

Software Quality **Management**

Dr. Stefan Wagner
Technische Universität München

Garching
4 June 2010

Last QOT: Why is cloning a problem?

"More code to manage"

"Performance issues"

"Defect fixed in one place needs to be fixed in most clones"

2

The major problem with cloning (in code) is that then there is more code to manage. The maintenance costs increase

If cloning constitutes a performance issue depends on what kind of performance we are interested in.

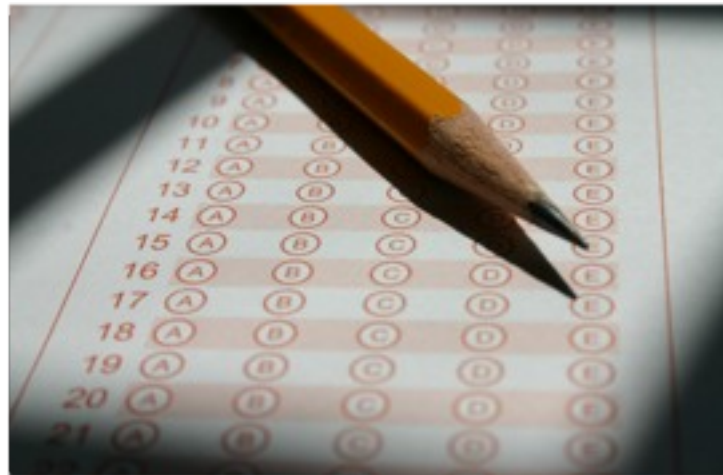
Cloning might in some cases increase speed, but it also increases the footprint of the code in memory.

The additional effort for fixing defects in many places is a problem. It gets even worse if we forget to fix bugs in some clones.

New QOT: "Why do we need continuous quality control in software development?"



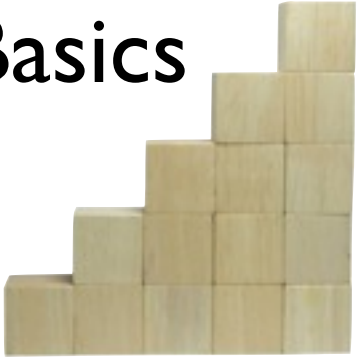
Code analysis



Quality evaluation

Review of last week's topics.

Basics



Product



Metrics and



Measurement

Process
Quality



Management

**Certifi-
cation**



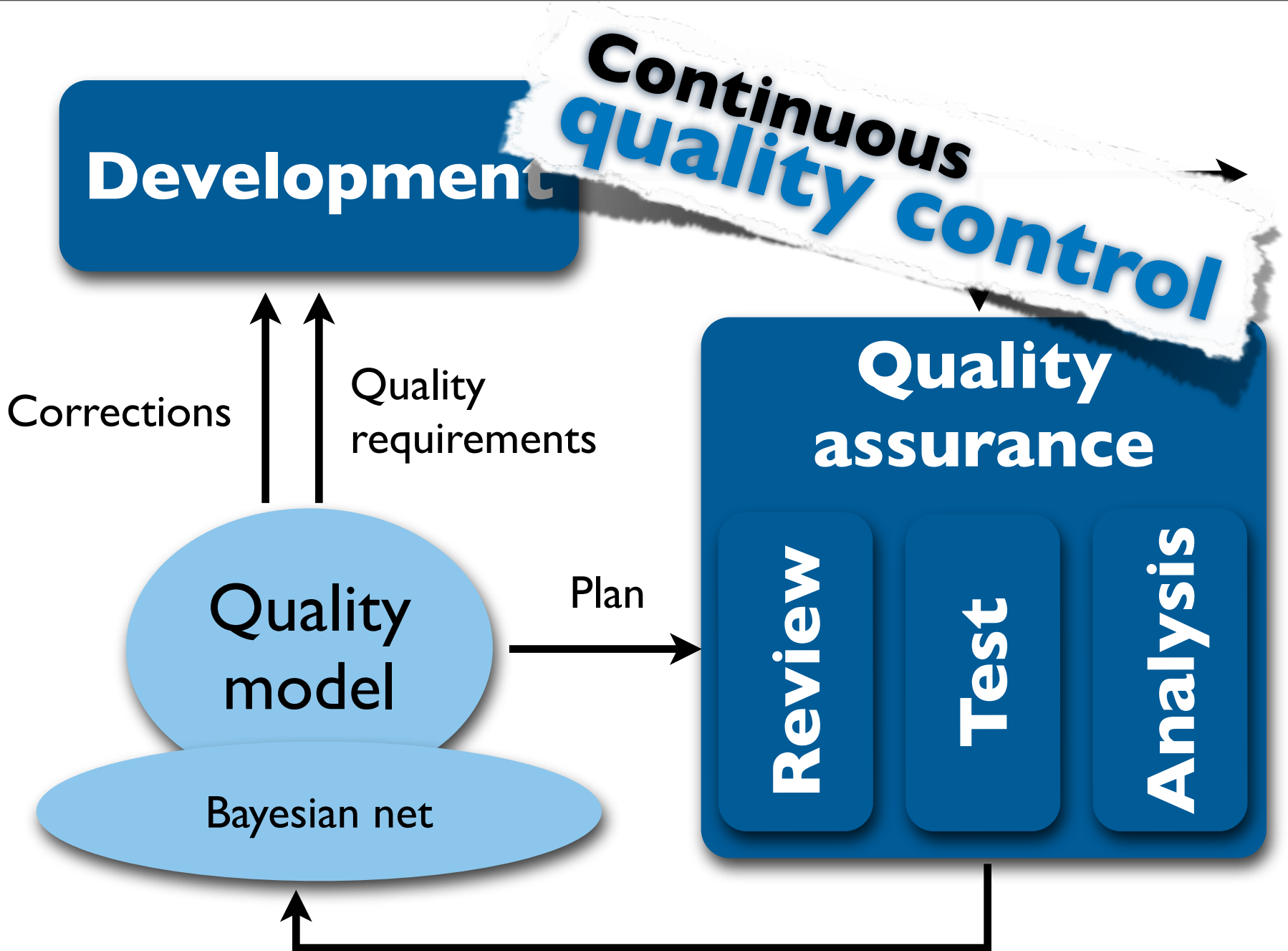
"By the time you figure out you have a quality problem it is probably too late to fix it."

—John S. Reel



5

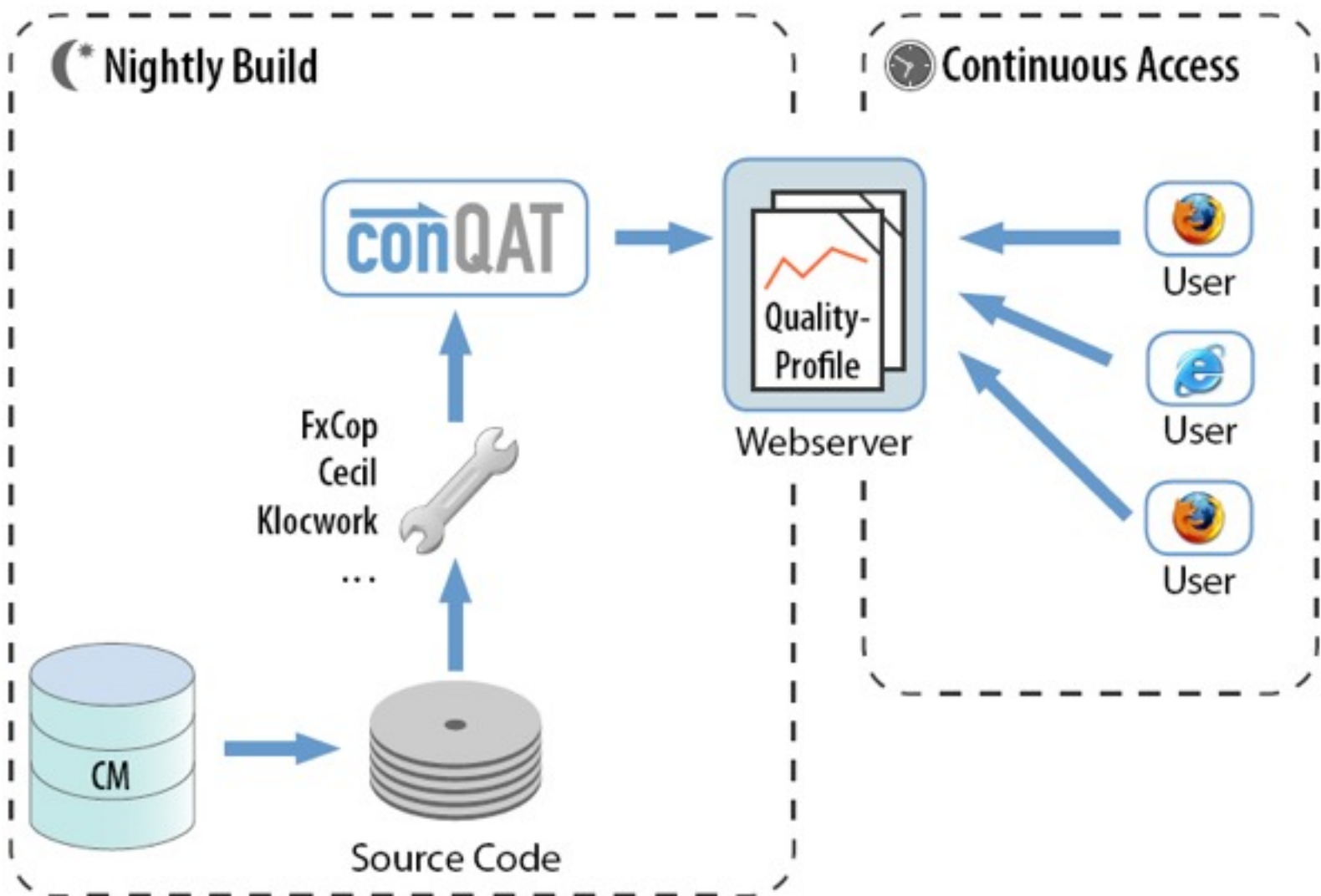
It might be too late to fix the quality problem, because it has become too expensive. In various studies, among them a study by Boehm, showed that it becomes roughly 10 times more expensive if we let slip a defect from one development phase to the next.



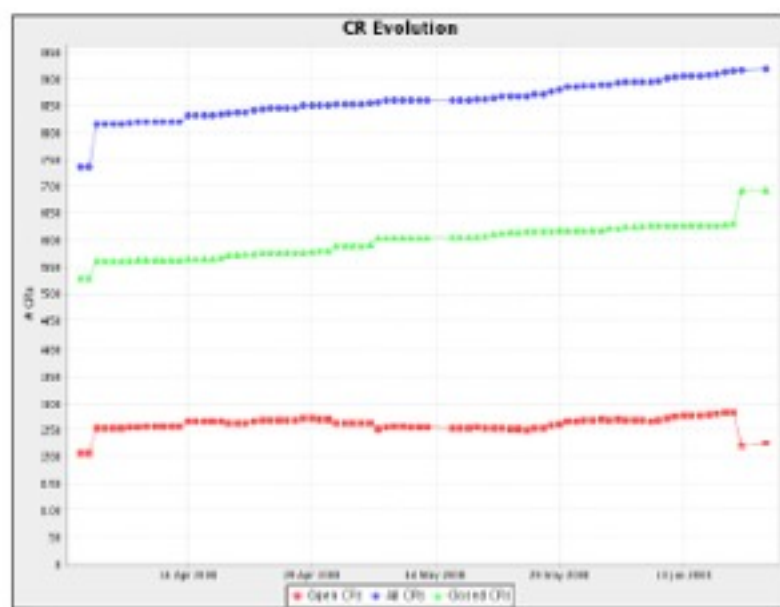
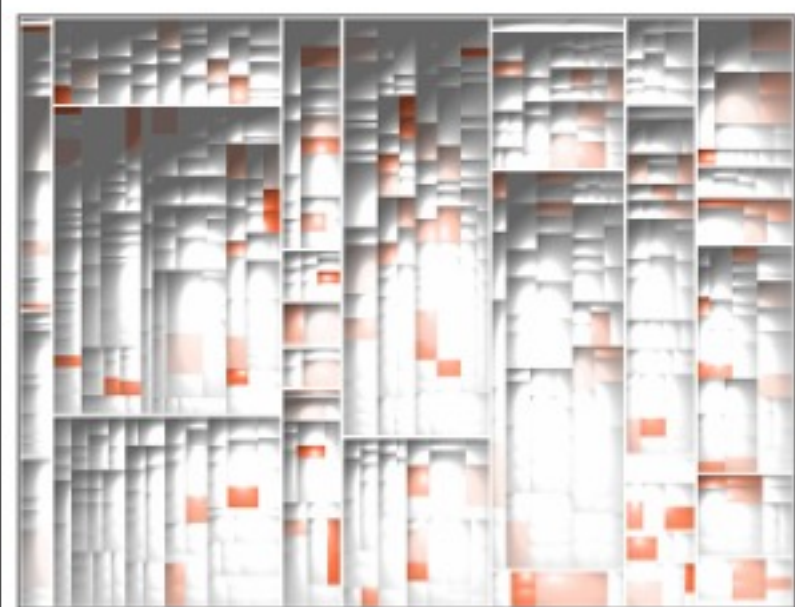
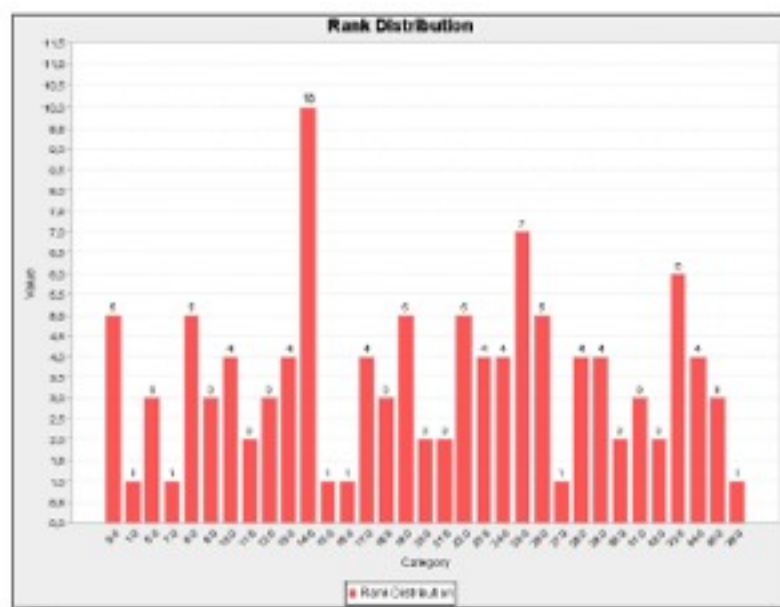
Deissenboeck et al., IEEE Software, 2008

6

The quality model is the central means for specifying quality requirements, planning quality assurance, and evaluating quality. This introduces a quality control loop similar to the Deming cycle. We specify quality requirements based on the model and give them to development. In development, we produce a software system that goes into quality assurance. What is done in quality assurance is also guided by the quality model (what kind of assurance?). The results of quality assurance are fed back to the model (e.g., by a Bayesian net) to evaluate the quality level. The current quality level is compared with the specification and corrections are sent to development. If this loop is done as often as possible, it becomes continuous quality control.

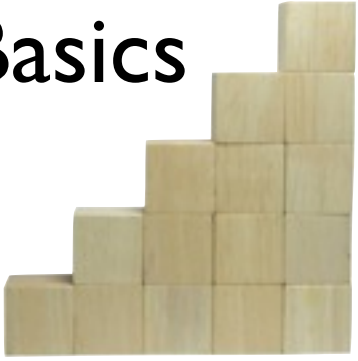


- To make continuous quality control efficient, tool support is necessary.
- Our open source tool ConQAT (<http://www.conqat.org>) automates many steps.
- It gathers the required artefacts, runs analysis tools, and visualises the results.



- Here are four types of visualisations:
- Traffic lights
- Bar charts
- Tree maps
- Trend charts

Basics



Product



Metrics and



Measurement

Process
Quality



Management

**Certifi-
cation**



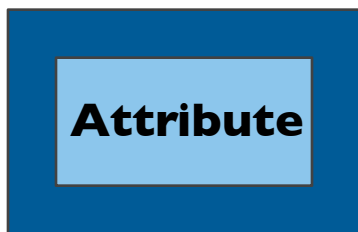


**Empirical
world**

Measurement



**Formal
world**



Entity

Measurement

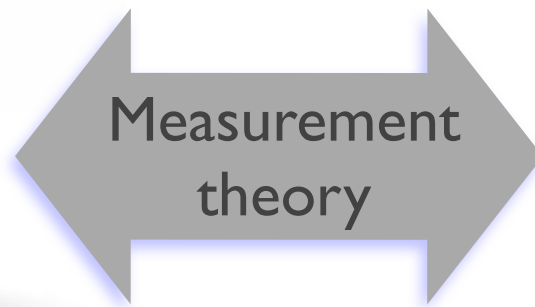
#

**Measure
Metric**

Measurement is the mapping from the empirical world to the formal world. In the empirical world, there are entities (things) that have certain attributes. These attributes can be expressed with measures from the formal world.

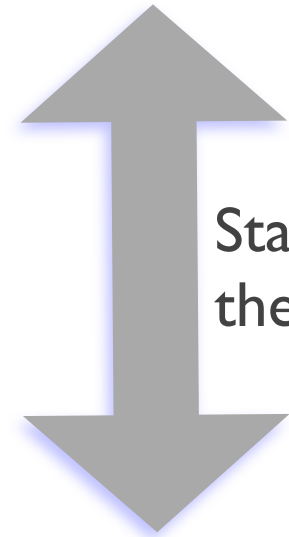


**Empirical
world**



#

Measure



Statistical
theory

#

Measure

Measurement theory is therefore responsible for arguing about the relationship between reality and measures.
The relationships between measures is the task of statistical theory.

Scales

- Nominal
- Ordinal
- Interval
- Ratio
- Absolute

Scales are the most important part of measurement theory.

- Data that only gives names to entities has a nominal scale. Examples are defect types.
- If we can put the data in a specific order, it has an ordinal scale. Examples are ratings (high, medium, low).
- If the interval between the data points in that order is not arbitrary, the scale is interval. An example is temperature in Celcius.
- If there is a real 0 in the scale, it is a ratio scale. An example are LOC.
- If the mapping from the empirical world is unique, i.e., there is no alternative transformation, it is an absolute scale. An example are the ASCII characters in a file.

Why scales?



- Scales are necessary to do the right interpretation!
- 40 degrees today in relation to 20 degrees yesterday is not twice as hot.
- The scales define what is permissible to do with the data.

Exercise

- Assign the measure examples on the hand-out to the correct scale types.
- 10 Minutes
- You can discuss with your neighbours.
- We will go through the results together.

Results

- Number of defects
- Defect types
- Effort in person-hours
- Rating of ease of use
- Requirements IDs
- Lines of code
- Cyclomatic complexity
- Response time in minutes
- Maintenance hours
- Training hours
- Recovery time
- Probability that attacker breaks the s.
- Workload / time
- Number of clicks

Ratio

Nominal

Ratio

Ordinal

Nominal

Ratio

Interval

Ratio

Ratio

Ratio

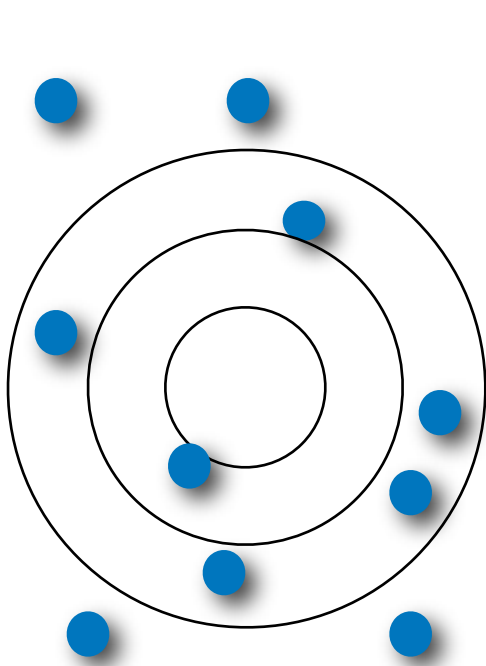
Ratio

Ratio / Absolute

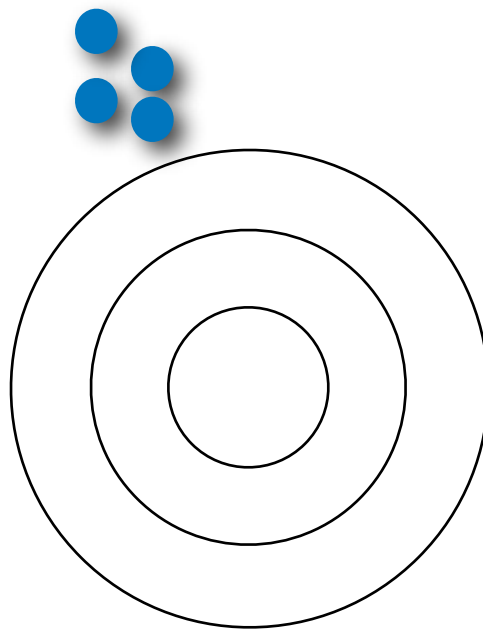
Ratio

Absolute

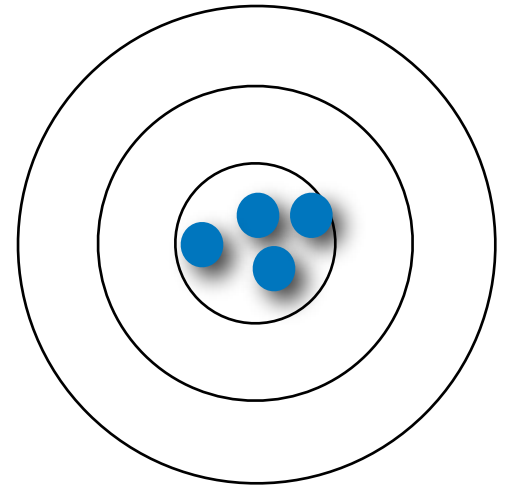
Reliability and validity



not reliable
not valid



reliable
not valid



reliable
valid

Very important desired properties of measures are reliability and validity.

Reliability means that the measure gives (almost) the same result if it is measured repeatedly.

Validity means that its value corresponds correctly to the attribute of the empirical entity.

Further properties

- **Objectivity** No subjective influence in measurement
- **Usefulness** Practical needs are fulfilled
- **Standardisation** There is a scale for the results
- **Comparability** Can be compared with other measures
- **Economy** Measurement can be done with low costs

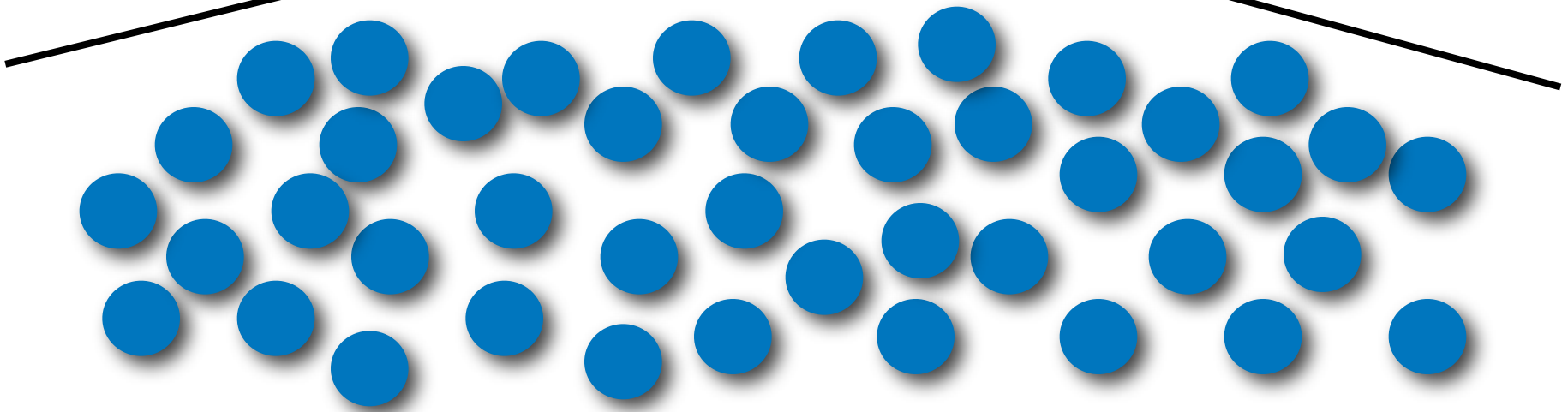
These properties of measures are also desired, but not always possible to achieve.

Aggregation

Single value



Measured data



Aggregation has the aim to reduce a huge amount of data into a single value. This happens in software quality management as we can (automatically) collect a lot of data at low cost. An example are warnings from static analysis tools that we have for each Java class, that we want to aggregate to the package level.

Aggregation operator

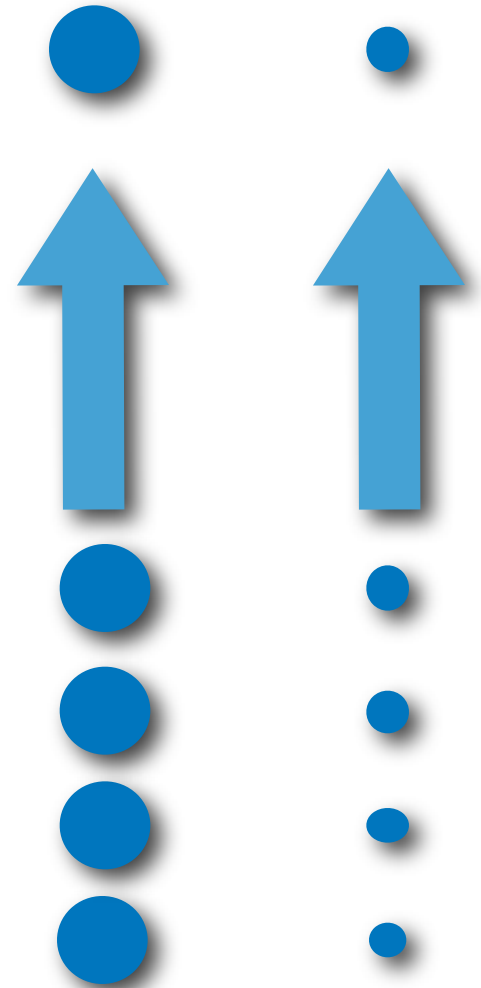
Identity



Boundary

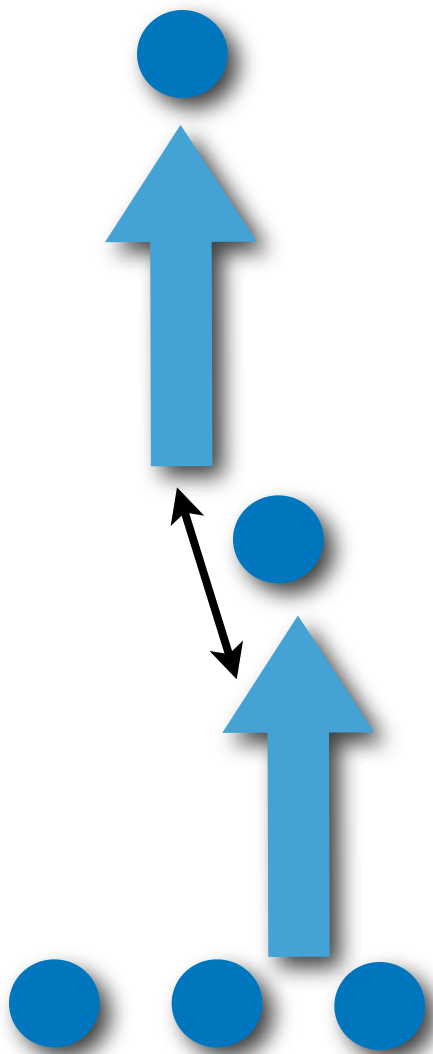


Monotonicity



Further properties

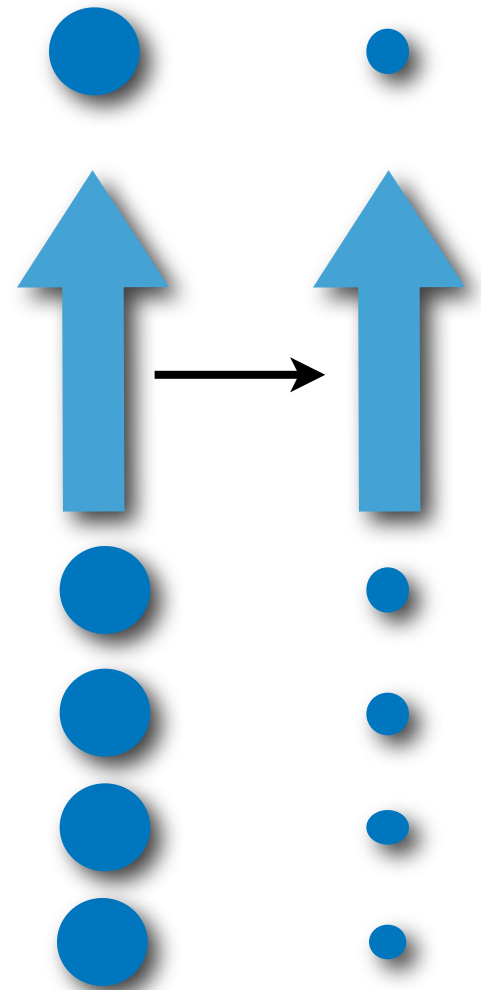
Associativity



Symmetry



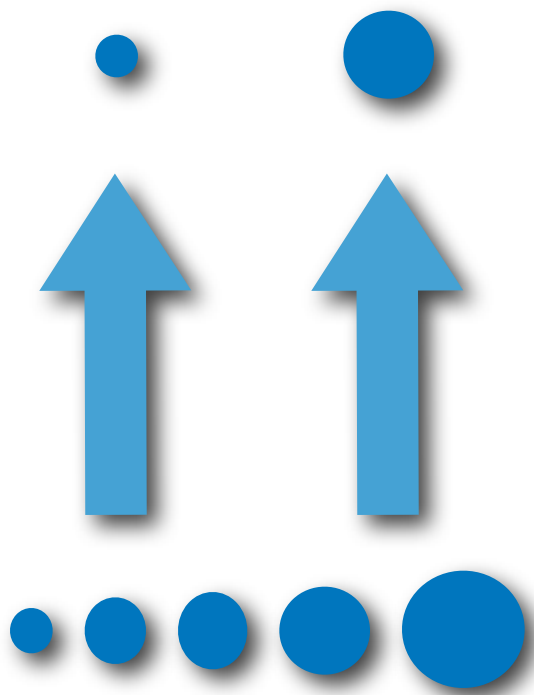
Idempotence



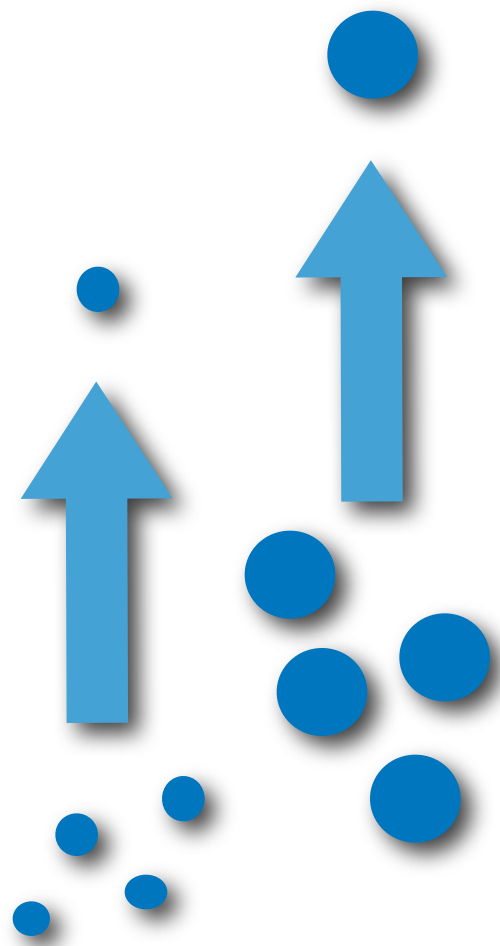
Details are on work sheet 1.

Grouping

Rescaling



Clustering



Details are on work sheet 1.

Central tendency

Mode

A, B, C, A



A

Median

5, 7, 2, 2, 8



5

Mean

5, 7, 2, 2, 8



4.8

Dispersion

Variation Ratio

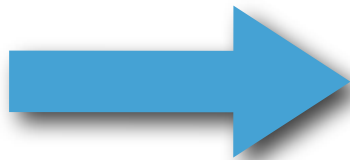
A, B, C, A



0.5

Maximum and Minimum

5, 7, 2, 2, 8



8, 2

Range

5, 7, 2, 2, 8



6

More dispersion

Median absolute deviation

5, 7, 2, 2, 8



2.2

Variance

5, 7, 2, 2, 8



6.16

Standard deviation

5, 7, 2, 2, 8

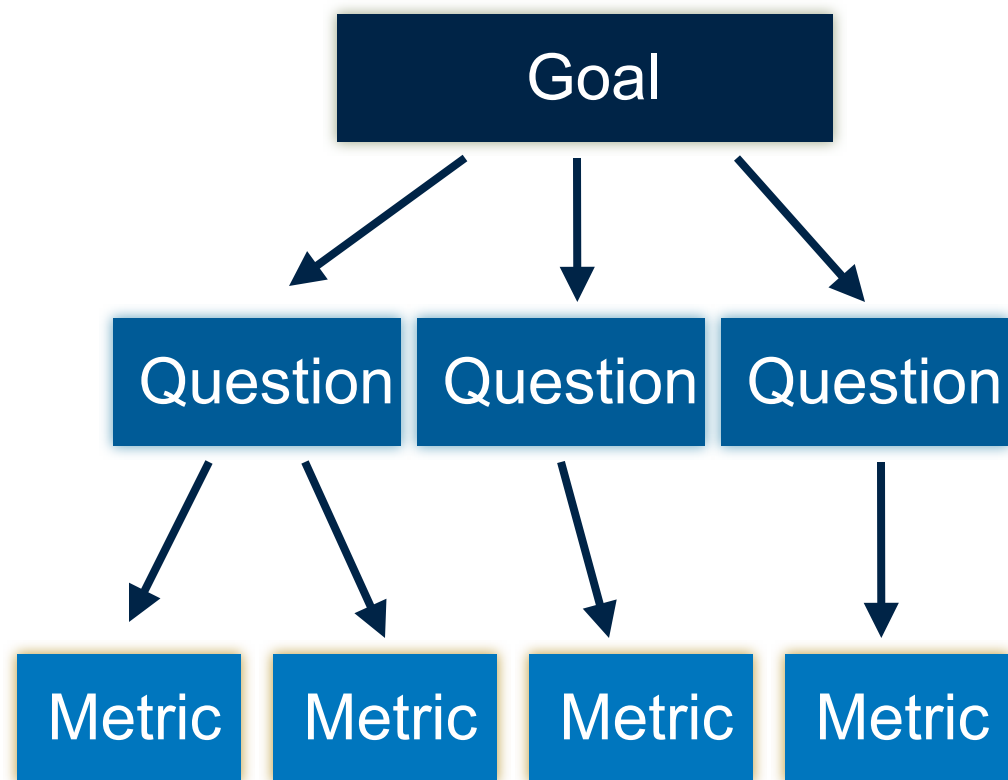


2.48

Exercise

- Write the appropriate scales and possible uses in software engineering next to each aggregation operator.
- 15 Minutes
- You can discuss with you neighbours.
- We will discuss the results together.

GQM



- Approach of Basili and Rombach
- „Measurement requires both goals and models“
- Against unsystematic data collection
- Goal: How do I improve my QA?
- Questions: How effective is the QA? How efficient is the QA?
- Metrics: # of found defects, Severity of found defects, found defects per person day

Conceptual level: Goals

Operational level: Questions

Quantitative level: Metrics

- Definition of goals (object, reasons, quality model, point of view, environment)
- Products, processes, resources
- Question: How to assess?
- Metric: objective or subjective

GQM example

Goal	Purpose Issue Object (process) Viewpoint	Improve the timeliness of change request processing from the project manager's viewpoint
Question		What is the current change request processing speed?
Metrics		Average cycle time Standard deviation % cases outside of the upper limit
Question		Is the performance of the process improving?
Metrics		$\frac{\text{Current average cycle time}}{\text{Baseline average cycle time}} * 100$ Subjective rating of manager's satisfaction