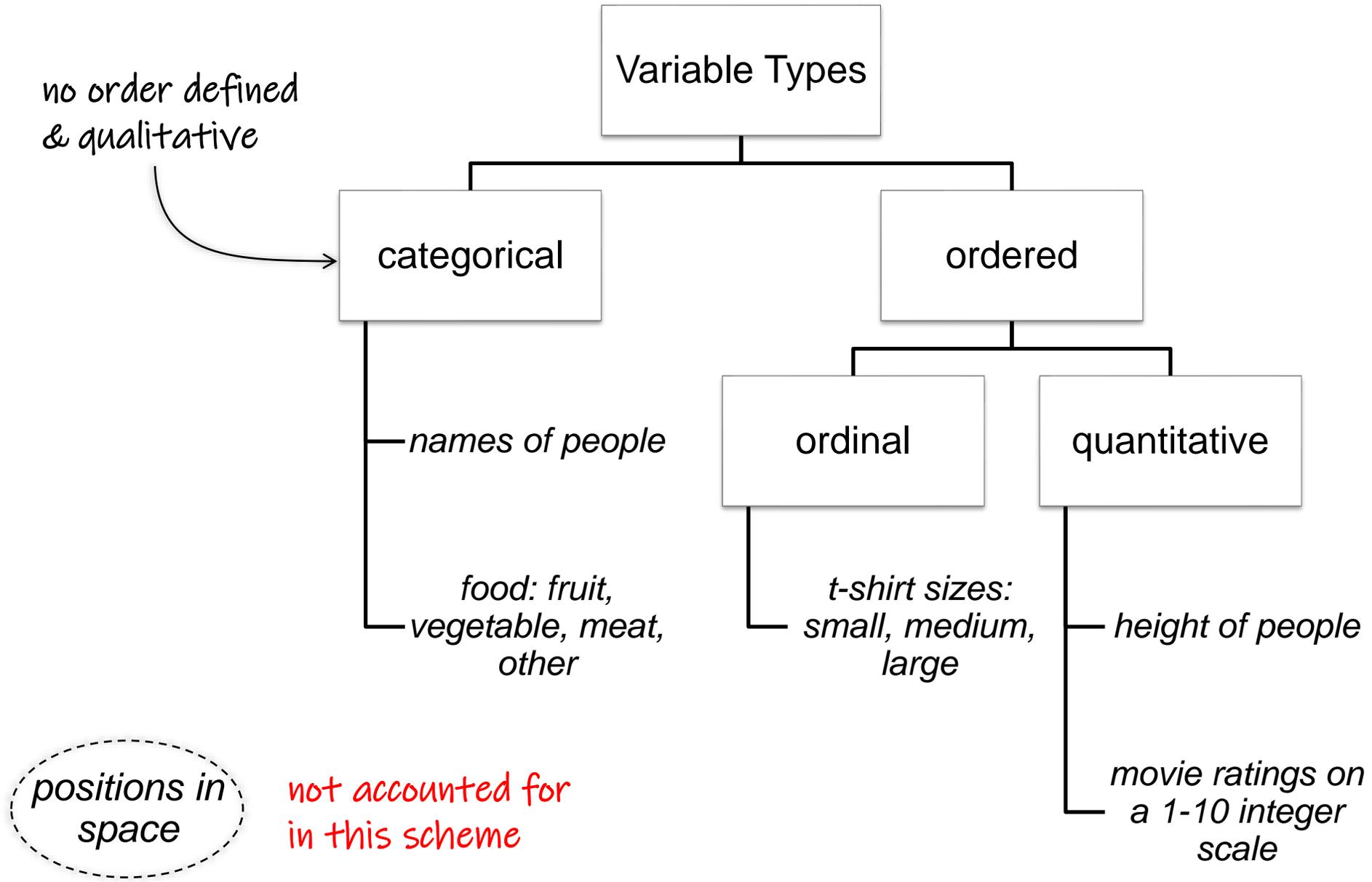
There is a positive minimum distance between any two values. The number of permitted values is either finite or countably infinite.

- movie ratings on a 1-10 integer scale

### *continuous variable*

The variable attains values from a continuous infinite range. Consequently, we have an uncountable set of values.

- height of people
- positions in space



- int, short
- float
- double
- enum
- string

# Summary

- Independent / dependent variables
- Semantics of variables: real-world meaning
- Types of variables:
  - properties: quantitative/qualitative, order, metric, discrete/continuous
  - Munzner's hierarchical scheme for variable types