DCC / ICEx / UFMG

Metrics and Thresholds

Eduardo Figueiredo

http://www.dcc.ufmg.br/~figueiredo

Definition of Thresholds

- A crucial factor in working with metrics is to interpret values correctly
  - What is too high or too low?
- Thresholds divide the metric values into two groups
  - Above the threshold
  - Below the threshold

Motivation Example

- We define 2 meters for a *very tall person*
  - All people higher than 2 meters are classified as very tall
- Issues with thresholds
  - How did we come up with a threshold of 2 meters? Why not 1.90 m?
  - How about a person 1.95 m high compared to one 2.05 m high?

Facts about Thresholds

- There is no perfect threshold
- We can define a explicable threshold
  - That is, values chosen based on reasonable arguments
- Thresholds are useful in practice
  - This makes them good enough for our purpose

How do we define them?

- We have two major sources for defining threshold values?
  - **Statistical information**: based on statistical measurements, such as mean, median, and standard deviation
  - **Generally accepted semantics**: based on widely accepted knowledge. For example, threshold 3 (three) for number of meals a person consumes per day

Statistically-based Thresholds

- Statistically-based thresholds are often used for size metrics
- Let's suppose the number of hairs on the head of a person is 10,000
  - Question: is it low, average, or high?
  - Answer: the average number of hair is between 80,000 and 120,000

NOM, LOC, and CYCLO

- Statistics-based thresholds for 3 metrics
  - Number of Methods (NOM) per class
  - Lines of Code (LOC) per method
  - Cyclomatic Number (CYCLO) per loc
- Two statistical values were used
  - Average (AVG) to determine the most typical value
  - Standard Deviation (STDEV) to get a measure of spread

Defined Thresholds

- Lower margin
  - AVG - STDEV
- Higher margin
  - AVG + STDEV
- Very high margin
  - (AVG + STDEV) * 1.5
  - A value is considered very high if it is 50% higher than the threshold for a high value

Results

Based on 45 Java projects and 37 C++ projects

	Java				C++			
	Low	AVG	High	Very High	Low	AVG	High	Very High
CYCLO	0.16	0.20	0.24	0.36	0.20	0.25	0.30	0.45
LOC	7	10	13	19.5	5	10	16	24
NOM	4	7	10	15	4	9	15	22.5

Meaningful Thresholds

- In some sense, meaningful thresholds are also based on statistics
  - But, their values are part of our culture
- We do not need statistically measure
  - We infer them from common knowledge
- There are two cases of thresholds based on meanings
  - Commonly-used fractions
  - Generally-accepted meaning

Commonly-used Fractions

- Normalized metrics (0 to 1) may have thresholds which seem natural to us
  - 0.25 : one-quarter
  - 0.33 : one-third
  - 0.5 : half
  - 0.67 : two-thirds
  - 0.75 : three-quarters
- You can also use rounded numbers
  - 0.10, 0.20 … 0.80, 0.90

Tight Class Cohesion (TCC)

- TCC is defined as the relative number of method pairs of a class that access at least one common attribute of that class
  - This metric has values between 0 and 1
  - The lower the value, the less cohesive a class is
- If we want to find non-cohesive classes, the threshold could be **0.33** or **0.25**

Generally-Accepted Meaning

- Not only fractions can be associated with generally accepted semantics
  - Absolute values can also be well accepted
- Example
  - Access to Foreign Data (ATFD) counts how many attributes from other classes are accessed from the measured class
  - 0 (NONE): no access to attribute of others
  - 3 (FEW): some accesses are fine

Bibliography

- M. Lanza e R. Marinescu. **Object-Oriented Metrics in Practice**. Springer, 2006.
  - Section 2.1 Metrics and Thresholds