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Quality Management of Software and Systems (WS13/14)

Problem Set 5

Due: in exercise, 22.01.2014

Problem 1: Measuring and Scales

a) What is the objective of measurement? Why is it relevant to software quality?
b) What can be measured when doing a software development?
c) Which measurement scales do you know? Please give a brief explanation and an example of each one.

Problem 2: Halstead Metrics

To measure textual complexity of software, Halstead has proposed some metrics, based on the number of different and on the overall number of present operands and operators used. An operator is each symbol, function, procedure call or keyword indicating an action like `+,-,*,/, while, for, if, =, (…),{…}`, etc. Operands are all symbols indicating data, like variables, constants, jump, labels, etc. Please do not take into account variable declarations, comments as well as procedure declarations. This means you should start from line "`pos = 0;`" with the calculation.
The base factors for Halstead metrics are:

- η_1 number of different operators
- η_2 number of different operands
- N_1 overall number of used operators
- N_2 overall number of used operands
- $\eta = \eta_1 + \eta_2$ size of vocabulary
- $N = N_1 + N_2$ length of implementation

Based on these fundamental metrics, Halstead has defined other metrics to measure different aspects of a program. One such metric is D, the difficulty to write or understand a program

$$D = \frac{\eta \cdot N_2}{2\eta_2}$$

The volume of a program is defined as:

$$V = N \cdot \log_2 \eta$$

V is the volume of the program in bits provided that a binary coding with a fixed word length of the vocabulary is used.
And finally you can calculate the Effort for the implementation with the difficulty and the code volume

$$E = D \cdot V$$

a) Calculate the Halstead metrics for the given piece of code!

```csharp
private void ZaehleZchn(String text, ref int gesamt, ref int vokale)
{
    String zchn;
    int pos;
    pos = 0;
    gesamt = 0;
    vokale = 0;
    text = text.ToLower();  //converts to lowercase
    while (text.Length > pos)
    {
        gesamt +=1; //increment of the variable 'gesamt'
        zchn= text.Substring(pos,1); //get the next character of 'text'
        if (zchn == "a" ||
            zchn == "e" ||
            zchn == "i" ||
            zchn == "o" ||
            zchn == "u")
        {
            vokale +=1; //increment of 'vokale'
        }// end if
        pos++;
    }// end while
}
```

b) Calculate the Halstead metrics and the cyclomatic number for the given piece of code!

```csharp
private int FindeZchn(String Schuhmenge, Char Element)
{
    int pos;
    for (pos = 0; pos <= Schuhmenge.Length; pos++)
        if (Convert.ToChar(Schuhmenge.Substring(pos, 1)) == Element)
            return pos;
    return -1;
}
```

Problem 3: Cyclomatic Number

Determine the cyclomatic number for the following flow graphs. Compare this with your intuitive impression.

G1   G2   G3