

MOBILE LEARNING SYSTEM FOR NUMERICAL ANALYSIS BY USING PHP[†]

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ABSTRACT. Programming tools are essential for students learning numerical analysis. It is troublesome to go to a laboratory where a computer is located after taking a lecture. Nowadays most students have mobile phones which can be used for programming practice through the Internet. PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language. However, PHP has many inconveniences, such as adding a dollar symbol (\$) to every variable. This paper introduces a slightly modified language, NAPHP, and a system which is designed for students to use their own mobile phone to write down the language NAPHP and run it on the web page. The system NAPHP-SYS is an educational tool that turns NAPHP into PHP, run PHP code and show the results on the web.

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Key words and phrases : PHP, programming tool, Numerical Analysis

1. Introduction

PHP is a kind of programming language. The name ‘PHP’ was originally ‘Personal Home Page’, but now it uses recursive acronyms such as ‘PHP: Hypertext Preprocessor’. It was first unveiled by Rasmus Ludolf [1] in 1995 and is responsible for development and management by The PHP Group[2]. It is one of the typical server-side scripting language, and it is the basis of many web systems around the world. Similar languages include ASP and JSP. Using C-like syntax, it is easy and fast to create a small web page, so there are many users and applications of it. PHP can be thought of as an alternative to Microsoft’s ASP.NET, Visual Basic, Java from Sun Microsystems, and Python, Perl, and Ruby in the open source community.

PHP was originally designed to create dynamic web pages. To implement this, code written in PHP is placed in an HTML source document, and the web

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FIGURE 1. The first screen of NAPH

server with PHP processing recognizes the code and generates the web page the author wants. In recent years, it is common to separate PHP code and HTML into separate files, and PHP is increasingly being run through the PHP-FPM (PHP FastCGI Process Manager) [3] rather than the web server. PHP has strengths in handling text, especially HTML. URL parsing, form processing, and regular expressions are examples. It also supports a variety of databases, so it also acts as a bridge between the database and the user. PHP provides its own interpreter in the form of a command-line interface that allows it to be used as a general-purpose programming language and to create graphics applications.

Students who take a numerical analysis course deal with a very simple form of algorithm in order to practice the numerical calculations from the textbooks. To do this, students must move from the classroom to the PC room. Recently, however, with the popularization of smart phones, it has become possible to do numerical analysis exercises by using a smart phone in the classroom. You may install a suitable professional programming tool on your smartphone, but instead of it, you can use PHP running on a Linux server to practice the programming skill on the web. In this paper, we introduce the newly developed program tool NAPH. NAPH uses also the PHP server to provide students with a convenient way to provide examples, assign homework assignments, or collect them.

2. PHP Numerical Analysis Program Tool (NAPH)

When you access the NAPH homepage [4] on Linux server, the screen of Figure 1 appears by default. Students enter their own ID and password, select an example, and click the button [RUN], as shown in Figure 2. Here you can select the width and height of the screen.

By creating or modifying the code in the textarea field of the screen and clicking the button [RUN], the NAPH system translates the input code into the PHP language, executes the PHP code to produce the result. In NAPH, we can use all PHP languages and functions. The most difficult thing for students to do coding with PHP on smartphones is that every variable must preceded by a '\$' symbol . In NAPH, you do not have to prefix the variables with the '\$' symbol. NAPH automatically add '\$' symbol in front of all strings which are not in the list of reserved keyword. The default list is shown below. Users can

Newton Method

INPUT of CODE :

```
function f(x){ return exp(x)-1.4-atan(x)}
function g(x){ return exp(x)-1/(x^2+1 )}

print "-----\n"
print "n x e p \n"
print "-----\n"
ntol=30
xtol=1.0e-7
x0 =-1.0
for(i=0;i<ntol;i++){
  x=x0 - f(x0)/g(x0)
  e=abs(x-x0)
  if(i>=2 and e<>0) p=log(e/e1)/log(e1/e0 )
  printf("%2d%11.5e%11.5e%11.5e \n",i,x,e,p)
  if( e <= xtol ) break
  x0=x; e0=e1; e1=e
}
print "-----\n"
printf(" The approximate solution of the equation is x = %11.5e\n",x)
```

ID: PASS: size(X*Y): example:

OUTPUT of EXECUTION :

```
-----
n x e p
-----
0 -2.8674e+0 1.8674e+0 0.0000e-1
1 -4.9592e+0 2.0918e+0 0.0000e-1
2 -5.6194e+0 6.6021e-1 -1.0163e+1
3 -5.6818e+0 6.2350e-2 2.0463e+0
4 -5.6823e+0 5.0534e-4 2.0405e+0
5 -5.6823e+0 3.2841e-8 2.0022e+0
-----
```

The approximate solution of the equation is x = -5.6823e+0

FIGURE 2. Sample code and output

add or remove some keywords from the list if necessary.

```
function global return for while if else elseif and or
continue break print printf sprintf array count grapL
abs exp pow log sin cos tan asin acos atan sinh cosh
tanh asinh acosh atanh
```

PHP requires a semicolon (;) at the end of each statement, but we can omit the semicolon in NAPHP. In addition,

```
== != && ||
```

used in PHP can be replaced with the following easy expressions.

```
= <> and or
```

| Usage of NAPHP | |
|--|--|
| In NAPHP, we use every representation of PHP plus the following equivalent ones. | |
| PHP grammar | NAPHP grammar |
| semicolon(; | abbreviation of semicolon |
| \$variable | variable |
| &\$variable | variable (array function argument) |
| == | = |
| != | <> |
| && | and |
| | or |
| A=array("",a,b,c) | A=[a,b,c] : index of component starts at 1. |
| A=array(a,b,c,d) | A=[0=>a,b,c,d] : index of component starts at 0. |
| A[i][j] | A[i,j] |
| pow(a,b) | a^b |
| imagecreate | grapL(x0,x1,y0,y1,xx,yy,dd) where (x0,x1): range of x-axis (y0,y1): range of y-axis (xx,yy): data points of least square method dd : coefficients of solution polynomial |

1. The parentheses must be used in before and after the exponent operator(^), except of an integer or a pure text variable. (example: aa^tt, aa^(0.5), (ap34)^5, (1.0e-5)^12, 342^(3.5)).

2. The NAPHP assumes that any string not in the keyword list below is a variable, so add a variable symbol (\$) in the front of the string and execute the resulting PHP code. Users can add any string to the list or delete anything in the list.

Keywords: function global return for while if else elseif and or continue break print printf sprintf array count grapL abs exp pow log sin cos tan asin acos atan sinh cosh tanh asinh acosh atanh

FIGURE 3. Comparison table between PHP and NAPHP

If it is not a character variable or an integer that immediately precedes or follows the exponentiation operator (^), it must be enclosed in parentheses. Eg,

aa^tt aa^(0.5) (ap34)^5 (1.0e-5)^12 342^(3.5)

In PHP, every array consists of components starting from index 0 but most of the index of vectors in numerical analysis starts at 1. Therefore, the expression of

$$A=\text{array}("", a, b, c)$$

in PHP can be expressed as

$$A=[a, b, c]$$

in NAPHP. Two-dimensional array representation

$$A[i][j]$$

in PHP is also very inconvenient for students to use, so it can be replaced by

$$A[i,j]$$

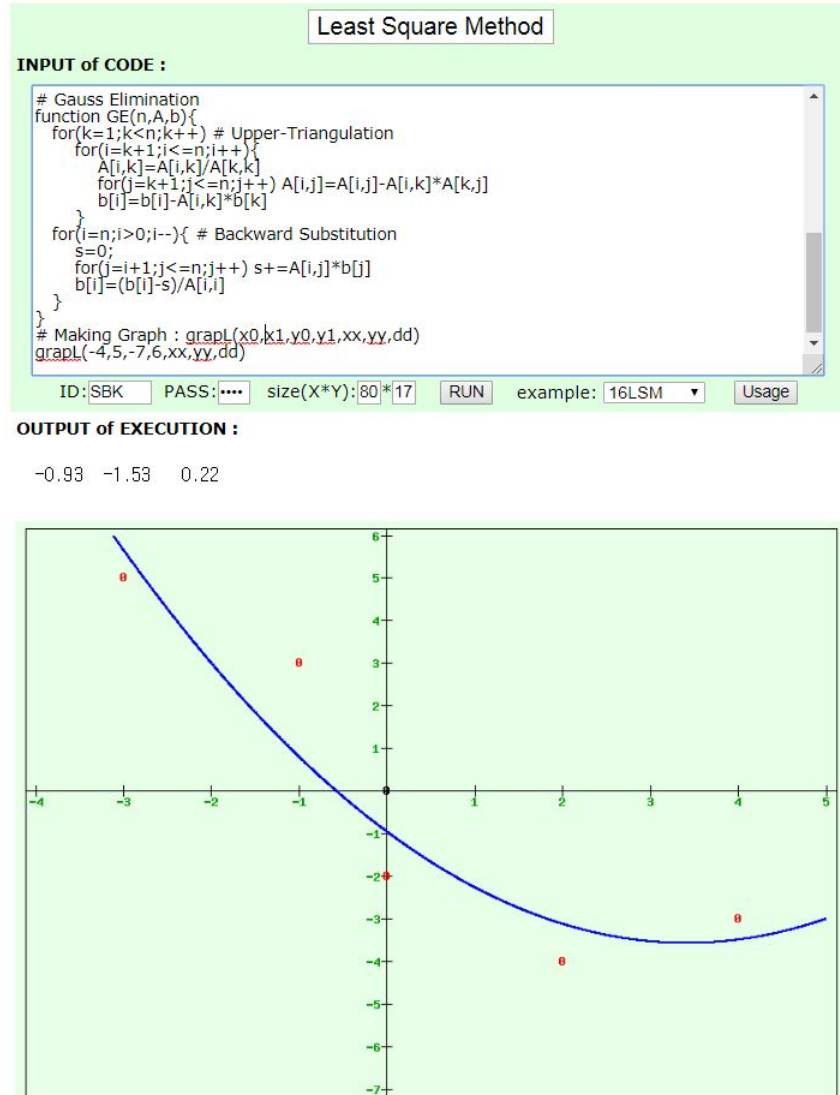


FIGURE 4. Graph of solution function of least squares problem

in NAPHP. we summarize the comparison between PHP and NAPHP in Figure 3.

It is not easy for students to start coding for the first time. If you have some examples, you may easily get started. NAPHP basically provides the following

example codes:

```
Bisection, Newton, Secant , Fixed point iterative ,  
Gauss elimination, Steffen , Root of polynomial,  
LU decomposition, Jacobi iterativ , Gauss-Seidel ,  
Lagrange interpolation polynomial, Least square,  
Power method for Eigenvalue Problem
```

In addition, NAPHP provides a drawing function `grapL` (See Figure 4) which draws a graph of a solution function of least squares method by using ‘image-create’ function of PHP.

3. Conclusion

Our goal is for students to practice numerical analysis coding on the web using a smartphone. NAPHP provides easy grammatical form in the view of typing the code. Another advantage of NAPHP is that students can use their own ID and password to manage them as a group. NAPHP does not have a debugging tool yet. If the grammar of the code entered by the students is not correct, NAPHP does not point out any grammatical errors and does not produce any result, either. A debugging tool must be developed in the future so that it should inform grammatical errors and can let the code go step by step to print out some values of variables if needed.

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