A METHOD FOR EVALUATION OF INFORMATIONAL SERVICES -
STEP 1: COMPUTING THE HARDWARE PROPORTIONALITY CONSTANTS

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Abstract: Enhancing the hardware power does not cause linear enhancing of the informational services' performance. To discover the value of growth, one has to test both source and enhanced systems running equal or similar services. If we need to discover the growth of services' performance for different computers' configurations we have to have common basis for comparing one software service with those of other systems, which are tested on different computer configurations. In this paper we outline the first step of a method for solving such problem. This step consists of computing the hardware proportionality constants. Further two papers will present the rest two steps of the method. All examples in the paper are based on results from real experiments presented in the [Markov et al, 2015].

Keywords: Evaluation of informational services; computing the hardware proportionality constants.

ACM Classification Keywords: H.3.4 Systems and Software - Performance evaluation (efficiency and effectiveness); H.3.5 Online Information Services.

Introduction

If one needs to discover the growth of services' performance for different computers' configurations he/she has to have common basis for comparing one service with same or other services which are tested on different computer configurations.

Enhancing the hardware power does not cause linear enhancing of the software performance. To discover the value of growth one has to test both source and enhanced systems running equal or similar software. Practically, the computers have different characteristics and operational systems. In addition, the target computers and operational systems may be not available for experiments but some benchmarks may be published.

Let we have to compare loading times for given datasets for different software services in the next conditions:

— Service **X** is tested on two computer configurations: **U** and **W**, where **W** is enhanced configuration in respect of **U**; service **Y** is tested on different computer configuration **V** of the same class and similar characteristics as **U**. We have testing couples **(X,U)**, **(X,W)**, and **(Y,V)**;

— Computer configurations **U** and **W** are not available for testing and all work has to be done on computer configuration **V**;

— **X** has published results from tests on **U** by dataset **S1** with |**S1**| instances and on **W** with similar dataset **S2** with |**S2**| instances; **Y** is tested on configuration **V** by datasets **S1** and **S2**;

— Loading times are respectively: $L_{(X,U,S1)}$, $L_{(X,W,S2)}$, $L_{(Y,V,S1)}$, $L_{(Y,V,S2)}$.

The problem we have to solve is: "What will be the loading time of service **Y** if it will be run on computer configuration **W** with dataset **S2**?" i.e. $L_{(Y,W,S2)}$ **= ?**.

The method for solving this problem consists of three steps:

　　1. Computing the hardware proportionality constants;

　　2. Computing the software systems' performance and proportionality constants;

　　3. Analysis of experiments: Rank-based multiple comparison.

In this paper we outline the first step of the method. This step consists of computing the hardware proportionality constants. Further two papers will present the rest two steps of the method. All examples in the paper are based on results from real experiments presented in the [Markov et al, 2015].

Computing the hardware proportionality constants

Evaluation, comparison, and selection of modern computer and communication systems are complex decision problem. System evaluation techniques can be either qualitative or quantitative [Dujmovi'c, 1996]:

— Qualitative techniques are usually based on a list of features to be analyzed for each competitive system. The list includes technical characteristics, costs, and other components for evaluation. After a study of proposed systems the evaluator creates for each proposal a list of advantages and a list of disadvantages. The lists summarizing advantages and disadvantages are then intuitively compared and the final ranking of proposed systems is suggested. Such an approach is obviously attractive only when the decision problem is sufficiently simple. In cases with many decision criteria it is difficult to properly intuitively aggregate a number of components affecting the final decision, and it is not possible to precisely identify minor differences between similar proposals. In addition, it is extremely difficult to justify whether a given difference in total cost is commensurate to a corresponding difference in total

performance. These difficulties can be reduced by introducing quantitative components in the decision process [Dujmovi'c, 1996].

— The aim of quantitative methods is to make the system evaluation process well structured, relatively simple, and accurate, providing global quantitative indicators which are used to find and to justify the optimum decision [Dujmovi'c, 1996].

For purposes of this research we will use simple evaluation system based on traditional scoring techniques. The basic idea is very simple [Dujmovi'c, 1996]: for a set of evaluated systems we first identify n relevant components (performance variables) that are individually evaluated. The results of evaluation are individual normalized scores $E_1, ..., E_n$, where $0 \leq E_i \leq 1$ (or $0 \leq E_i \leq 100\%$). The average score is then

$$E = (E_1 + ... + E_n)/n.$$

If all components are not equally important then we introduce positive normalized weights, which reflect the relative importance of individual components. $W_1,...,W_n$. Usually, $0 \leq W_i \leq 1$, i = 1, 2,..., n, and $W_1 + ... + W_n = 1$.

The global score is defined as a weighted arithmetic mean:

$$E = W_1E_1 + W_2E_2 + ...W_nE_n, \ 0 \leq E \leq 1.$$

Let compare a basic hardware configuration with three others. The characteristics we will take in account are Processor (**P**), Physical Memory (**M**) and Hard Disk capacity (**D**).

We assume that the operating systems and service software are equivalent in all cases. For concrete computer systems used in the experiments let we have respectively:

- ✓ **Configuration K** is basic configuration:
  - Processor: Intel Core2 Duo T9550 2.66GHz; CPU Launched: 2009; *Average CPU Mark: 1810* (P_K=1810) [T9550, 2009];
  - Physical Memory: 4.00 GB (M_K=4);
  - Hard Disk: 100 GB data partition; 2 GB swap (D_K=100);
  - Operating System: 64-bit operating system Windows 7 Ultimate SP1.

Characteristic values of configuration **K** are: P_K=1810, M_K=4, D_K=100.

- ✓ **Configuration A** is benchmark configuration of [Becker, 2008]:
  - – Processor: Intel Pentium Dual Core 2.8 GHz; CPU Launched: 2008; Average CPU Mark: 598 (PA =598) [Pentium Dual, 2008];
  - – Physical Memory: 1 GB (M_A =1);
  - – Hard Disk: 40 GB data partition; 2 GB swap (D_A =40);
  - – Operating System: Ubuntu Linux 7.10 64-bit.

Characteristic values of configuration **A** are: P_A =598, M_A =1, D_A =40.

- ✓ **Configuration B**: is benchmark configuration of [BSBMv2, 2008] and [BSBMv3, 2009] DELL workstation:
- – Processor: Intel Core2Quad Q9450 @ 2.66GHz, CPU Launched: 2008; *Average CPU Mark: 3791* (P_B =3791) [Q9450, 2008];
- – Physical Memory: 8GB DDR2 667 (4 x 2GB) (M_B =8);
- – Hard Disks: 160GB (10,000 rpm) SATA2, 750GB (7,200 rpm) SATA2 (D_B =160 + 750 = 910);
- – Operating System: Ubuntu 8.04 64-bit, Kernel Linux 2.6.24-16-generic; Java Runtime: VM 1.6.0, HotSpot(TM) 64-Bit Server VM (build 10.0-b23); Separate partitions for application data (on 7,200 rpm HDD) and data bases (on 10,000 rpm HDD).

Characteristic values of configuration **B** are: P_B =3791, M_B =8, D_B =910.

- ✓ **Configuration C** is benchmark configuration used for LDIF [LDIF Benchmarks, 2013; LDIF, 2013]:
  - – Processor: Intel i7 950, 3.07GHz (quad core); CPU Launched: 2009, *Average CPU Mark: 5664* (P_C =5664) [i7 950, 2009];
  - – Physical Memory: 24GB (M_C =24);
  - – Hard Disks: 2 × 1.8TB (7,200 rpm) SATA2 (D_C =3600);
  - – Operating System: Ubuntu 11.04 64-bit, Kernel: 2.6.38-10; Java version: 1.6.0_22.

Characteristic values of configuration **C** are: P_C =5664, M_C =24, D_C =3600

Global scores of computer configurations

Normalized estimation E_P of processors' power will be computed by formula:

$$E_p = \frac{P_i}{P_K}, \, i = A, B, C$$

where P_j, j=K,A,B,C is the processor's average CPU mark.

We assume that the processors' power is very important and because of this we will use processors weight as 0.5, i.e.

$$W_P = 0.5.$$

Normalized estimation E_M of physical memory will be computed by formula:

$$E_M = \frac{M_i}{M_K}, \ i = A, B, C$$

where M_j, j=K,A,B,C is the size of main memory in Giga bytes.

We assume that main memory is more important than hard disk memory and because of this we will use main memory weight as 0.3, i.e.

$$W_M = 0.3.$$

Normalized estimation E_{HD} of hard disk capacity will be computed by formula:

$$E_D = \frac{D_i}{D_K}, \ i = A, B, C$$

where D_j, j=K,A,B,C is the size of hard disk memory in Giga bytes.

We assume that the hard disk memory weight as 0.2, i.e.

$$W_D = 0.2.$$

Formula for computing the global score of computer configuration is defined as a weighted arithmetic mean:

$$E_i = W_P \, E_P + W_M \, E_M + W_D \, E_D$$

or

$$E_i = 0.5 \, E_P + 0.3 \, E_M + 0.2 \, E_D$$

Global scores of experimental computer configurations

The global scores of experimental computer configurations are as follow.

◇ Global score E_K of configuration **K** is **1:**

$$P_K=1810; \ \mathbf{EK_P} = 1810/1810 = \mathbf{1}$$

$$M_K=4; \quad \mathbf{EK_M} = \quad 4/4 \quad = \mathbf{1}$$

$$D_K=100; \quad \mathbf{EK_D} = \quad 100/100 \ = \mathbf{1}$$

$$\mathbf{E_K} = 0.5EK_P + 0.3EK_M + 0.2EK_D = 0.5*1+0.3*1+0.2*1 =$$
$$= 0.5+0.3+0.2 = \mathbf{1}$$

⬦ Global score E_A of configuration **A** is **0.32**:

$$P_A=598; \quad \textbf{EA}_P = \quad 598/1810 \quad = \textbf{0.33}$$

$$M_A=1; \quad \textbf{EA}_M = \quad 1/4 \quad = \textbf{0.25}$$

$$D_A=40; \quad \textbf{EA}_D = \quad 40/100 \quad = \textbf{0.40}$$

$$\textbf{E}_A = 0.5EA_P+0.3EA_M+0.2EA_D = 0.5*0.33+0.3*0.25+0.2*0.40 =$$
$$= 0.165+0.075+0.08 = \textbf{0.32}$$

⬦ Global score E_B of configuration **B** is **3.465**:

$$P_B=3791 \quad \textbf{EB}_P = \quad 3791/1810 \quad = \textbf{2.09}$$

$$M_B=8 \quad \textbf{EB}_M = \quad 8/4 \quad = \textbf{2}$$

$$D_B=910 \quad \textbf{EB}_D = \quad 910/100 \quad = \textbf{9.1}$$

$$\textbf{E}_B = 0.5EB_P+0.3EB_M+0.2EB_D = 0.5*2.09+0.3*2+0.2*9.1 =$$
$$= 1.045+0.6+1.82 = \textbf{3.465}$$

⬦ Global score E_C of configuration **C** is **10.565**:

$$P_C=5664; \quad \textbf{EC}_P = \quad 5664/1810 \quad = \textbf{3.13}$$

$$M_C=24; \quad \textbf{EC}_M = \quad 24/4 \quad = \textbf{6}$$

$$D_C=3600; \quad \textbf{EC}_H = \quad 3600/100 \quad = \textbf{36}$$

$$\textbf{E}_C = 0.5EC_P+0.3EC_M+0.2EC_D = 0.5*3.13+0.3*6+0.2*36=$$
$$= 1.565+1.8+7.2 = \textbf{10.565}$$

Hardware proportionality constants

The ***hardware proportionality constants*** H_i, i = A, B, C, for normalizing our results to be comparable with results received on other computer configurations are as follow:

$$\textbf{K}{\propto}\textbf{A}: \quad H_A = \quad E_K/E_A = \quad 1 / 0.32 \quad = \textbf{3.125}$$

$$\textbf{K}{\propto}\textbf{B}: \quad H_B = \quad E_K/E_B = \quad 1 / 3.465 \quad = \textbf{0.289}$$

$$\textbf{K}{\propto}\textbf{C}: \quad H_C = \quad E_K/E_C = \quad 1 / 10.565 \quad = \textbf{0.095}$$

Conclusion

The goal of this work was to outline the first step of a method for estimating further development of any informational service. This step consists of computing the hardware proportionality constants. All examples in the paper were based on results from real experiments presented in the [Markov et al,

2015]. Enhancing the hardware power does not cause linear enhancing of the informational services' performance. To discover the value of growth one has to test both source and enhanced systems running equal or similar services. If we need to discover the growth of services' performance for different computers' configurations we have to have common basis for comparing one software service with those of other systems, which are tested on different computer configurations. Further two papers will present the rest steps of the method.

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