A Large-Scale Differential Evolution Optimization Platform Based on Transdifferentiation Strategy （V1.3）

MANUAL

Jiangsu University of Science and Technology
Machine Learning and New Software Technology Institute

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Developer Statement

Thank you for using the large-scale differential evolution optimization platform based on transdifferentiation strategy developed under the auspices of Jiangsu University of Science and Technology. This platform can be used to solve the rail-guided vehicle dynamic scheduling problem (RDSP). The software copyright of this platform is shared by Jiangsu University of Science and Technology and its co-developers. Thanks to these developers for their important contributions during the development of this platform.

This platform is an open source and free code base, which is only for teaching and scientific research, not for commercial use. Part of the code in this platform is written based on the author's understanding of the paper, and the author is not responsible for any consequences of the user's use of the code. Papers containing data generated using this platform should declare the use of the differential evolution algorithm based on transdifferentiation strategy (DE-TS), and cite the corresponding references correctly.

This platform does not directly contain any open source code or open source data. However, the operation of this platform depends on other supporting software. This platform can run normally only in the software environment where MATLAB and PlatEMO are installed (the recommended software environment is MATLAB R2020b and PlatEMO v3.3). When you use this platform with other software, you also need to comply with the prerequisites and relevant requirements of other software. If you have any comments or suggestions, please contact jiangyuanhao@stu.just.edu.cn (Yuanhao Jiang). Finally, thank you again for using this platform.

Content

1 Quick start

1.1 Introduction

Rail-guided vehicle (RGV) is a logistics management device that is widely used in material processing workshops. It is often used to perform various material processing operations in place of manual work. At present, RGV has been widely used in various production and processing systems such as aviation safety, parts processing, magnetic levitation control, and intelligent warehousing, and has been used to replace manpower to perform material loading and unloading, material handling, and finished material cleaning and other material processing operations, so as to realize the refined control of the material flow status.

In recent years, the use of RGV for integrated scheduling control of high-precision computer number controller (CNC) has become very common. In this operation scenario, the RGV performs integrated control on the CNC, so that the CNC can stably and efficiently complete the scheduled processing tasks under appropriate material supply conditions. This practical problem can be called the rail-guided vehicle dynamic scheduling problem (RDSP).

For academic and research purposes, this platform provides examples of the RDSP series' test problems. At the same time, this platform also provides a large-scale differential evolution optimization algorithm (DE-TS) based on the differentiation transfer strategy to solve the RDSP. This platform is for teaching and research purposes only, not for commercial purposes. Part of the code in this platform is written based on the author's understanding of the published papers, and the author is not responsible for any consequences of the user's use of the code. Papers containing data generated using this platform should declare the use of DE-TS and properly cite the corresponding references.

1.2 Environmental requirements

Before running this platform, please ensure that the correct operating environment has been configured. The recommended software environment is MATLAB R2020b and PlatEMO v3.3.

The operation of this platform also relies on the parallel computing toolbox and the statistics and machine learning toolbox in MATLAB. Normally, these toolboxes are automatically installed on the system when MATLAB is installed. If you find that the platform cannot be used normally, please check whether these toolboxes have been installed correctly.

2 Platform installation

2.1 Decompress

After you download this platform, if you get a compressed package file, you need to perform the decompression operation first. Then, you will get two folders named "DETS" and "RDSP". The decompression result is shown in the figure below:

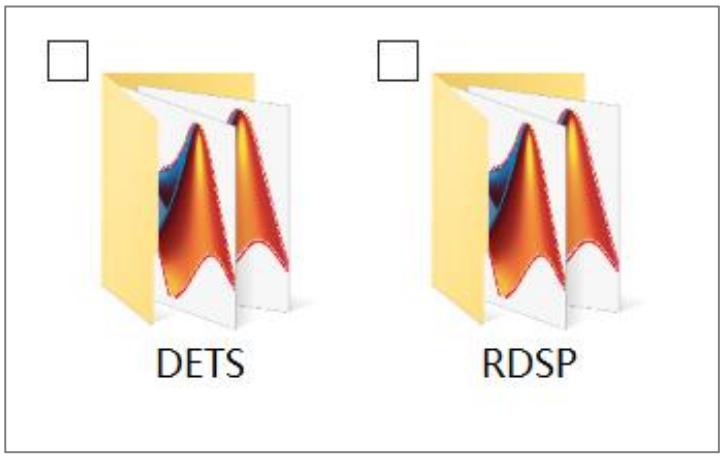


Fig. 2-1. Decompress result

2.2 File copy

After the decompression operation is complete, the resulting files need to be copied to the correct path. First, you need to find where the Platform for Evolutionary Multi-Objective Optimization (PlatEMO) is installed. In the example, in this document, PlatEMO is installed at the following path:

C:\Workspace\PlatEMO-master

Enter the installation path of PlatEMO, you can see a folder named "PlatEMO". Double click to enter this folder.

Fig. 2-2. PlatEMO installation path

The "PlatEMO" folder contains two folders named "Algorithms" and "Problems", as shown in Fig. 2-3.

Fig. 2-3. Target path

Next, you need to copy the two folders "DETS" and "RDSP" to the above two folders respectively. In the example, in this document, the "DETS" folder needs to be copied to the following path:

C:\Workspace\PlatEMO-master\PlatEMO\Algorithms

Meanwhile, the "RDSP" folder needs to be copied to the following path:

C:\Workspace\PlatEMO-master\PlatEMO\Problems

After you complete the above copy operation, the installation process of this platform is declared complete.

3 Call the DE-TS in the test module

3.1 Running PlatEMO

There are two ways to use this platform. On the one hand, you can use DE-TS or other algorithm to solve RDSP in PlatEMO's test module. On the other hand, you can also use DE-TS and other algorithms to solve RDSP in the experimental module, and compare the performance of different algorithms.

This chapter introduces the method of calling the DE-TS in the test module. Previously, you needed to run the PlatEMO platform first. First, double-click the shortcut of the MATLAB software to run it:

Fig. 3-1. The shortcut of the MATLAB software

Then, copy the installation path of PlatEMO to the clipboard. E.g:

C:\Workspace\PlatEMO-master\PlatEMO

Next, modify MATLAB's current folder by pasting the PlatEMO installation path into MATLAB's address bar and pressing Enter:

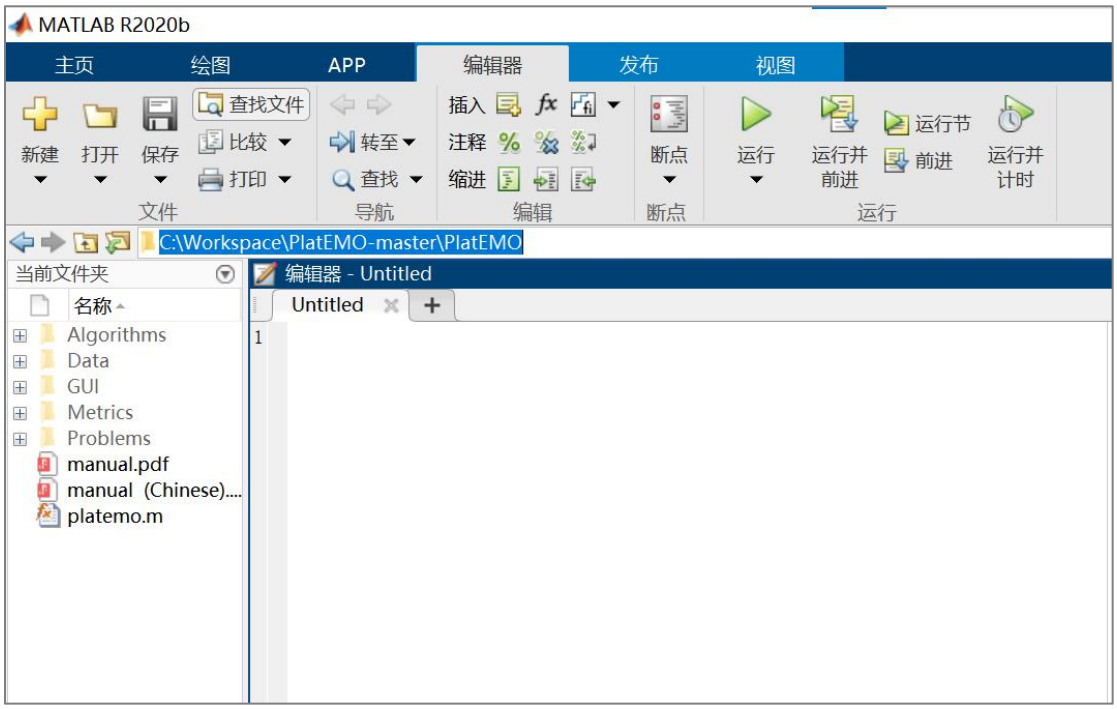


Fig. 3-2. Modify the current folder of MATLAB

Next, double click and open the "platemo.m" file in the editor window, as shown

in the image below:

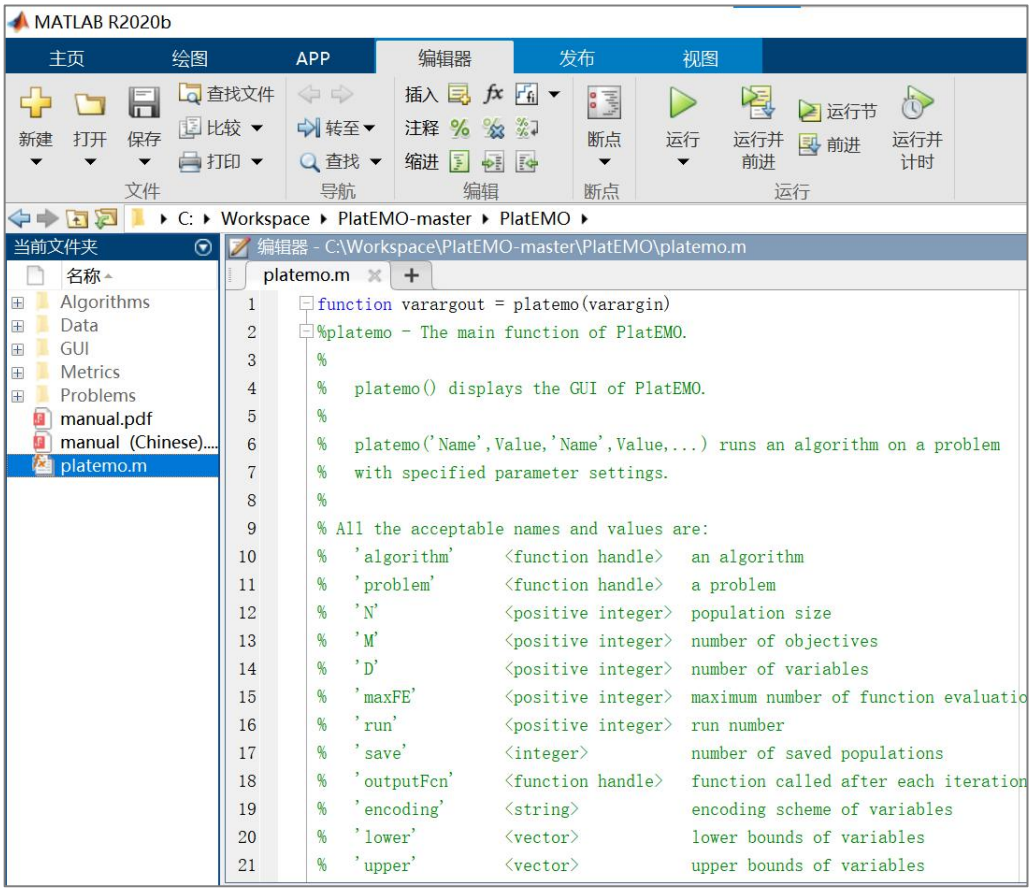


Fig. 3-3. Editor window

Then, click the "Run" button at the top of the window and wait for the loading to complete.

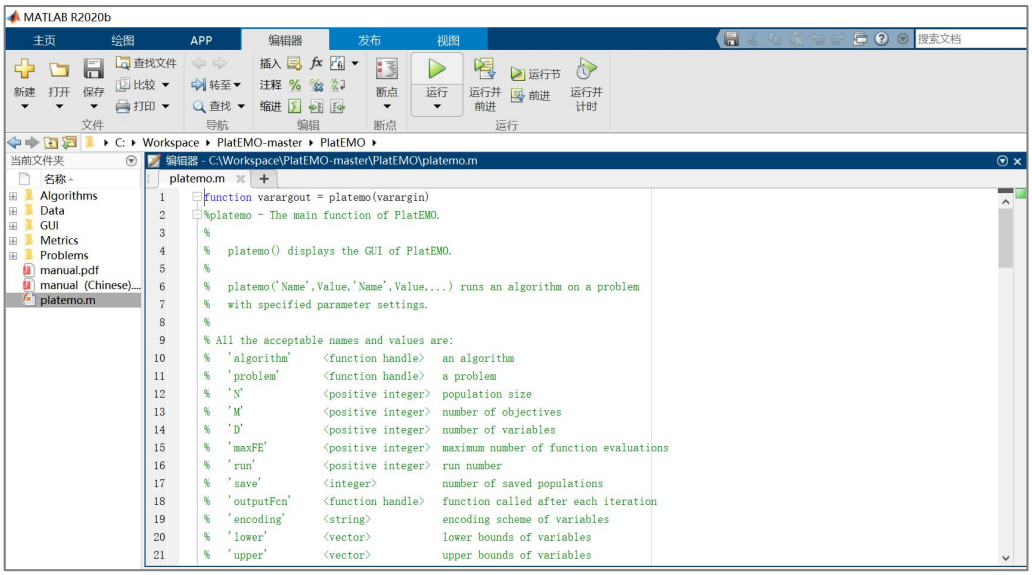


Fig. 3-4. Click the "Run" button

After the loading is complete, the main window of PlatEMO will be opened

automatically.

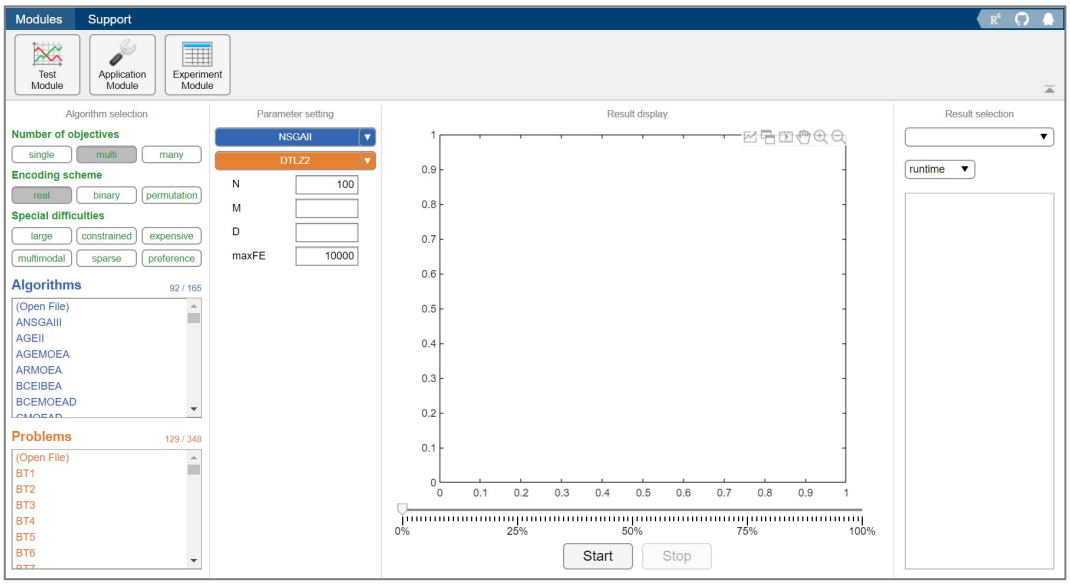


Fig. 3-5 The main window of PlatEMO

3.2 Enter the test module

In the test module, you can use DE-TS or some other algorithm to solve the RDSP. When the main window of PlatEMO is opened, the program will automatically switch to the test module. You can also click the "Test Module" button in the upper left corner to actively switch to the test module.

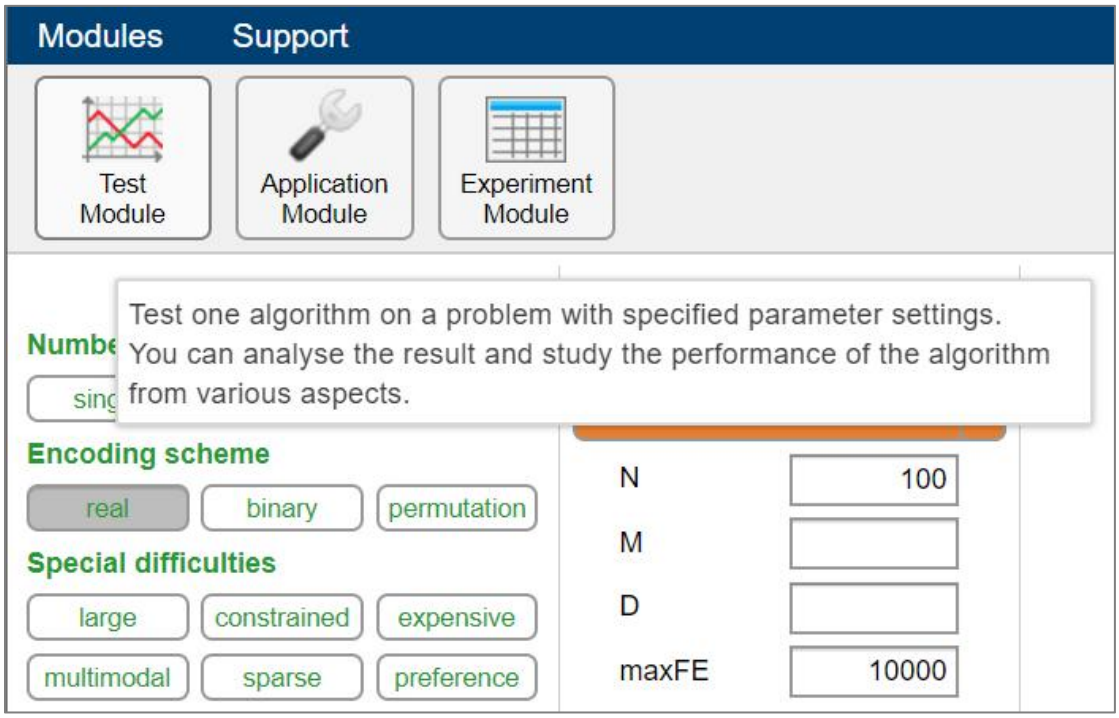


Fig. 3-6. Switch to test module

3.3 Configuration parameters

When solving the RDSP in the test module, you need to set "Number of objectives" to "single", and at the same time set "Encoding scheme" to "real", as shown in Fig. 3-7.

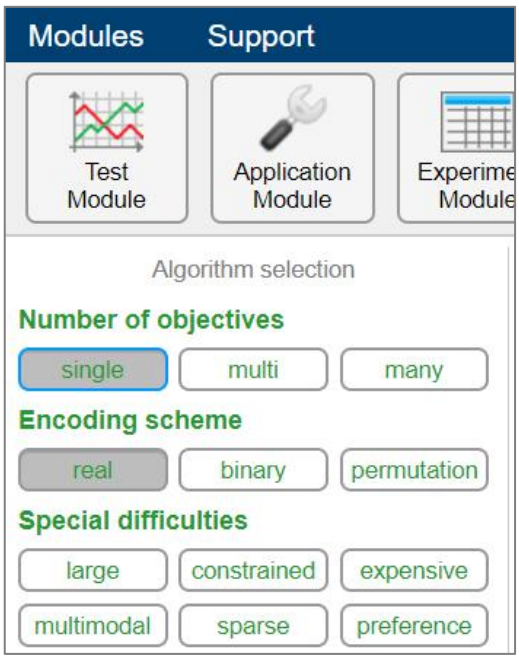


Fig. 3-7. Test module settings

After completing the above operations, the "Algorithms" and "Problems" lists on the left side of the window will be automatically updated. At this point, you can select the DETS in the "Algorithms" list and any of the problems in RDSP1-3 in the "Problems" list. Fig. 3-8 shows a configuration method for solving the RDSP1 using the DE-TS:

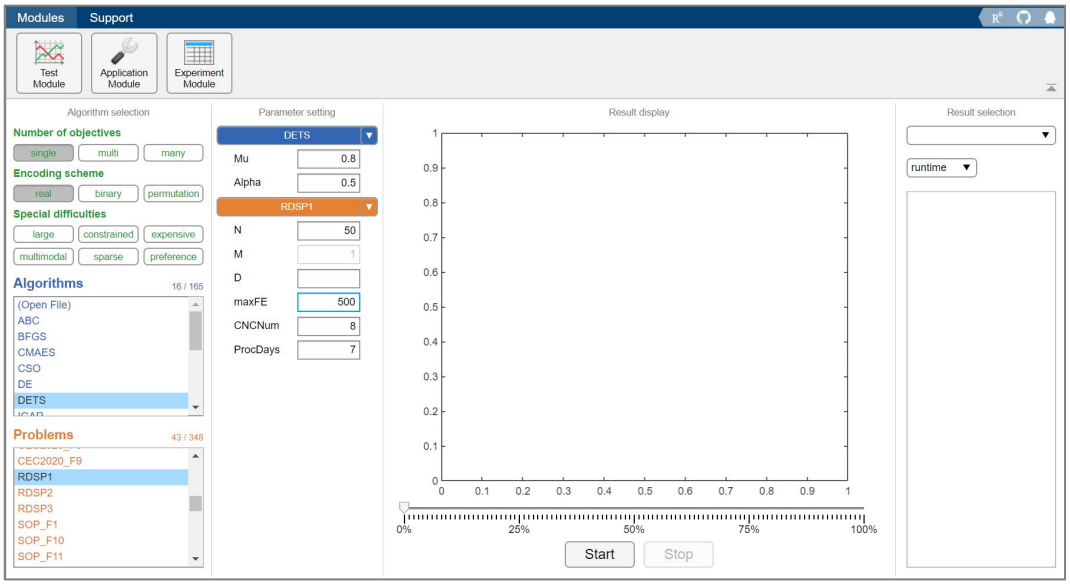


Fig. 3-8. Problem and algorithm selection

At this point, you can modify the relevant parameters of the problem or algorithm in the "Parameter setting" block. The relevant parameters and their meanings are shown in the following table:

Table 3-1. Parameter list

Parameter	Name	Default	Meaning	Notes
Algorithm parameters	Mu	0.8	Debilitating factor	The rate at which the probability value decays as the number of rounds increases
	Alpha	0.5	Environmental pressure	Proportion of populations performing a transdifferentiation strategy
Problem parameters	N	100	population size	The recommended value is 50
	M	1	Number of goals to optimize	RDSP1-3 are all single-objective optimization problems
	D	-	Decision vector dimension	No need to modify, the algorithm is automatically generated
	maxFE	10000	Maximum number of function evaluations	The recommended value is 500
	CNCNum	8	Number of CNCs	Recommended values are 8, 10 or 12
	ProcDays	7	Continuous processing days	Recommended value is 7 or 30

3.4 Run DE-TS

After completing the parameter configuration, you can click the "Start" button at the bottom of the window to use the DE-TS to solve the RDSP. After clicking the button, the progress bar at the bottom of the window will gradually move from 0% to 100%. Please wait patiently for the algorithm to finish running.

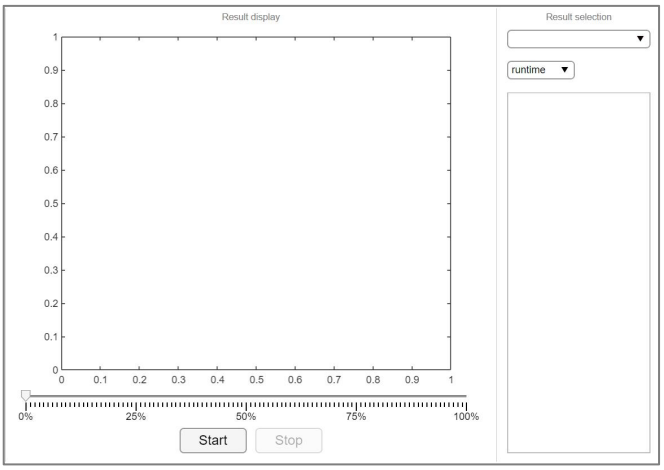


Fig. 3-9. Running the algorithm

During operation, you can view the temporary data generated during the operation of the algorithm in the command line window in the main window of MATLAB. After each evaluation operation is performed on an individual, the platform will output the evaluation information of the solution in the command line window. For example, the output for an individual might be:

8Day 0h 0:45 ， output=4468，RGV mobile unit=229210，loss=20.9483%

The meaning of the above information is: the current individual stops after continuous processing for 8Day 0h 0:45, the output of finished materials produced during this period is 4468, the RGV has moved a total of 229210 units, and the loss of the individual is 20.9483%. It is important to note that when each individual is assessed, the downtime will be slightly greater than the preset continuous processing time, but this is normal. Rest assured that the value of the finished material output will not increase after the preset continuous processing time.

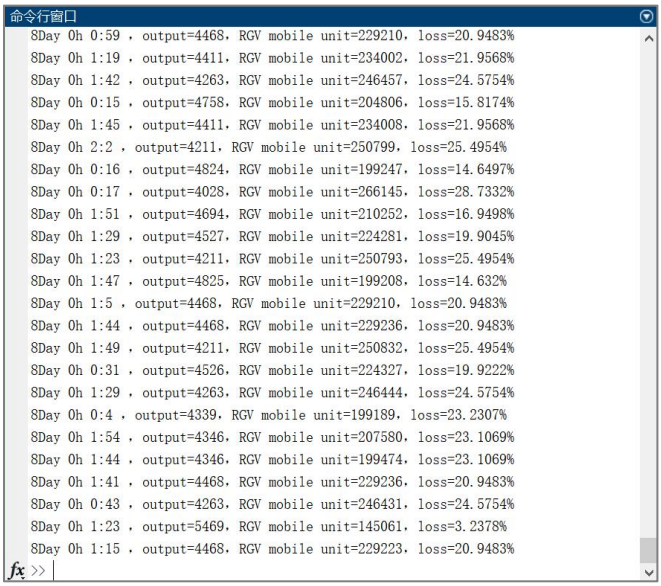


Figure 3-10 Command line window

During the operation of the algorithm, the adjustment of related parameters will be temporarily prohibited. At this point, you can pause or prematurely terminate the running of the algorithm by clicking the "Pause" or "Stop" buttons at the bottom of the page.

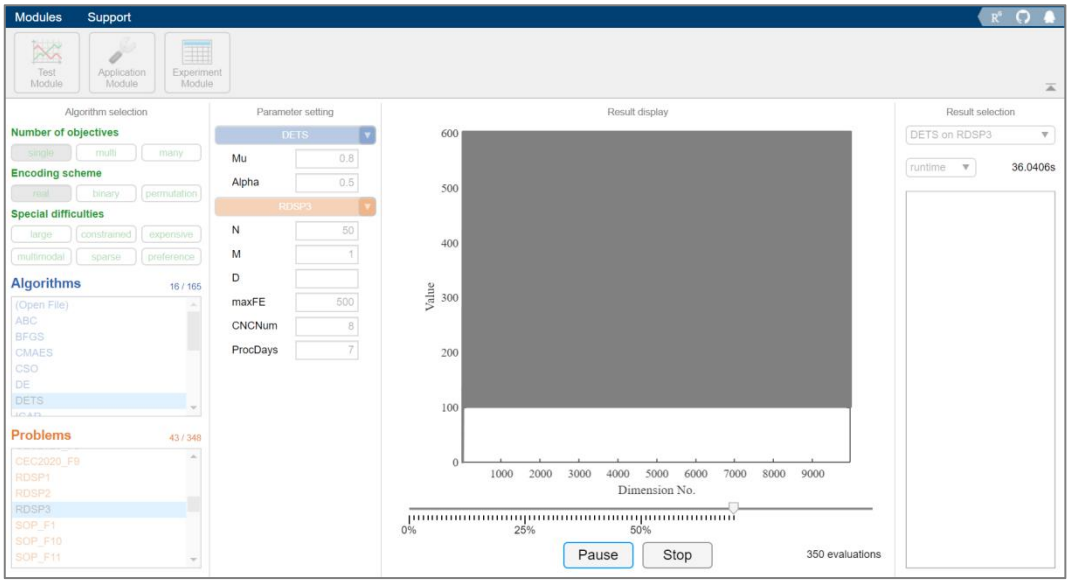


Fig. 3-11. Algorithm in action

3.5 View results

After this run, the "Result selection" module on the right side of the page will display the total time of the run and the incoming values of related parameters.

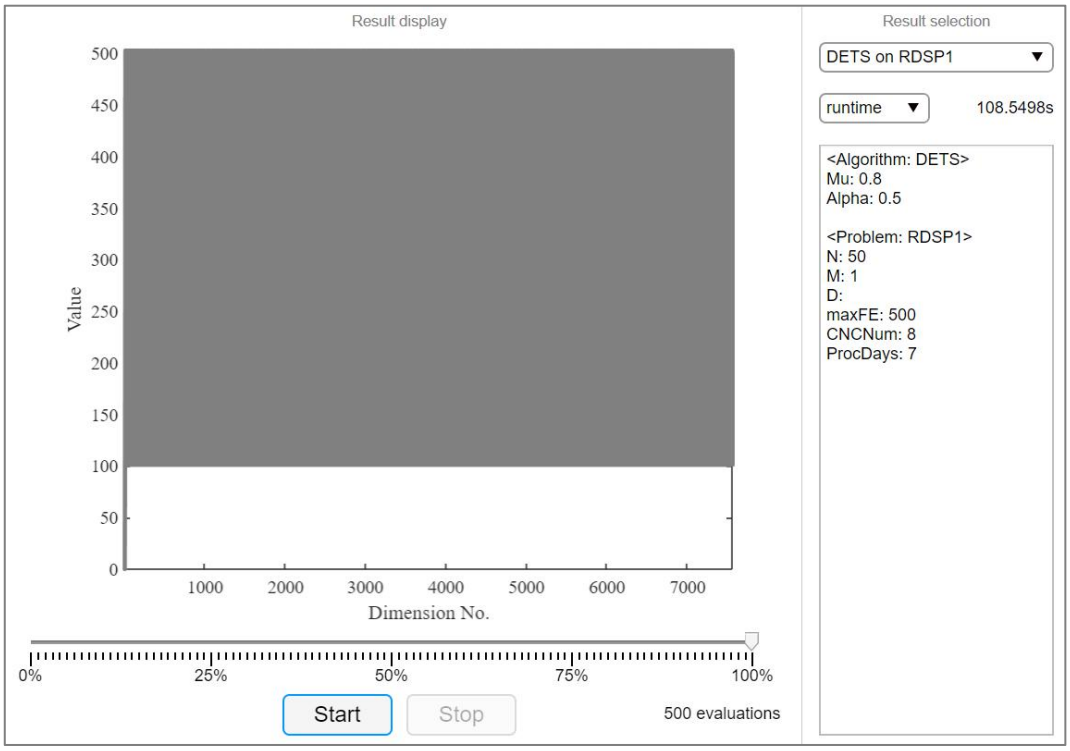


Fig. 3-12. Algorithm running ends

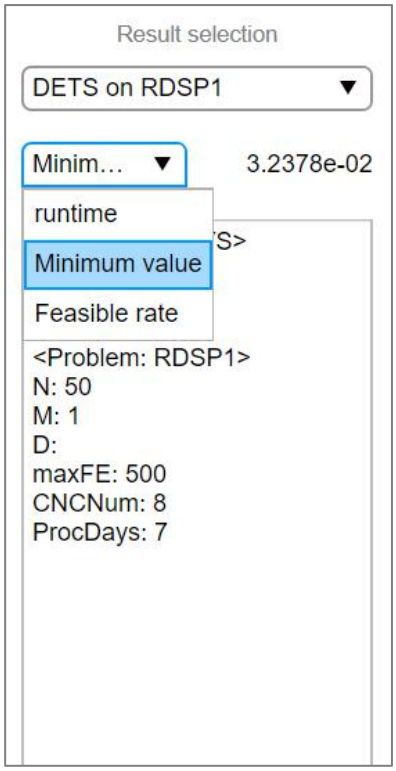


Fig. 3-13. Switching data sources

You can also view the changes in the population minimum as shown in Fig. 3-13. When you switch the data source to "Minimum value", the change of the minimum *loss* of the population will be displayed in the "Resut display" module, as shown in Fig. 3-14.

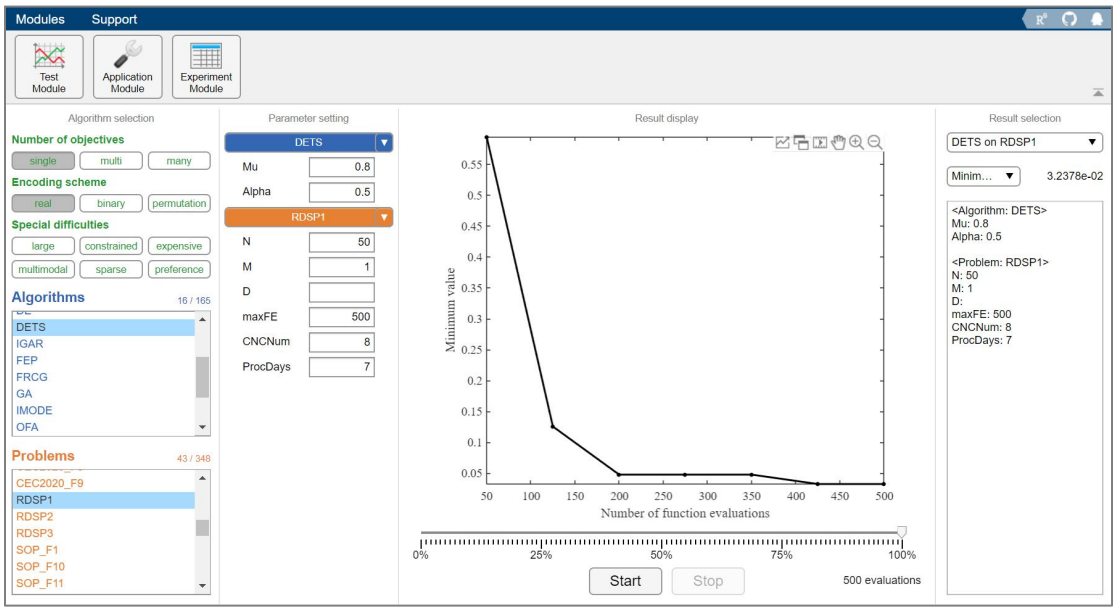


Fig. 3-14. Changes in the minimum *loss* of the population

In the "Resut display" module, you can also click "Data source" in the upper left corner to switch the data source, as shown in Fig. 3-15.

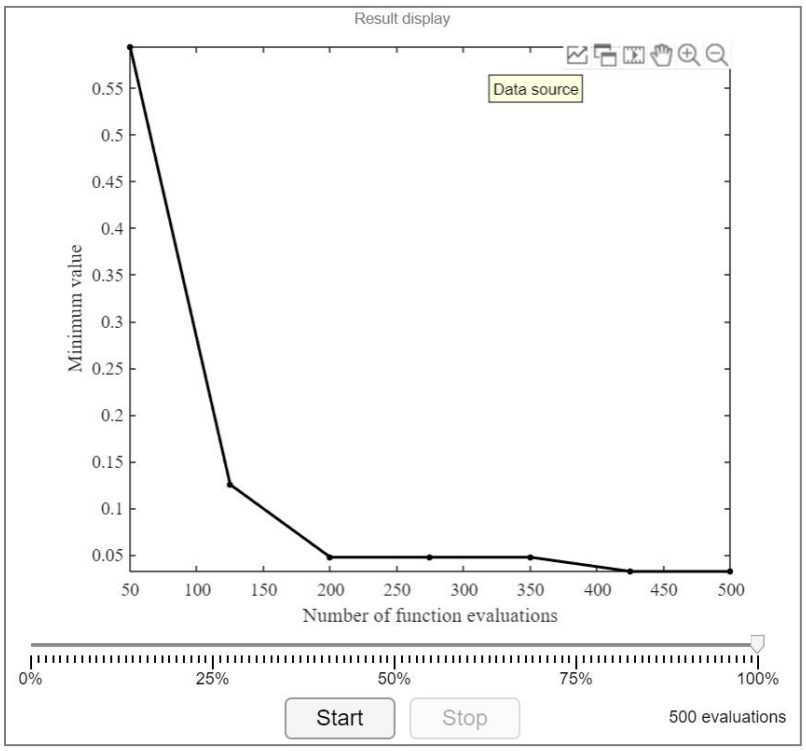


Fig. 3-15. Data source switching

As shown in Fig. 3-16, you can also export the result data by clicking the second button in the upper left corner of the "Resut display" module. After clicking, the data will be stored in the MATLAB workspace in the format of Cell matrix, and the graph will also be opened in a new window synchronously to facilitate further processing of the related data.

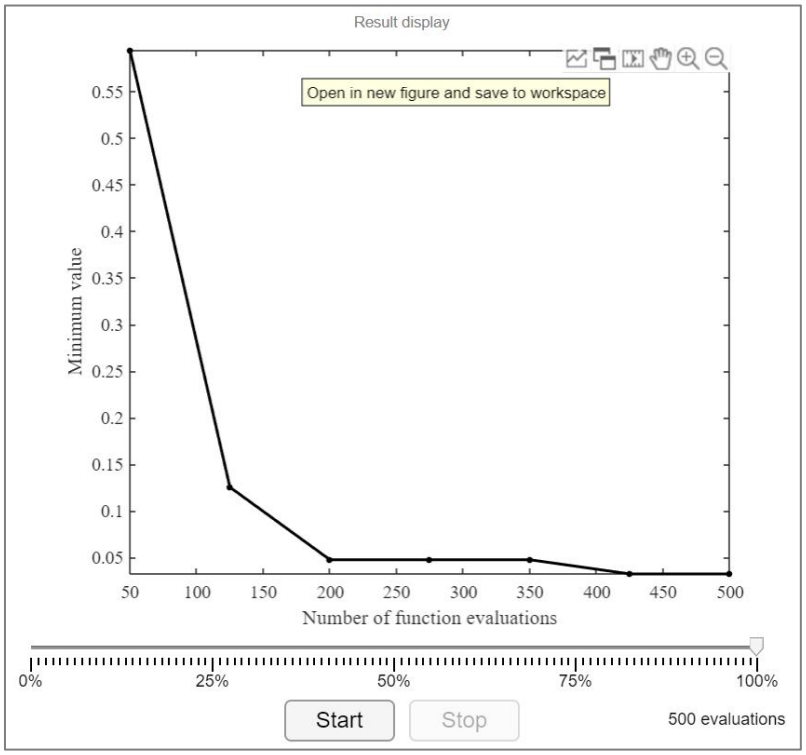


Fig. 3-16. Export data

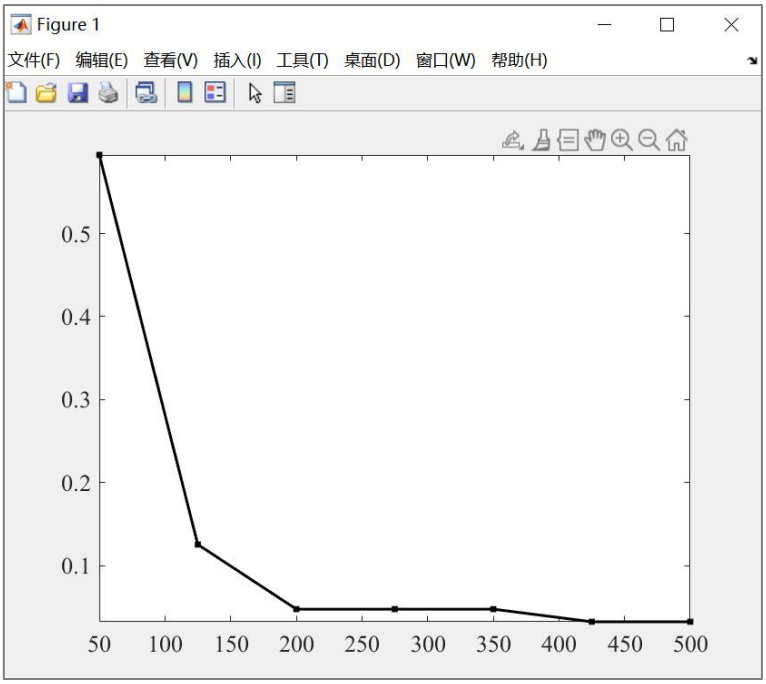


Fig. 3-17. Open the graph in a new window

You can also export result data by clicking the second button in the upper left corner of the "Resut display" module. After clicking, the data will be stored in the MATLAB workspace in the format of Cell matrix. As shown in Figure 3-17, the graph will also be opened in a new window synchronously to facilitate further processing of related data.

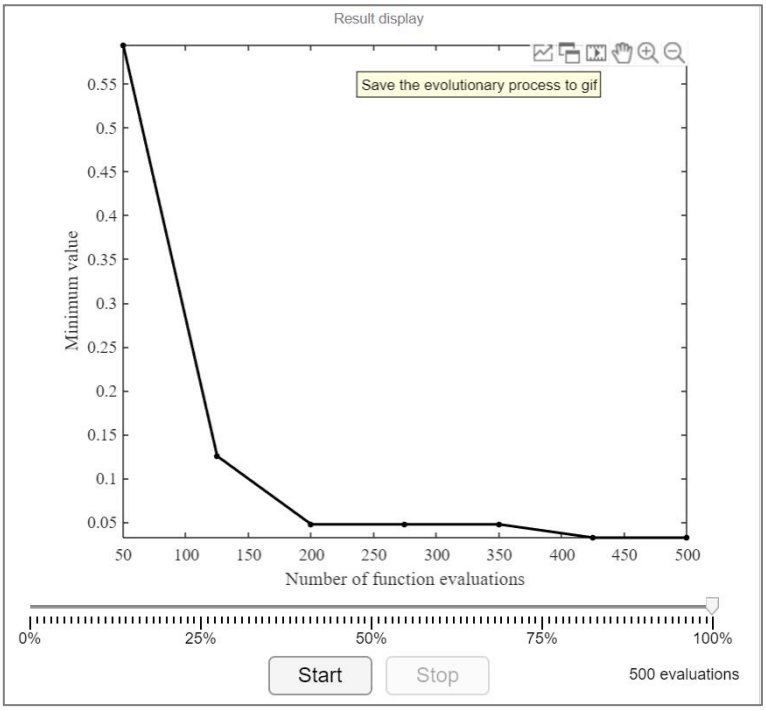


Fig. 3-18. Save as a gif image file

As shown in Fig. 3-18, you can also export an image file in gif format by clicking the third button in the upper left corner of the "Resut display" module. The image file will then be saved to the path you specified.

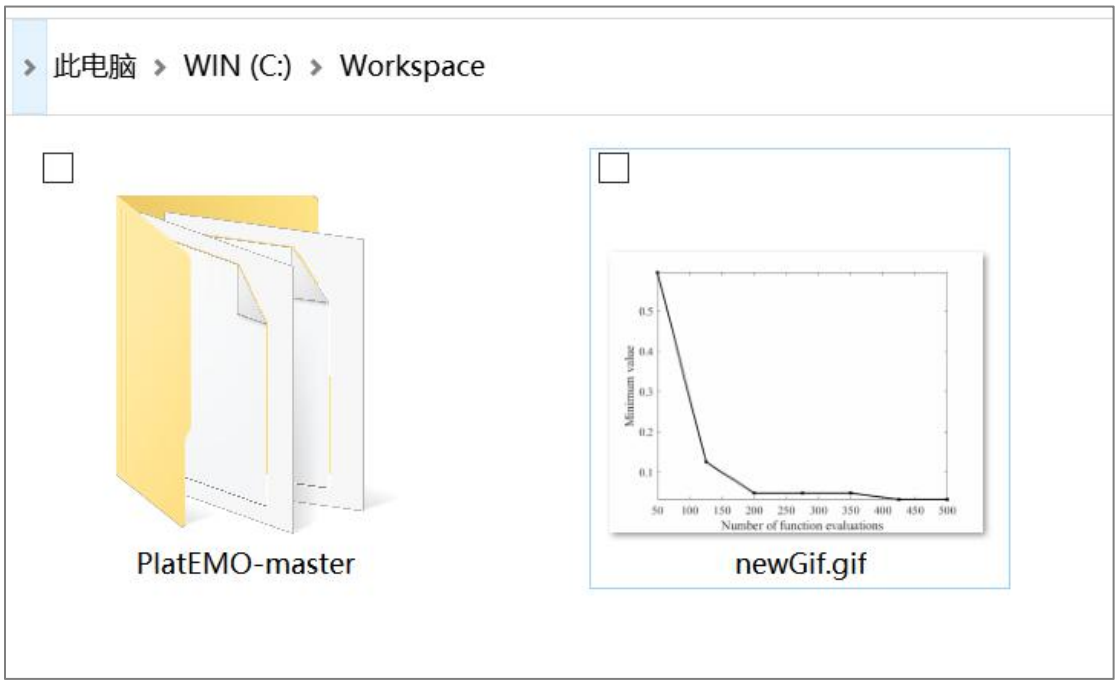


Fig. 3-19. The save path of the image file

As shown in Fig. 3-20, you can also pan, zoom in or zoom out on the graph by clicking the last three buttons in the upper left corner of the "Resut display" module.

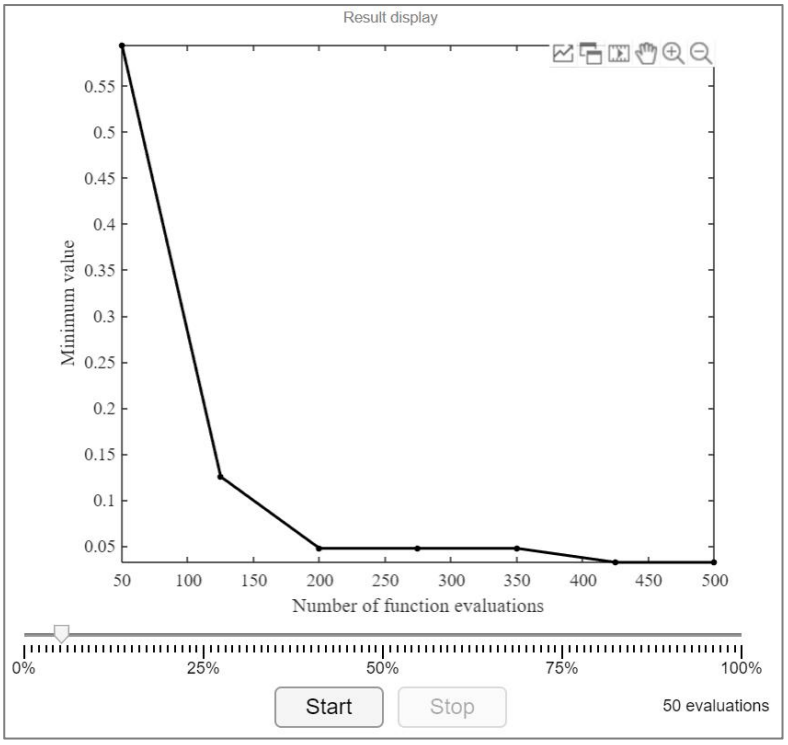


Fig. 3-20 Export data

You can do the above time and again and try to solve the RDSP with algorithms with different parameters. These data will be saved in the system until the window is closed. You can switch the viewed historical data in the "Result selection" module as shown in Fig. 3-21. After selecting a history record, the window will display the relevant data generated during the execution.

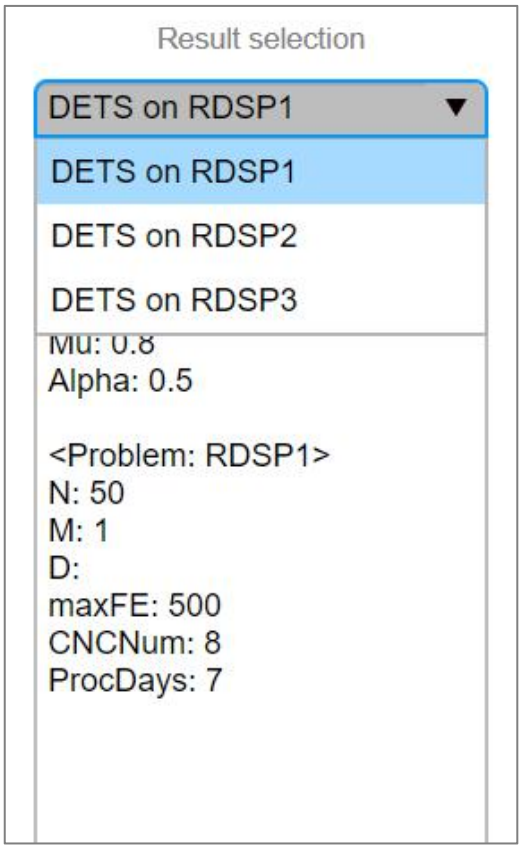


Fig. 3-21. View historical data

4 Call the DE-TS in the experimental module

4.1 Running PlatEMO

This chapter introduces the method of calling the DE-TS in the experimental module. In the experimental module, you can use various algorithms such as DE-TS to solve RDSP, and compare the algorithm performance of different algorithms. Previously, you needed to run the PlatEMO platform first. The method of running the PlatEMO platform has been introduced in sub-section 3.1, and will not be repeated here. After the system is loaded, the main window of PlatEMO will be opened automatically.

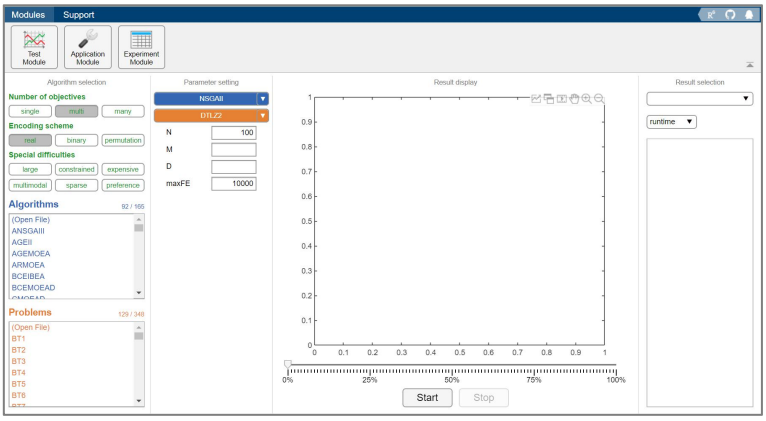


Fig. 4-1. The main window of PlatEMO

4.2 Enter the experimental module

After the main window of PlatEMO is opened, the program will automatically switch to the test module. At this point, you need to click the "Experiment Module" button in the upper left corner to switch to the experiment module.

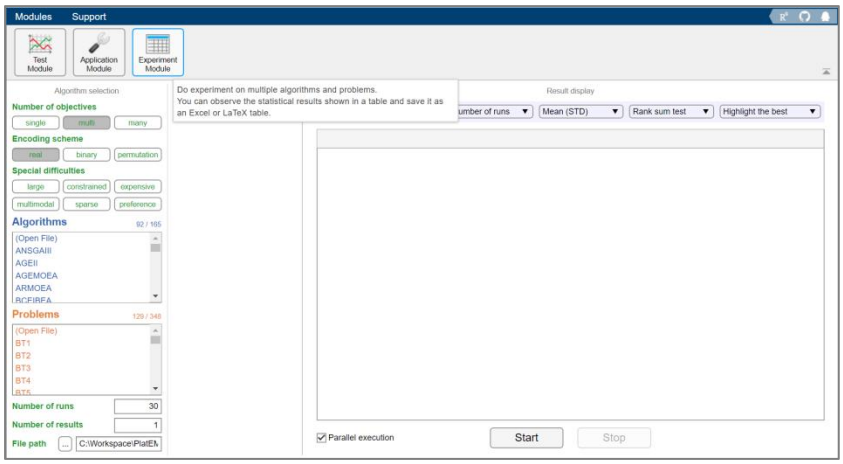


Fig. 4-2. Switch to the experimental module

4.3 Configuration parameters

When solving the RDSP in the experiment module, you need to set "Number of objectives" to "single" and set "Encoding scheme" to "real", as shown in Fig. 4-3. Settings such as "Number of runs", "Number of results" and "File path" at the bottom of the "Algorithm selection" module can be modified as needed.

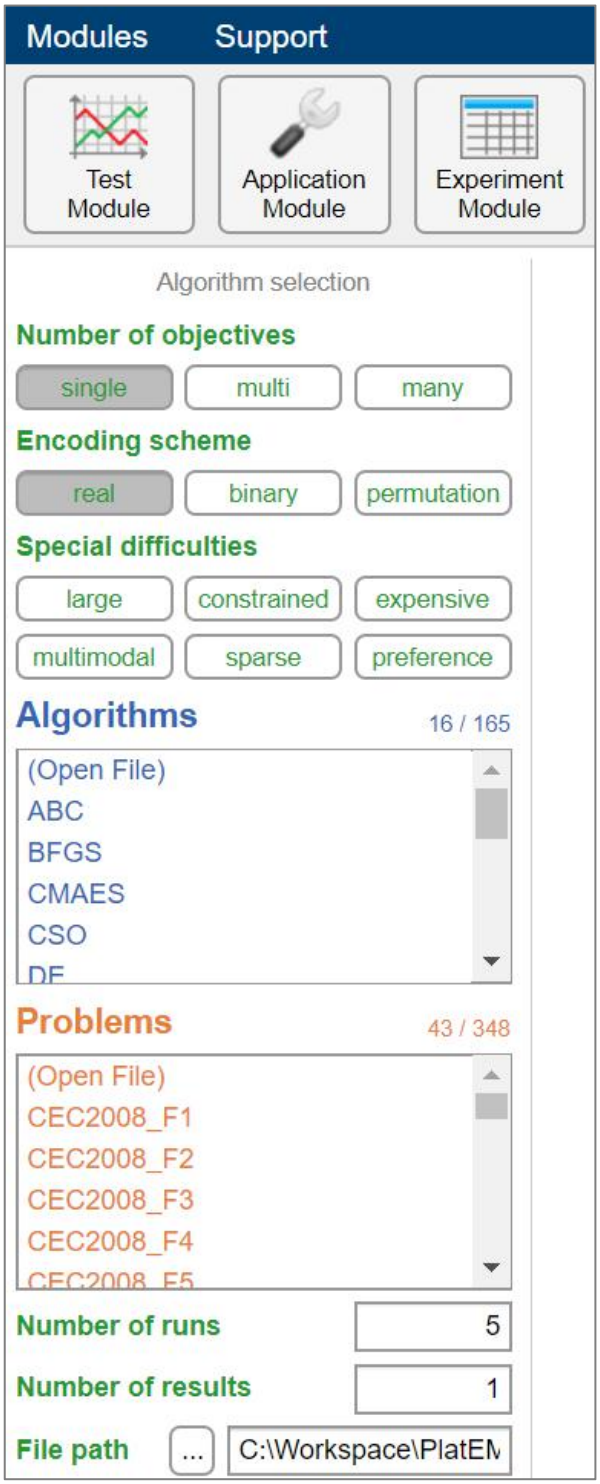


Fig. 4-3. Experimental module setting

After completing the above settings, the "Algorithms" and "Problems" lists on the left side of the window will automatically update. At this point, you can select the algorithm you want to use in the "Algorithms" list, and the problem you want to solve in the "Problems" list. Fig. 4-4 shows a configuration method using both the DE-TS algorithm and the GA algorithm to solve both the RDSP1 and RDSP2. At this point, you can modify the relevant parameters of the problem or algorithm in the "Parameter setting" block.

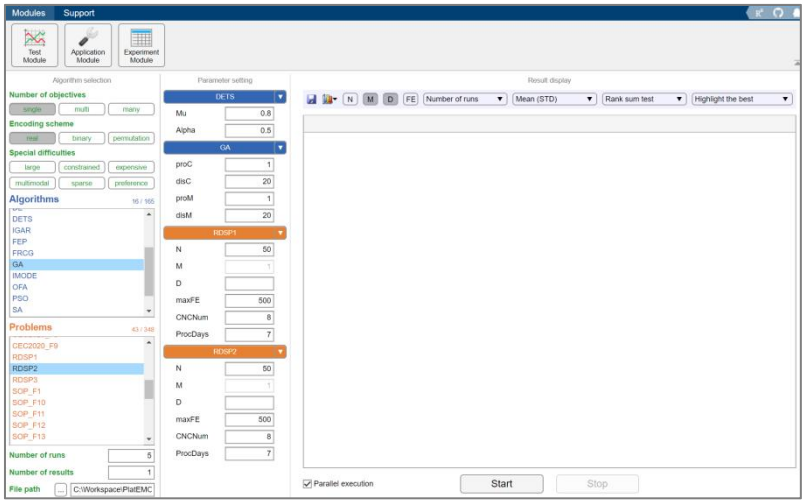


Fig. 4-4. Problem and algorithm selection

4.4 Run DE-TS

After completing the parameter configuration, you can click the "Start" button at the bottom of the window to execute the solution process. You can also check the "Paralel executon" option at the bottom of the page to execute the task in parallel. This operation relies on the Parallel Computing Toolbox in MATLAB.

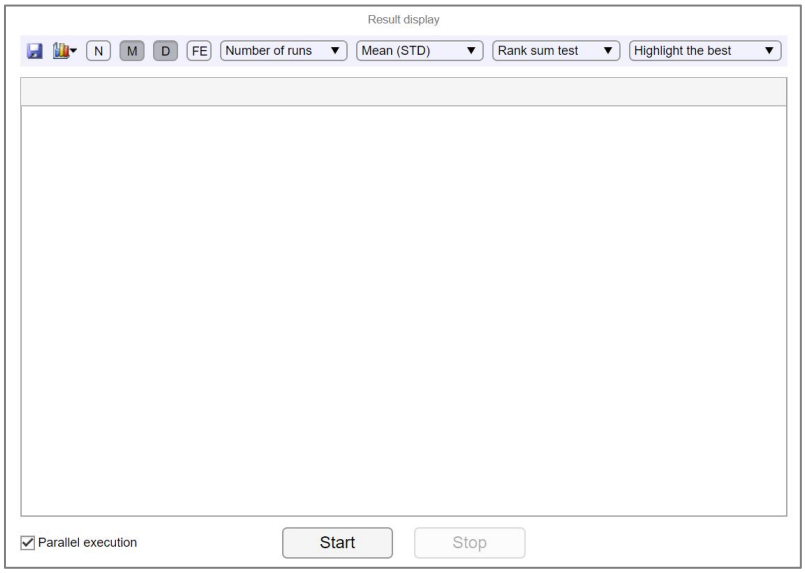


Fig. 4-5. Running the algorithm

During the operation of the algorithm, the adjustment of related parameters will be temporarily prohibited. At this point, you can pause or prematurely terminate the running of the algorithm by clicking the "Pause" or "Stop" buttons at the bottom of the page.

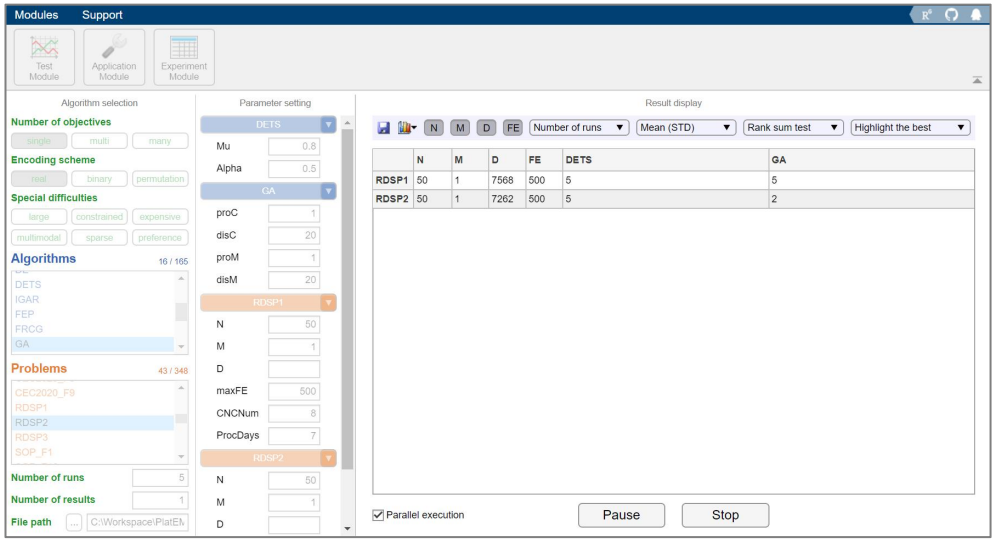


Fig. 4-6. Algorithm running

4.5 View results

After this run, the "Result selection" module on the right side of the page will display the results of the run. You can switch the displayed data sources as shown in Fig. 4-7. Fig. 4-8 and Fig. 4-9 show the situation when the data source is "runtime" and "Minimum value" respectively.

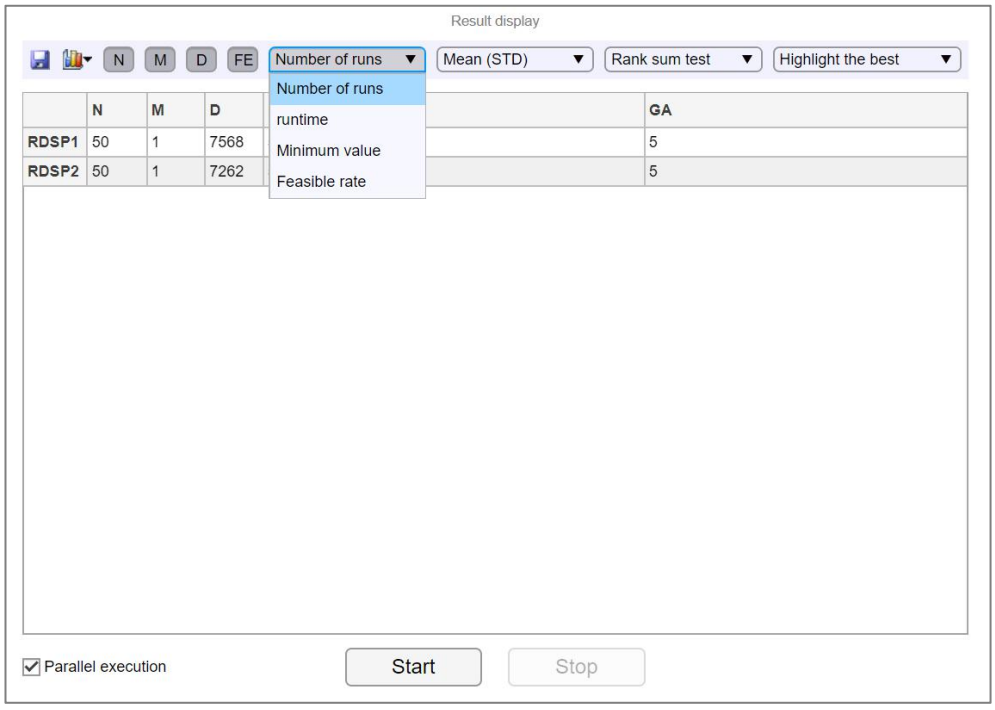
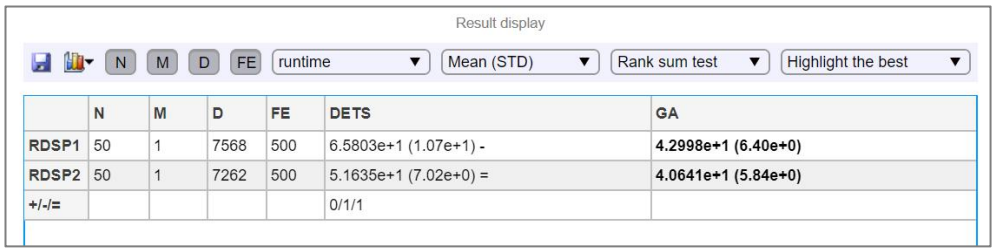
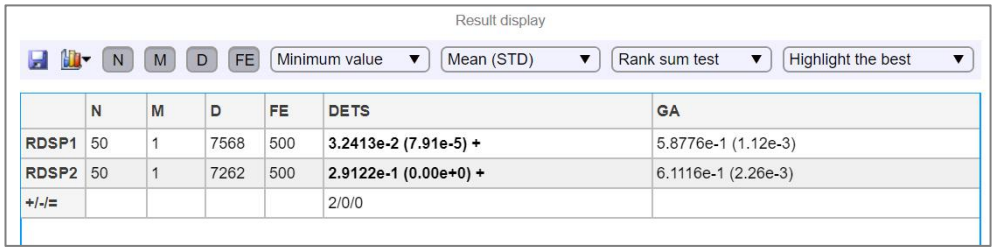


Fig. 4-7. Running result



	N	M	D	FE	DETS	GA
RDSP1	50	1	7568	500	6.5803e+1 (1.07e+1) -	**4.2998e+1 (6.40e+0)**
RDSP2	50	1	7262	500	5.1635e+1 (7.02e+0) =	**4.0641e+1 (5.84e+0)**
+/-/=					0/1/1	

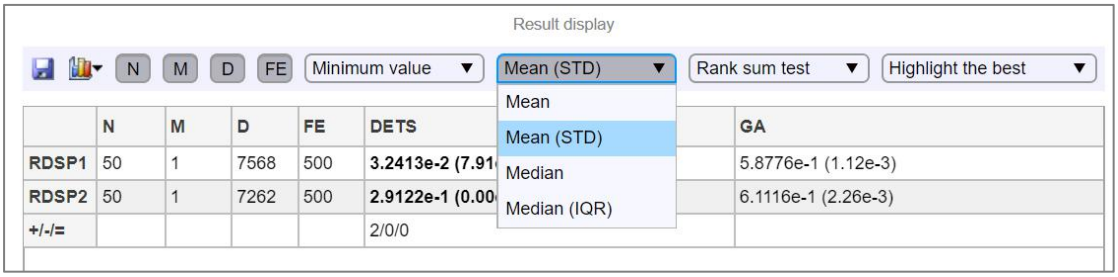
Fig. 4-8. The data source is switched to "runtime"



	N	M	D	FE	DETS	GA
RDSP1	50	1	7568	500	**3.2413e-2 (7.91e-5) +**	5.8776e-1 (1.12e-3)
RDSP2	50	1	7262	500	**2.9122e-1 (0.00e+0) +**	6.1116e-1 (2.26e-3)
+/-/=					2/0/0	

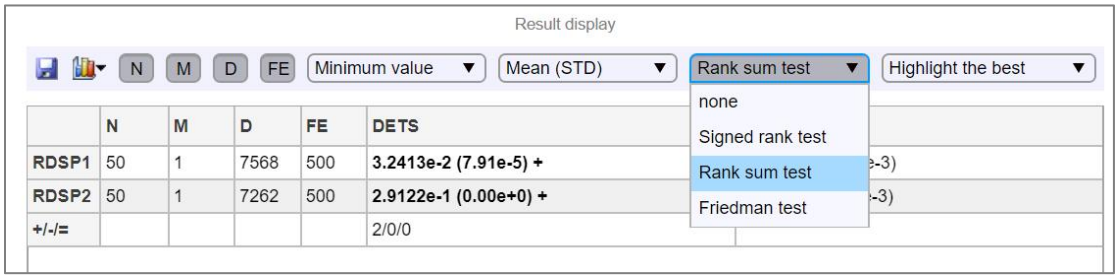
Fig. 4-9. The data source is switched to "Minimum value"

As shown in Fig. 4-9, when the data source is switched to "Minimum value", the table will display the mean and standard deviation of the *loss*. You can also modify the presentation of the data, as shown in Fig. 4-10, 4-11, and 4-12.



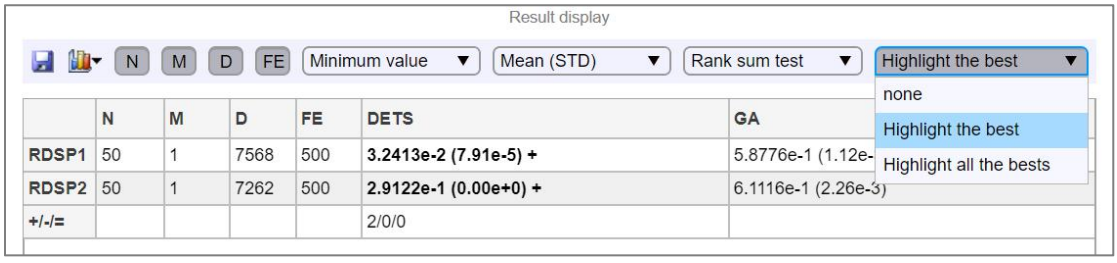
	N	M	D	FE	DETS	GA
RDSP1	50	1	7568	500	**3.2413e-2 (7.91**	5.8776e-1 (1.12e-3)
RDSP2	50	1	7262	500	**2.9122e-1 (0.00**	6.1116e-1 (2.26e-3)
+/-/=					2/0/0	

Fig. 4-10. Modify the displayed data



	N	M	D	FE	DETS	GA
RDSP1	50	1	7568	500	**3.2413e-2 (7.91e-5) +**	-3)
RDSP2	50	1	7262	500	**2.9122e-1 (0.00e+0) +**	-3)
+/-/=					2/0/0	

Fig. 4-11. Modify the displayed data



	N	M	D	FE	DETS	GA
RDSP1	50	1	7568	500	**3.2413e-2 (7.91e-5) +**	5.8776e-1 (1.12e-
RDSP2	50	1	7262	500	**2.9122e-1 (0.00e+0) +**	6.1116e-1 (2.26e-3)
+/-/=					2/0/0	

Fig. 4-12. Modify the displayed data

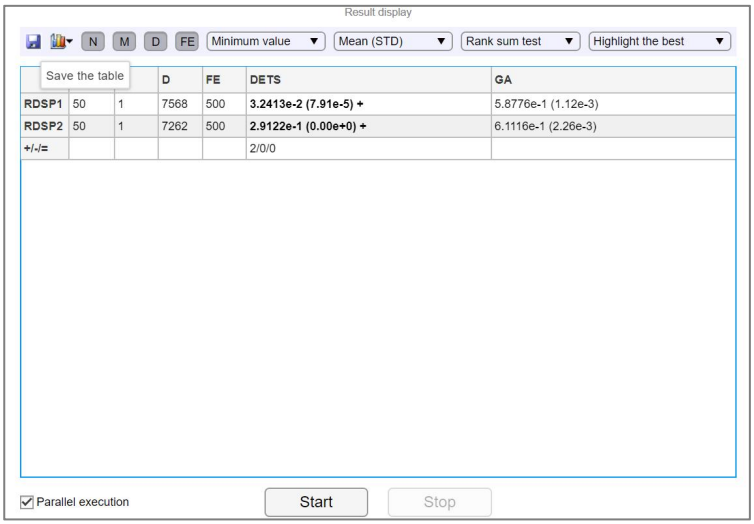


Figure 4-13. Save data

You can also save the data table by clicking the save button in the upper left corner of the "Result selection" block. After clicking, the data in the table will be saved to the location you specified in "xlxs" format.

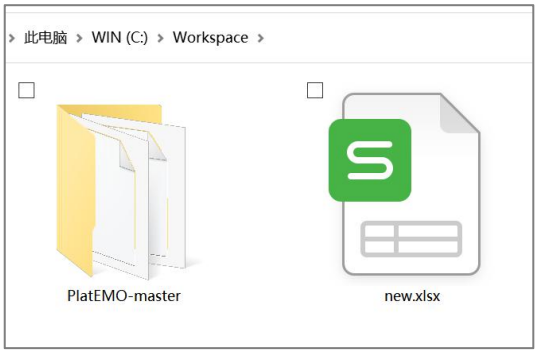


Fig. 4-14. Save as xlxs file

In the above example, the resulting table file contains the following:

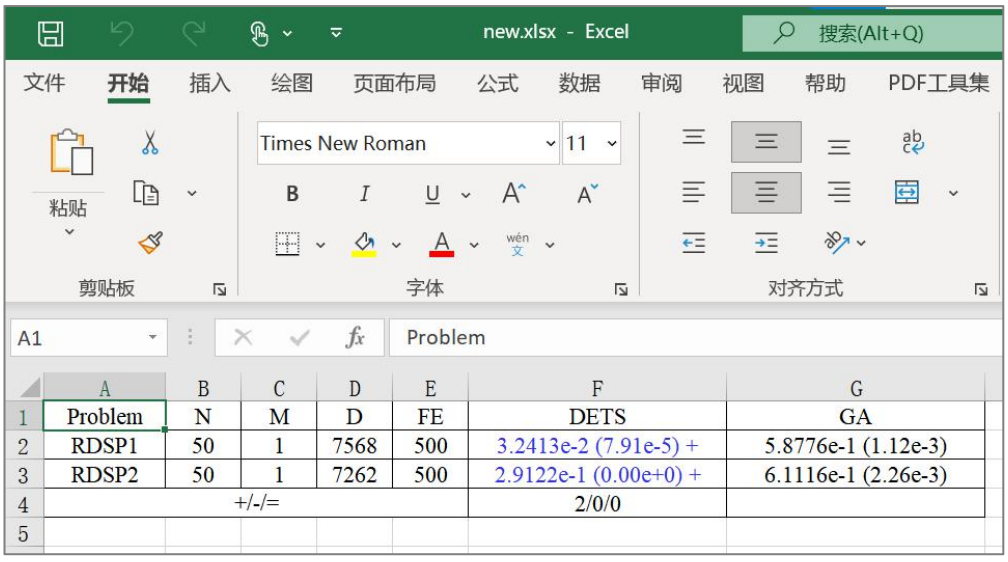


Figure 4-15 The content of the exported table