VPMR Tutorial

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Contents

1 Introduction

The VPMR (Vallée-Poussion sums and Model Reduction) App, is used for approximating non-singular functions by sum-of-Gaussians (SOG) or sum-of-exponentials (SOE) on MATLAB. The algorithm of VPMR is introduced in
J.Liang, Z.Gao, Z.Xu, A Kernel-independent Sum-of-Gaussians method by de la Vallée-Poussion sums,arXiv:2010.05192.

VPMR used the technical support of Multiprecision Computing Toolbox produced by Advanpix company. Users can download Trail and know more about the toolbox from
www.advanpix.com.

2 Modes

The bold font represents the names displaced on the App. And the underlined words indicate something that needs to be highlighted.

2.1 Function

Users can input the kernel function into the textbox of **Function**. If users click the **PW** radio button, more details will be shown. **PW** means piecewise, which is designed for piecewise kernel functions. The current version supports only two-part piecewise functions. Users input the first part into the textbox of **Function**, and the other part into the textbox next to **PW**. And the splitting point needs to be input in the toolbox of **SP**. If users click the **PW** radio button again and turn it off, the input function will only be the function in the textbox of **Function**. The input of all functions must follow the MATLAB matrix format.

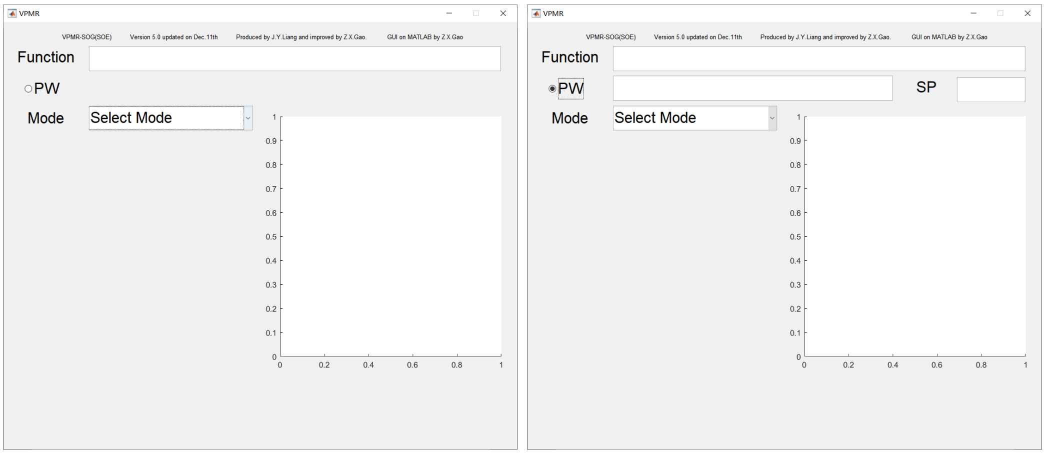
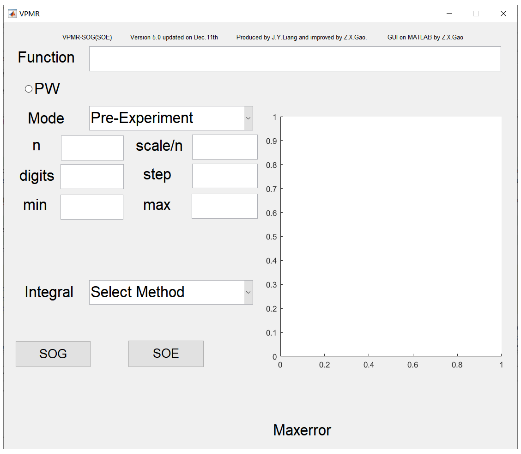


Figure 1: The **PW** radio button

2.2 Pre-experiment

In the pop up menu of **Mode**, we can choose **Pre-Experiment** to do the pre-experiment. Pre-experiment is faster while it can only output the error of the approximation. Users can use this mode to try the proper parameters even though it does not end up producing coefficients.



VPMR

VPMR-SOG(SOE) Version 5.0 updated on Dec.11th Produced by J.Y.Liang and improved by Z.X.Gao. GUI on MATLAB by Z.X.Gao

Mode: Pre-Experiment

Integral: Select Method

Figure 2: The interface of **Pre-Experiment**

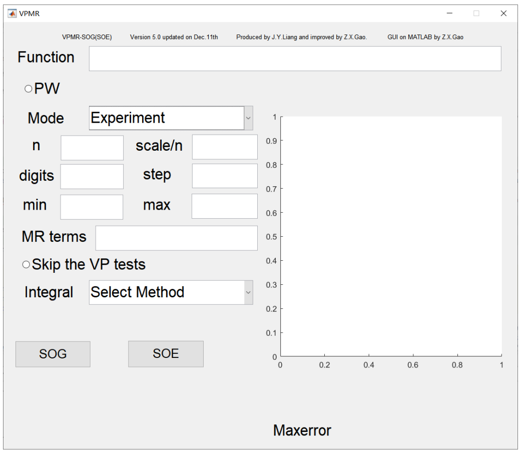
Users input parameters into the proper textbox and click the **SOG** or **SOE** button to output errors. The meanings of these parameters are:

1. **n**: the half of the number of the terms.
2. **scale/n**: the square of the bandwidth.
3. **digits**: the number of bits reserved during the calculation.
4. **step**: the stepsize of the sample when calculating the error.
5. **min** and **max**: the domain of the objective function.

These definitions remain unchanged in other modes. The error graph will be plotted on the right, and the maximum error will be shown on the bottom. All the errors are absolute errors.

2.3 Experiment

In this mode, we can calculate the result by model reduction. Users can input the number of the terms into the textbox of **MR terms**. If users want to skip the VP sum tests which cost much time, click the radio button **Skip the VP tests** and keep it on. Click the **SOG** or the **SOE** button to output the results. The setting of the other parameters is detailed in Section 2.2.



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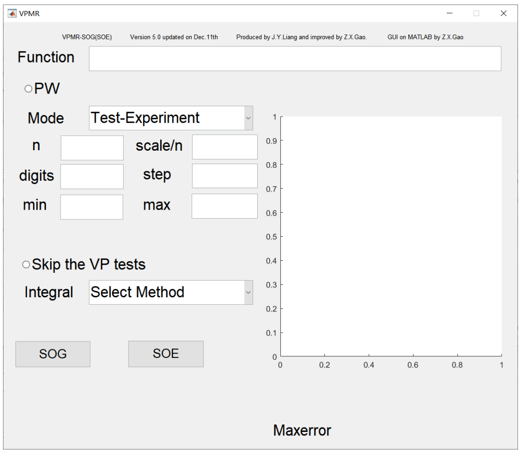
Mode: Experiment

Integral: Select Method

Figure 3: The interface of **Experiment**

2.4 Test-experiment

In this mode, when users input the proper parameters, the VPMR will test ALL the valid number of the model reduction terms. The result will output the relationship between the error and the number of terms which can help users determine which number is better.The setting of the other parameters is detailed in Section 2.2 and Section 2.3.



VPMR

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Mode: Test-Experiment

Integral: Select Method

Figure 4: The interface of **Test-Experiment**

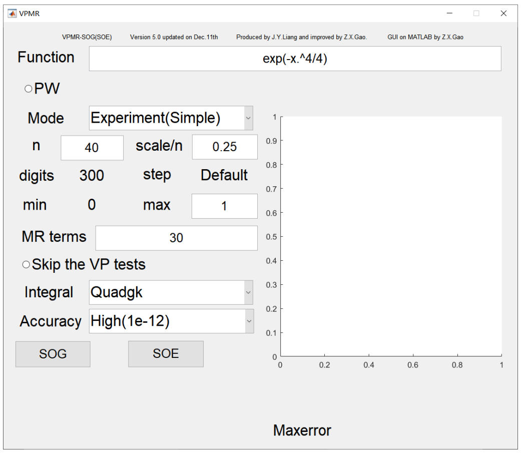
2.5 Simple mode

Pre-Experiment, **Experiment** and **Test-Experiment** have their simple mode. In the simple mode, some parameters will be set to default values.

2.6 Run

Users firstly select the integral method. VPMR provides two different methods, Quadgk and Gauss base points. The former is implemented by Gauss-Kronrod quadrature of MATLAB.

And the latter is implemented by the algorithm given by Davis and Rabinowitz in Methods of Numerical Integration, page 365, Academic Press, 1975. For both two methods the VPMR provides four different accuracy options. The VPMR perform the 11-step algorithm. The process will be updated in the lower right corner. If the process is found to be no longer updating, the VPMR has already failed.



VPMR

VPMR-SOG(SOE) Version 5.0 updated on Dec.11th Produced by J.Y.Liang and improved by Z.X.Gao. GUI on MATLAB by Z.X.Gao

Function exp(-x.^4/4)

○PW

Mode Experiment(Simple)

n 40 scale/n 0.25

digits 300 step Default

min 0 max 1

MR terms 30

○Skip the VP tests

Integral Quadgk

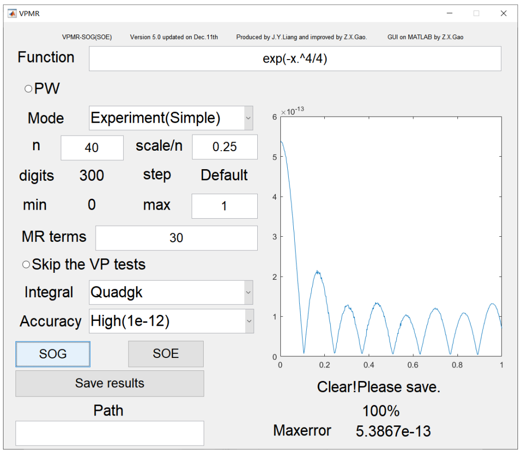
Accuracy High(1e-12)

Maxerror

Figure 5: The calculation process

2.7 Save results

The VPMR provides users with an extremely convenient way of saving data. When **Experiment** or **Test-Experiment** is finished(no matter simple or not), users can input the path into the textbox of **Path**.



VPMR

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Function exp(-x.^4/4)

○PW

Mode Experiment(Simple)

n 40 scale/n 0.25

digits 300 step Default

min 0 max 1

MR terms 30

○Skip the VP tests

Integral Quadgk

Accuracy High(1e-12)

Path

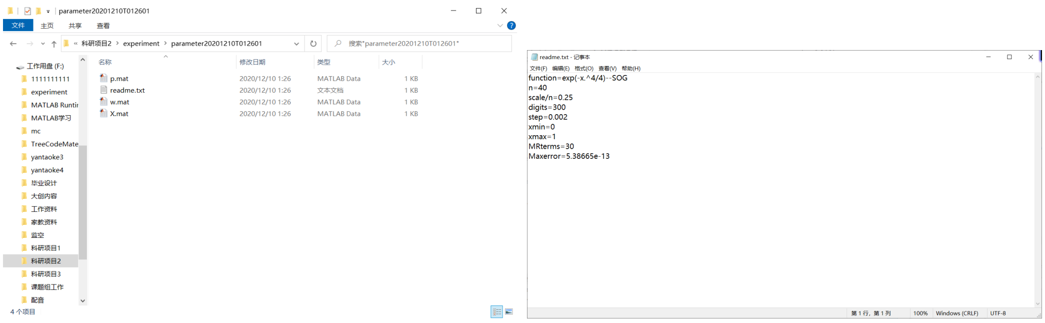
Clear!Please save.

100%

Maxerror 5.3867e-13

Figure 6: The interface of save the results.

The VPMR will create a new folder in the path and the name of the new folder only depends on the system time, so it is unique. The file X.mat, p.mat,and w.mat store the constant term,



名称	修改日期	类型	大小
p.mat	2020/12/10 1:26	MATLAB Data	1 KB
readme.txt	2020/12/10 1:26	文本文档	1 KB
w.mat	2020/12/10 1:26	MATLAB Data	1 KB
X.mat	2020/12/10 1:26	MATLAB Data	1 KB

```
function=exp(-x.^4/4)--SOG
n=40
scale/n=0.25
digits=300
step=0.002
xmin=0
xmax=1
MRterms=30
Maxerror=5.38665e-13
```

Figure 7: The results

exponential coefficients and the linear coefficients,respectively. In other words,

$$f(x) \approx X + \sum_{i=1}^{N} w_i e^{-p_i x^\alpha}, \quad \alpha = 1 \; or \; 2$$

The file readme.txt stores all the parameters so that users can know the result information at any time.

3 Appendix

Please contact the author by 1270157606gzx@sjtu.edu.cn to solve the problems and bugs.