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BENCHMARKING PHP MODULES

MJERENJE BRZINE RADA PHP MODULA

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Abstract
This paper presents how C programming language could be used for this type of tasks, created as PHP module and then get imported in the PHP language. The purpose of this paper is to show how and when is better to build PHP modules in C, instead of normal PHP functions, and to show negative sides of this type of programming. Profiling, as an important aspect of finding application bottlenecks, is also discussed. Profiling systems like Xdebug, Qcachegrind and Webgrind are also elucidated. This paper contains source code which calculates Fibonacci sequence and multiplies 800x800 matrices written in C and PHP programming languages. Results show that whenever there is a need for a mathematical computation, C will be many times faster and that it is much more cost-effective to write such code in C and create a PHP module.

Sažetak
Ovaj rad predstavlja kako se za ovakve probleme može koristiti programski jezik C, kao PHP modul, te pozvati iz PHP jezika. Cilj ovog ujedno je pokazati kako i kada je bolje, umjesto običnih PHP funkcija, raditi PHP module u programskom jeziku C te prikazati i negativne strane takvoga programiranja. Rad objašnjava i pronalazak „uskog-grla" u aplikacijama pomoću sustava kao što su Xdebug, qcachegrind i webgrind. U radu je prikazan izvorni kod koji računa Fibonaccijev niz te množi matrice veličine 800x800 u programskim jezicima C i PHP. Dobiveni rezultati pokazuju da je u svim slučajevima gdje je bio potreban matematički izračun, programski jezik C bio višestruko brži te da je u takvim slučajevima isplativije napisati izvorni kod u programskom jeziku C i izraditi PHP modul.

1 Introduction

PHP language is mostly designed for developing web applications /**1**/ and, as such, is not suitable for complex mathematical operations, nor is suitable for systems where speed of such operation executions is important. PHP is mostly used for generating dynamic HTML content /**2**/. Since PHP is built with C, it is possible to create PHP modules in C and import them in the PHP language /**3**/. Examples given in this paper are executed and tested on Linux operating system, specifically Debian distribution, but it should work on any system with few or not any changes at all. Qcachegrind and Webgrind are tested with OSX. PHP source code could be downloaded with versioning control system like Git:

git clone https://github.com/php/php-src.git

2 PHP modules

PHP modules must be inside php-src/ext folder and after executing ext_skel script, the skeleton for your model should be created. After the skeleton is created, phpize prepares the build so it needs to be executed:

php-src/ext/mymod# phpize

Artificial intelligence is focused on presentation of knowledge and its use. It is critical for knowledge management. Artificial intelligence is not only focused on explicit knowledge that can be relatively easy to formalise with some form of its presentation (manufacturing rules, semantic networks, triplet object of attribute value, frameworks, predicates of the first row). Relationships between business intelligence and other technologies that are directly related to business intelli-

gence can be observed through five characteristics: inputs, nature of inputs, outputs, components, and users /**4**/.

Iside mymod.c are some templates for functions which a developer can remove or leave for testing purposes. In this example, the module is called mymod so the test function is called confirm_mymod_compiled and this is the function where the testing is performed. This is a simple function which returns a simple number 100 to the user.

```
// confirm_mymod_compiled() function
PHP_FUNCTION(confirm_mymod_compiled){
        RETVAL_LONG(100);
}

// inside shell (compiling and installing)
./configure && make && sudo make install

// module needs to be included inside php.ini
extension=mymod.so

// restarting server (in this example, Apache2)
sudo /etc/init.d/apache2 restart

// calling a function from PHP
<?php
        echo confirm_mymod_compiled(); // 100
```

2.1 Simple PHP benchmarking

Here is a simple test using Fibonacci Series in PHP and in C, both using recursion.

PHP version:

```
function fibonacci($f){
    if($f < 2){
        return 1;
    }else{
        return fibonacci($f-1) + fibonacci($f-2);
    }
}
```

C version:

```
long my_fib(long f){
    if (f < 2){
        return 1;
    }else{
        return(my_fib(f - 1) + my_fib(f - 2));
    }
}
```

```
// declaring PHP function which will call my_fib()
PHP_FUNCTION(confirm_mymod_compiled)
{
    long f;
    if (zend_parse_parameters(ZEND_NUM_ARGS() TSRMLS_CC, "l", &f) == FAILURE) {
        return;
    }

    long r = my_fib(f);

    RETVAL_LONG(r);
}
```

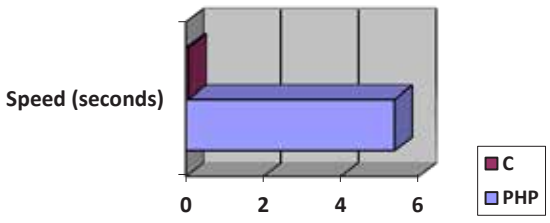
Testing is quite simple with microtime before and after the code. PHP function reference shows microtime returns the current UNIX timestamp in microseconds:

```
$startTime = microtime(true);

// your code

$endTime = microtime(true);
$result = $endTime - $startTime;
```

After executing the script few times, test shows (in average) that the C version is about 80 times faster when calculating 34th Fibonacci number:



	Speed (seconds)
C	0,064888954
PHP	5,378473997

Figure 1 - Benchmarking C and PHP with Fibonacci Series calculated with recursion (lower is better)

2.2. Matrix multiplication

Multiplication of two matrices can be very computationally expensive (O3) /**5**/. There are also ways to reduce some steps and speed up the computation but they are not part of this paper.

In C language, matrix could be implemented as a 2-dimensional array.

```
PHP_FUNCTION(run_multiplication)
{
        int n = 800;

        // matrices
        int firstM[n][n], secondM[n][n], re-
sultM[n][n];

        // counters and a temporary sum
        int i, j, k;
        int sum = 0;

        srand(time(NULL));
        for (i = 0; i < n; i++) {
                for (j = 0; j < n; j++) {
                        firstM[i][j] = rand() % 100 +
1;
                }
        }

        for (i = 0; i < n; i++) {
                for (j = 0; j < n; j++) {
                        secondM[i][j] = rand() %
100 + 1;
                }
        }
    …
}
```

Two 800x800 matrices are populated with random numbers between 1 and 100. srand function sets the global seed variable which changes the output of the rand function /**6**/. Multiplication in this example takes O^3:

```
for (i = 0; i < n; i++) {
  for (j = 0; j < n; j++) {
    sum = 0;
    for (k = 0; k < n; k++) {
      sum = sum + firstM[i][k] * secondM[k][j];
    }
    resultM[i][j] = sum;
  }
}
```

Defining matrices in PHP is similar:

```
$n = 800;
$firstM = $secondM = $resultM = [];
for ($i = 0; $i < $n; $i++) {
  for ($j = 0; $j < $n; $j++) {
    $firstM[$i][$j] = rand() % 100 + 1;
  }
}

for ($i = 0; $i < $n; $i++) {
  for ($j = 0; $j < $n; $j++) {
    $secondM[$i][$j] = rand() % 100 + 1;
  }
}
```

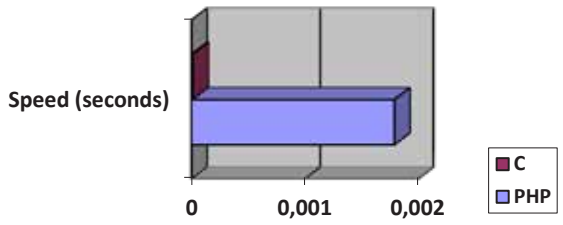
Multiplication in PHP stays the same:

```
for ($i = 0; $i < $n; $i++) {
  for ($j = 0; $j < $n; $j++) {
    $sum = 0;
    for ($k = 0; $k < $n; $k++) {
      $sum = $sum + $firstM[$i][$k] * $se-
condM[$k][$j];
    }
    $resultM[$i][$j] = $sum;
  }
}
```

2.3. Explanation

Relatively speaking, PHP is not a slow language. The problem is that PHP is an interpreted language. While executing C which is already compiled and directly executed on a processor, PHP language needs to go through some phases like parsing, converting to opcodes, etc. and this is the heart of the problem.

The problem also worth mentioning here is the stack. Whenever a function is called, a new stack is created only for that function and that is what is happening inside the Fibonacci version with recursion. The advantage that compiled languages have here, is the possibility of having a great compiler which can inline the function (like copying the code) instead of calling the function and creating the new stack. Without recursion, results (approximately, C was 110 times better) are better:

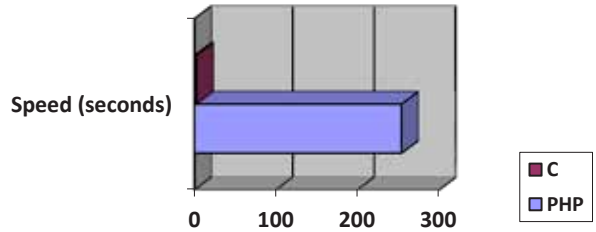


	Speed (seconds)
C	1,50204E-05
PHP	0,001790047

Figure 2 - Benchmarking C and PHP with Fibonacci Series calculated without recursion - 1000th Fibonacci number (lower is better)

Example with multiplying matrices has few things which needs to be pointed out. In the example written in C programming language, matrices are inside a stack (no malloc-family function were called) and the PHP example creates matrices on the heap which is slower /7/. Before calling the PHP example, a script must allow PHP to use 1GB of memory:

```
ini_set('memory_limit', '1024M');
```



	Speed (seconds)
C	2,46
PHP	254,03

Figure 3 - matrix multiplication

In this example, C is approximately 103 times faster.

3 Benchmarking with Xdebug, Qcachegrind and Webgrind

First step when optimizing PHP applications is profiling. With Xdebug, one can determine bottlenecks in the application. To enable Xdebug profiler, several lines must be added to the php.ini file:

```
xdebug.profiler_enable = 1
xdebug.profiler_output_name = xdebug.out.%t
xdebug.profiler_output_dir = /tmp
```

The first line enables the profiler. The second line formats the filename where the profiler data will be saved and the third line tells the profiler what is the default directory for saving the result. One can also add a "trigger" which will only enable/save Xdebug results if there is a parameter in the request:

```
xdebug.profiler_enable_trigger = 1
# only enabled if XDEBUG_PROFILE is passed
```

As stated on the Xdebug profiler homepage, Xdebug outputs a profiling information in the form of a cachegrind file. To sum it up, there are options for all major operating systems:

Operating system	Software
Microsoft Windows	QCacheGrind or WinCacheGrind
Linux	KCacheGrind
MacOS	QCacheGrind

Figure 4 - "cachegrind" software for different operating systems

It's recommended to install Graphviz also so a user could see a call graph. For example, to install QCacheGrind on OSX, one could do it with homebrew. First, Qt should be installed:
brew install qt

After installing qt, qcachegrind could be installed:
brew install qcachegrind --with-graphviz

Graphviz installs dot, plain text graph description language. Graphviz installs dot in /usr/local/bin/dot but in order to qcachegrind find dot, it should be in /usr/bin/dot. One can create a symlink for dot /8/ like this:
sudo ln -s /usr/local/bin/dot /usr/bin/dot

After installing qcachegrind, running it is easy:
$ qcachegrind

After opening and importing generated debug file, qcachegrind shows a list of functions called in the request. Generated debug file is in the xdebug.profiler_output_dir directory specified in php.ini.

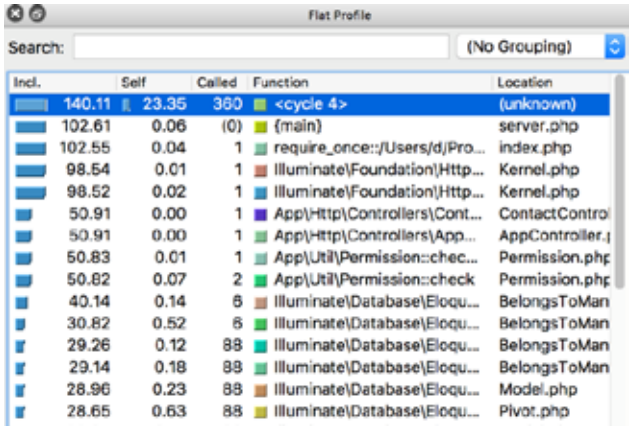


Figure 5 - list of function calls in one request

Figure 5 shows a list of function calls in a single PHP request.

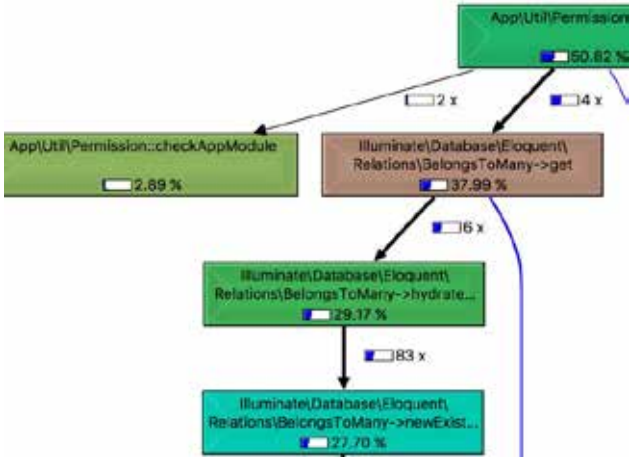


Figure 6 - call graph

There is also a call graph, generated with Graphviz. Figure 6 shows a generated call graph which shows how and where PHP functions are called. There is also a callee map, shown in Figure 7.

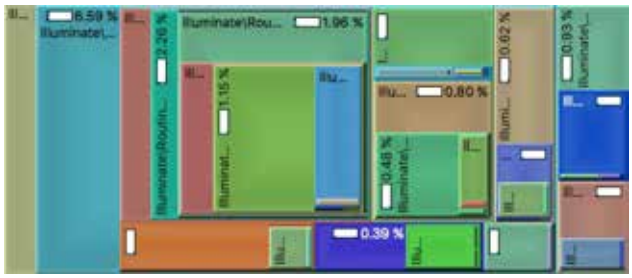


Figure 7 - callee map

There is a qchachegrind alternative, called Webgrind. Webgrind is a web frontend which understands Xdebug profiling information. To install Webgrind, it must be downloaded: wget https://github.com/jokkedk/webgrind/archive/master.zip

Unzip the application: unzip master.zip

cd webgrind-master

Serve the application with PHP: php –S localhost:1234

After opening localhost:1234 and opening your debug files, webgrind should show something similar like in Figure 8.

Figure 8- webgrind list of function calls

4 Conclusion

If a developer needs to create a cutting-edge code which needs to be fast and efficient, doing module in C and importing it into PHP is the best way to go. Module in C is much faster but the downside is that you need to know something about PHP internals. If there is a need for creating a module which needs to use heap memory, some part of PHP, maybe module needs to be called while PHP is starting or shutting down, developer needs to understand PHP internals and structures like zvalue /**9**/, understand a lot of macros, deal with memory management and with a lot of low programming concepts.

To find bottlenecks, developers can use Xdebug with Qcachegrind or Webgrind. It's crucial to find a good development time – execution speed ratio. There is no need to write everything as a module in C but writing only parts which are bottlenecks could give some amazing improvements.

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