

Assessment method of object-oriented programming languages for web development



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Abstract

The article describes an approach to evaluating the effectiveness of modern technologies for web development. Performance of different languages (C++, C#, JavaScript, PHP) is analyzed in the context of their suitability for the web. The method for determination of technology efficiency is considered in view of its cost, performance, size of community, the learning complexity and hardware requirements to the server. The validity of performance indicators is substantiated by real popularity of considered technologies. Author regards the prospects of server-side JavaScript with Node.js platform for web development.

Keywords: WEB DEVELOPMENT, PROGRAMMING LANGUAGES, TECHNOLOGY EFFECTIVENESS, NODE.JS

Introduction

Modern web technologies are developing very rapidly. The development of telecommunications, network equipment, increasing the capacity of communication channels, advances in digital technology have meant that more and more services are placed in cloud. Most software can now be found in the form of web services. Many computer users spend more time in the browser than in

desktop applications. According to Internet World Stats more than 3 billion people use Internet [1]. Many ISPs provide services with fiber optic communication bandwidth of 100 Mbps.

It should be noted that cost of developing and deploying applications significantly depends on the programming language in the field of web technologies [2, 3]. The effectiveness of the programming

language can be estimated based on the complexity of language learning, software development costs, the cost of hosting, hardware requirements etc. Therefore, research of programming languages efficiency is an actual problem for developers and web industry as a whole.

Problem statement

The paradigm of object-oriented programming has become the basis for software development. Object-oriented programming (OOP) languages (C++, Java, Object Pascal, C#, JavaScript, PHP) take pride in its suitability for sustaining huge software and web development projects. This is a far better option than using structured programming when you have huge code bases. Investigations in object-orientated design indicate that OOP is more preferable for complex information systems rather than functional programming [4].

There are many languages for web development: C#, JavaScript, Java, Python, Ruby and PHP. However, in this article author is going to consider in detail performance and prospects of new technology – Node.js (<http://nodejs.org>). C++, C#, JavaScript and PHP were selected for analysis because the author has experience with these languages. Node.js is relatively new platform for creating web applications. The base idea is asynchronous event driven approach. Testing new programming technology is rather difficult problem because it must consider different aspects such as maturity of this technology, its effectiveness, size of the community, speed of development and performance, hardware requirements, development and support costs etc. Let's consider these factors in details.

Research results

Benchmark in our case is a simple program (listing 1) that performs the following steps: reads data from the text file, replacing

certain words in each line, sorts the entire list, modifies the line, changes their case, concatenates strings, calculates the MD5-hash and generates a simple HTML-page. Text files contain 200-1000k e-mail lines.

Listing 1. PHP benchmark script.

```
function modifyString($str )
{
    return $str . "." . strlen($str);
}
$filename = "e-mail-1000k.txt";
$lines = file($filename,
FILE_IGNORE_NEW_LINES);
/* Find and replace all substrings, calculate the
number of replacements */
$lines = str_replace("mail.ru", "my.com",
$lines, $num);
sort($lines); /* Sorting e-mail addresses by
ABC*/
for ($i = 0; $i < count($lines); $i++) {
    $lines[$i] = modifyString($lines[$i]);
}
$lines = array_map('strtoupper', $lines);
$hash = md5(implode(";", $lines));
/* Output result */
echo "<p>Count: " . count($lines) . "</p>";
echo "<p>Num: " . $num . "</p>";
echo "<p>md5: " . $hash . "</p>";
echo "<table>\n";
for ($i = 0; $i < 10000; $i += 4) {
    echo "<tr>\n";
    echo "<td>" . $lines[$i] . "</td>\n";
    echo "<td>" . $lines[$i + 1] . "</td>\n";
    echo "<td>" . $lines[$i + 2] . "</td>\n";
    echo "<td>" . $lines[$i + 3] . "</td>\n";
    echo "</tr>\n";
}
echo "</table>"
```

Similar programs were written in C++, server-side JavaScript and C#. The first parameter for analysis was execution time of application within different data amount. As can be seen from the diagram (fig. 1)

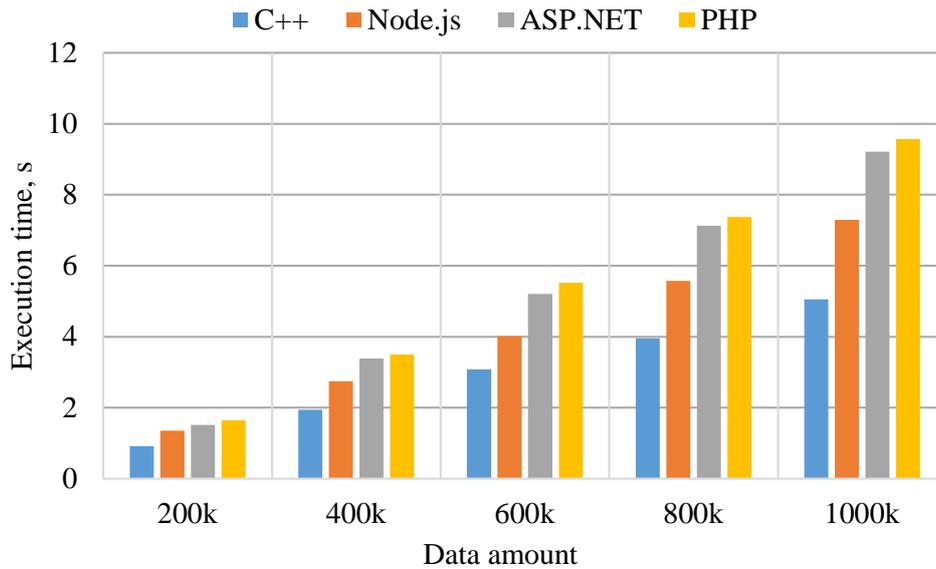


Figure 1. Execution time of different web applications (less is better)

Performance testing of different Web applications carried out on a computer with CPU Core 2 Duo E8400 (3 GHz), RAM 4 GB (DDR2 800 MHz). C++ program is 47% faster than the PHP script and 30% faster than JavaScript Node.js. Server-side JavaScript (Node.js) is 24% faster than PHP.

Apache webserver requires the most memory for processing PHP script. Fig. 2 shows rough memory usage by different web servers: Apache, IIS, V8 and handmade C++ server.

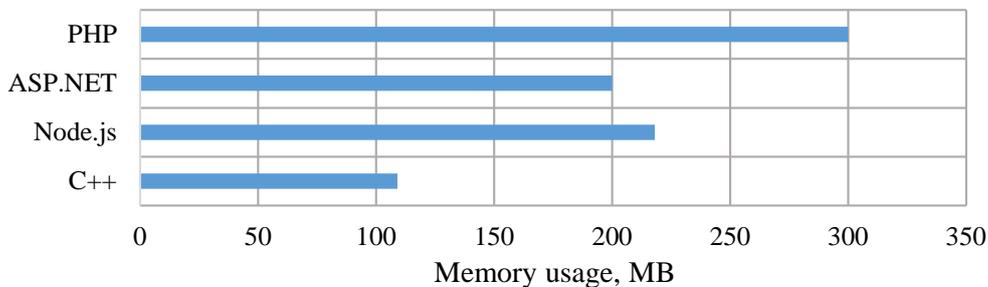


Figure 2. Memory usage of different web applications (less is better)

Technology selection for the web development of the future project is the task of multicriteria optimization. Table 1 illustrates some important characteristics of considered programming languages. Therefore, it is important to rank the different selection

criteria. There are many approaches to mathematical description of this task [5, 6]. However, the most appropriate way in this case is to use approach based on scalarizing multi-objective optimization.

Table 1. Some characteristics of web technologies

Language, web technology	Learning complexity	Type of hosting	Annual cost, \$/yr.	Community (stackoverflow.com)
C++	Very high	VPS	>60	347k
JavaScript (Node.js)	Medium	VPS	>60	69k

C# (ASP.NET MVC)	Medium	IIS	>35	755k
PHP	Low	Apache	>15, free	705k

To evaluate the effectiveness of the technology let's introduce the function

$$f = \sum_i \alpha_i k_i, \quad (1)$$

where α_i is the importance of the criteria ($0 \leq \alpha_i \leq 1$) and k_i is assessment of certain criteria ($0 \leq k_i \leq 1$). These variables would be restricted to normalize rating scale

$$\sum_i \alpha_i = 1. \quad (2)$$

k_i is relative indicator that can be calculated within the formula

$$k_i = \frac{v_i}{\max(v)}, \quad (3)$$

where v_i – numerical measure of i^{th} parameter, $\max(v)$ – maximum value of certain parameter. We use formula (3) when more value of v_i is better. Otherwise, it must be inverted k_i^{-1} .

Table 2. Evaluation of programming languages for web

Language	Complexity	Cost	Speed	Community	Hardware	Effectiveness
C++	0.5	0.25	1.0	0.49	1.0	0.574
JavaScript	0.7	0.25	0.67	0.09	0.52	0.480
C#	0.7	0.43	0.54	1.0	0.58	0.605
PHP	1.0	1.0	0.52	0.93	0.38	0.835
Importance	0.3	0.3	0.2	0.1	0.1	–

According to these assumptions we can rate considered technologies (table 2). It should be noted, however, that the indicator definition of language complexity and factor importance are little bit subjective. PHP is preferable choice nowadays if technologies are ranked in terms of simple projects. One of the most important factor in selection of technologies is its cost. Total cost includes expenses of developing, support and rent hosting.

It is easy to check that the results presented in table 2 are closely correlated with the actual situation in the job market of web development [2, 3]. For example, PHP is more suitable in small and medium web projects. If increasing performance is needed, we should use more productive languages like C/C++.

Conclusion

Developers and web studios can use the proposed method for the technology effectiveness evaluation when they monitor current state of programming industry. Consideration such parameters as cost, performance, size of community, the learning complexity and hardware requirements to the server can help select optimal language and frameworks.

Node.js is relatively new technology in web. It has attractive features such as non-

blocking asynchronous I/O operations. This technology provide higher speed execution (near 24%) comparatively with PHP but wide using of server-side JavaScript is limited by higher cost.

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