



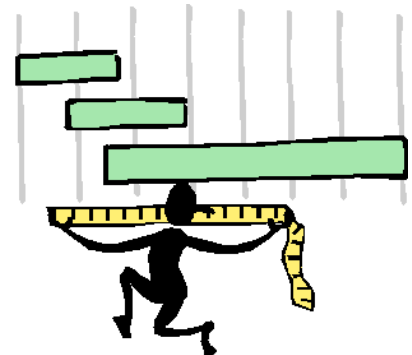
Measurement and Scale

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[Measurement in Experiments]

- Measurement is a central part in empirical studies
- Software measurement is crucial to enable control of software projects, products, and processes

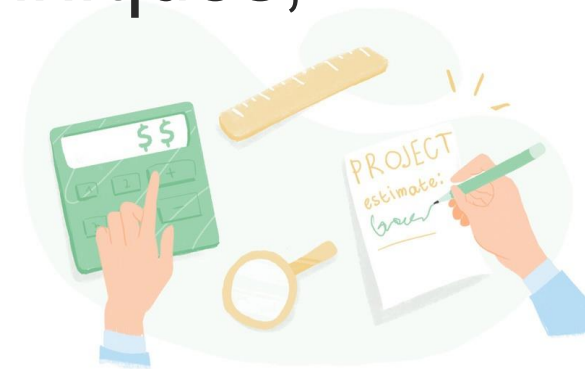


Evaluation is Control

“You can't control what you can't measure”

Tom DeMarco

- Control comes from being able to evaluate new methods, techniques, languages, and tools



Definitions

- Measurement is the process by which numbers or symbols are assigned to attributes of entities
 - They describe attributes of entities according to clearly defined rules
 - Entities are objects in the real world
- A measure is a mapping from the attribute of an entity to a value
 - Usually a numeric value

Measure vs. Metric

- A measure is the number or symbol assigned to an entity to characterize an attribute
- Software metrics denote the field of measurement in software engineering
- Product metric denotes a property or attribute which is measured
 - Example: lines of code (LOC)

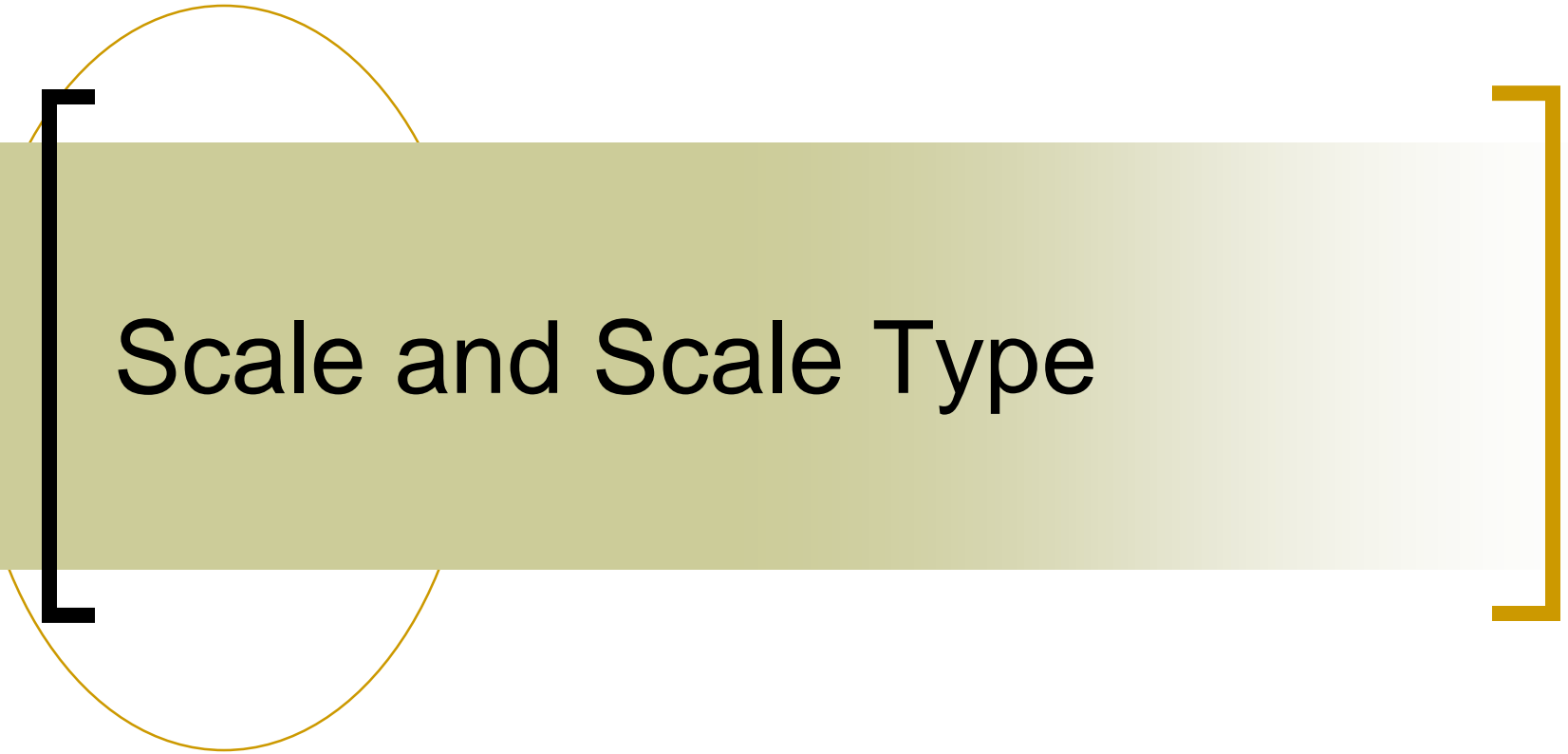
[Measure Validation]

- To use a measure, it must be valid
 - It must not violate any necessary property of the measured attribute
 - It must be a proper mathematical characterization of the attribute
- Different objects can have the same measurement value
 - The measure must preserve our intuitive notion about the attribute



[Analytical and Empirical Validation]

- Analytical validity of a measure relates to its ability to capture accurately and reliably the attribute of interest
- Empirical validity describes how well a score correlates to something measured in another context



Scale and Scale Type

[Measurement Scale]

- Scale defines the mapping from an attribute to a measurement
 - Meters, centimetres and inches are different scales of length
- We can transform the measure from one scale to another
 - If the transformation preserves the relationship among the objects, it is called *admissible transformation* or *rescaling*



[Meaningful Statement]

- Meaningful statements are true after rescaling
- Example
 - Object A is 1 metre long
 - Object B is 2 metres long
- Statement: B is twice as long as A
 - Statement is true even if we rescale to centimetres or inches



[Meaningless Statement]

- Meaningless statements are not true after rescaling
- Example
 - Room A is 10° C
 - Room B is 20° C
- Statement: B is twice as warm as A
 - The statement is no longer true if we rescale to Fahrenheit (50° F and 68° F)

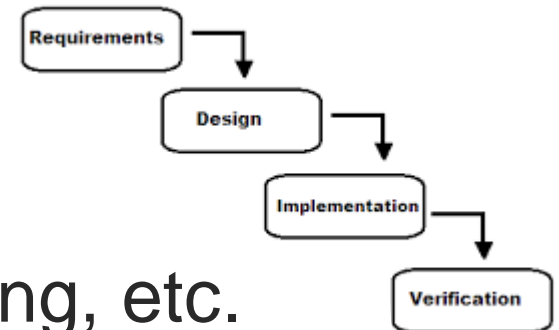


[Scale Types]

- Scales belonging to the same scale type share the same properties
- The most common scale types are
 - Nominal
 - Ordinal
 - Interval
 - Ratio

[Nominal Scale]

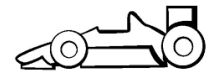
- The nominal scale is the least powerful of the scale types
- It maps the attribute into a name or symbol
- Transformations preserve the one-to-one mapping
- Example: Defect type
 - Requirements, Design, Coding, etc.



[Ordinal Scale]

- The ordinal scale ranks entities after an ordering criterion

- Greater than, better than, more complex...



- Transformations preserve the order of the entities

- Example

- Sorting systems by their complexity

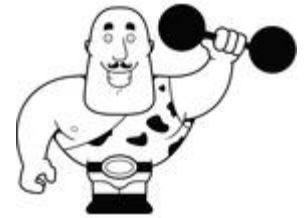
[Interval Scale]

- In the interval scale, the difference between two measures are meaningful
 - The value itself is not meaningful
- It orders the values as the ordinal scale
- There is a notion of relative distance between two entities
- Example
 - Temperature in Celsius and Fahrenheit



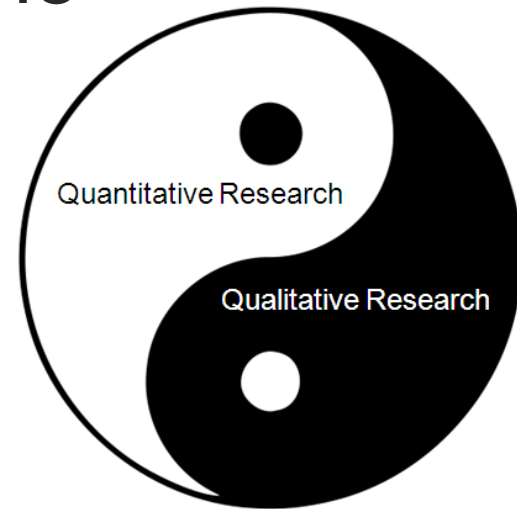
[Ratio Scale]

- It is the most powerful scale type
- In a ratio scale
 - There is a meaningful zero
 - Ratio between two measures is meaningful
- Example
 - Length of an array
 - Duration of a development phase



[Qualitative vs. Quantitative]

- Qualitative research is concerned with measurement mainly in the nominal and ordinal scales
- Quantitative research treats measurement on the interval and ratio scales



[Bibliography]

- C. Wohlin et al. **Experimentation in Software Engineering**, Springer. 2012.
 - Chapter 3 - Measurement
(up to Section 3.1)