

# The user manual of GS-Impute v1.0

System Requirements:

PyTorch installation (mandatory)

GPU-enabled PyTorch version (recommended)

Here are the install commands of PyTorch. Scroll down for the step-by-step instructions.

## 1 Step-by-step instructions of installing PyTorch

### 1.1 Install Miniconda

Miniconda is the recommended approach for installing PyTorch with GPU support. It creates a separate environment to avoid changing any installed software in your system. This is also the easiest way to install the required software especially for the GPU setup. Download the Miniconda Windows Installer ([https://repo.anaconda.com/miniconda/Miniconda3-latest-Windows-x86\\_64.exe](https://repo.anaconda.com/miniconda/Miniconda3-latest-Windows-x86_64.exe)) or the Miniconda Linux Installer (<https://repo.anaconda.com/miniconda/Miniconda3-latest-Linux-x86.sh>). Follow the on-screen instructions and choose the default options.

### 1.2 Create a Conda environment

Open a terminal (by clicking on the “Anaconda Promp” button through the Start menu in Windows). Create a Conda virtual environment named pytorch (other names are also acceptable) with the following commands in a terminal window (taking python 3.9 as an example).

```
conda create --name pytorch python=3.9
```

You can deactivate and activate it with the following commands.

```
conda deactivate
```

```
conda activate pytorch
```

Make sure it is activated for the rest of the installation.

### 1.3 Install PyTorch

Install PyTorch (with GPU support) using the following command (taking NVIDIA RTX 4090 as an example).

```
pip3 install torch torchvision torchaudio --index-url https://download.pytorch.org/whl/cu118
```

If you are not using a GPU (not recommended), run the following command.

```
pip3 install torch torchvision torchaudio
```

## 2 Install GS-Impute

You should download the GSImpute v1.0\_Windows package. If under the Windows operating system, open a terminal window and navigate to the download directory (taking “D:\GSImpute v1.0\_Windows” as an example). Then activate your Conda environment that has already installed PyTorch, and install GS-Impute with the following commands.

D:

```
cd GSImpute v1.0_Windows
```

```
conda activate pytorch
python install.py
```

## 3 Usage

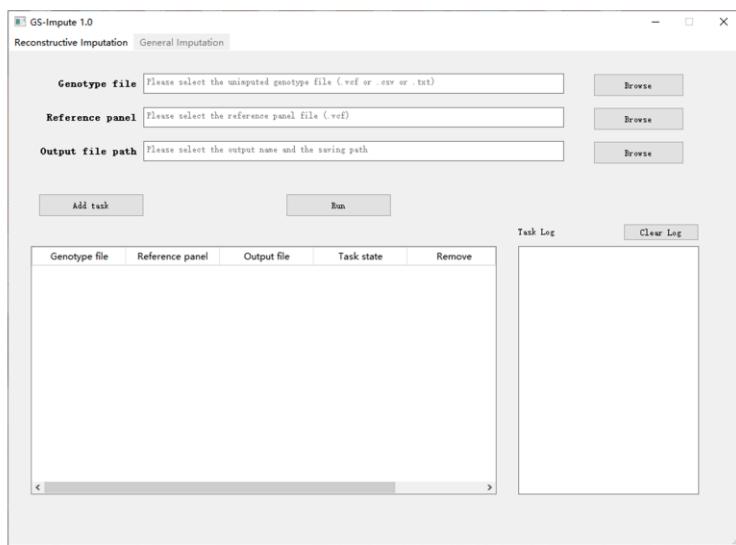
### 3.1 For the Windows operating system

In a Windows operating system, a typical command for running GS-Impute is as follows:

```
gsi
```

Once you execute the command above in a terminal window, general imputation screen will be opened by default. The software interface and input/output format examples are shown in Fig. 1.

**A**



**C** Reference panel

#CHROM	POS	...	030-1	08-64	1101	1121	1127
1	151132	...	0/1	1/1	0/0	0/0	0/0
1	175540	...	1/1	1/1	0/0	0/0	0/0
1	216928	...	0/1	1/1	0/0	0/0	0/0
1	217119	...	1/1	1/1	0/0	1/1	1/1
1	228672	...	0/0	0/0	0/0	0/0	1/1
1	237585	...	1/0	0/0	0/0	0/0	1/1
1	464437	...	1/1	1/1	0/0	0/0	0/0
1	464447	...	1/1	1/1	1/1	1/1	1/1
1	466225	...	0/0	0/0	0/0	0/0	1/1
1	563043	...	0/1	1/1	0/0	0/0	0/0
1	616495	...	1/1	1/1	0/0	0/0	1/1
1	616710	...	1/1	1/1	1/1	1/1	1/1
1	649450	...	0/0	0/0	0/0	1/1	0/0
1	649941	...	0/0	0/0	0/0	1/1	0/0
1	703209	...	0/0	0/0	0/0	1/1	0/0

**D** Output file

#CHROM	POS	...	A003	A005	A006
1	151132	...	0/0	0/0	0/0
1	175540	...	0/0	0/0	0/0
1	217119	...	0/0	0/0	0/0
1	237585	...	0/0	1/1	0/0
1	464437	...	0/0	0/0	0/0
1	464447	...	1/1	0/0	0/0
1	563043	...	0/0	0/0	0/0
1	649450	...	0/0	0/0	1/1

**B** Genotype file

***.vcf (or ***.csv)					
#CHROM	POS	...	A003	A005	A006
1	151132	...	0/0	J.	0/0
1	151180	...	0/0	0/0	0/0
1	175540	...	0/0	0/0	0/0
1	217119	...	0/0	0/0	0/0
1	237585	...	J.	1/1	0/0
1	464437	...	J.	0/0	0/0
1	464447	...	J.	0/0	0/0
1	563043	...	0/0	0/0	0/0
1	649450	...	0/0	0/0	1/1

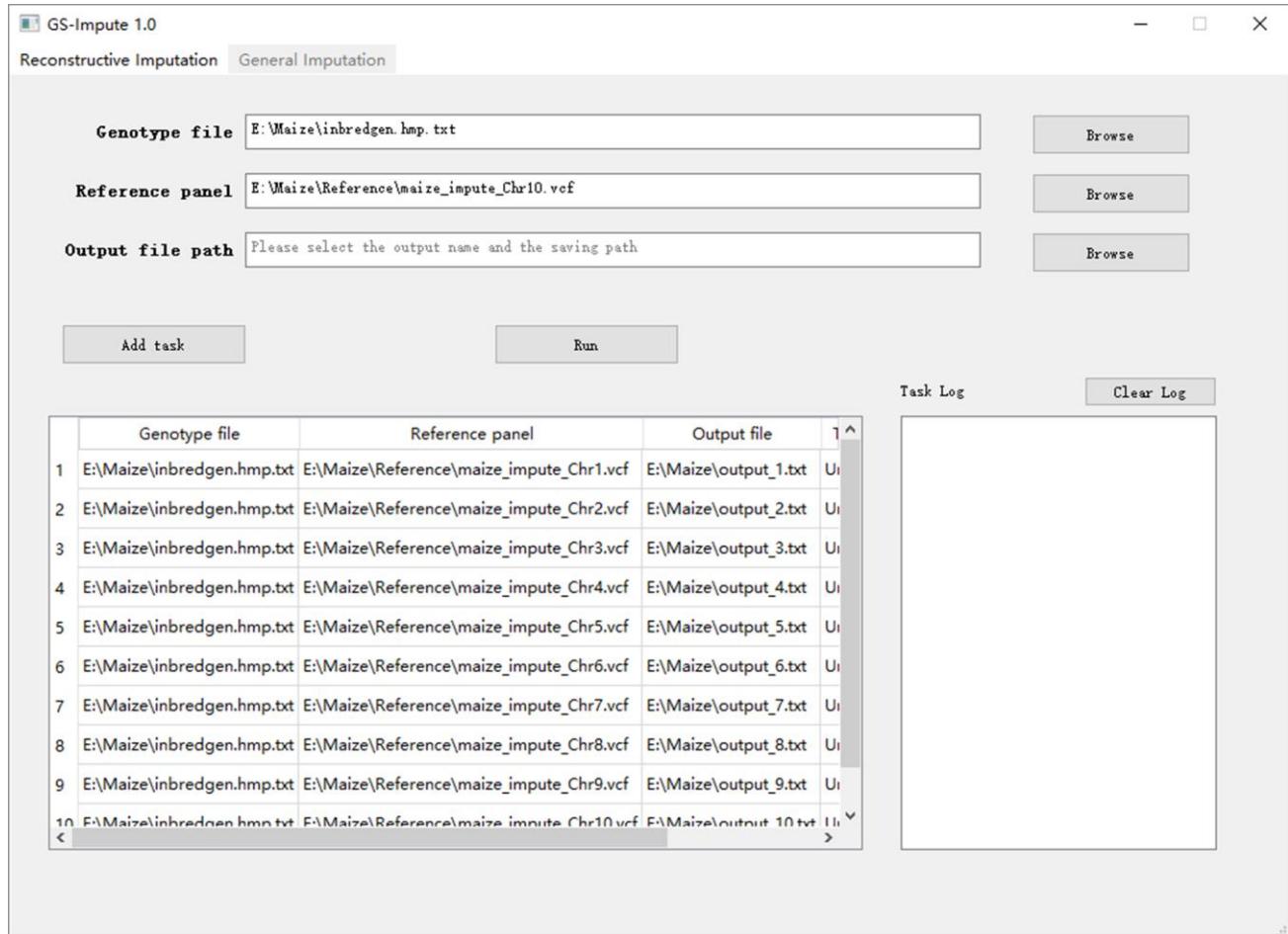
OR

***.hmp.txt					
...	chrom	pos	...	A003	A005
...	1	151132	...	GG	NN
...	1	151180	...	TT	TT
...	1	175540	...	GG	GG
...	1	217119	...	TT	TT
...	1	237585	...	NN	AA
...	1	464437	...	NN	AA
...	1	464447	...	NN	TT
...	1	563043	...	GG	GG
...	1	649450	...	AA	TT

**Fig. 1. Software interface on Windows system and input/output format examples of GS-Impute 1.0 for general imputation.** (A) The user interface of GS-Impute 1.0 for general imputation on Windows system. (B) The format example of the genotype file input for general imputation, where "..." represents some non-critical information. The file is allowed to contain markers of multiple chromosomes. For a genotype file in CSV or TXT format, the head of the column before valid genotype data must be ref, alt, or QCcode. (C) The format example of the reference panel input for general imputation. The panel should be a VCF file of a single chromosome, and only markers on the chromosome can be imputed. Missing markers are not permitted on the panel. (D) The format example of the output file for general imputation.

You can click the “Browse” button on the right side to select the genotype file, the reference panel and the output file path.

Once you have selected all the files, you can click the “Add task” button to add general imputation tasks to the task list (Fig. 2).

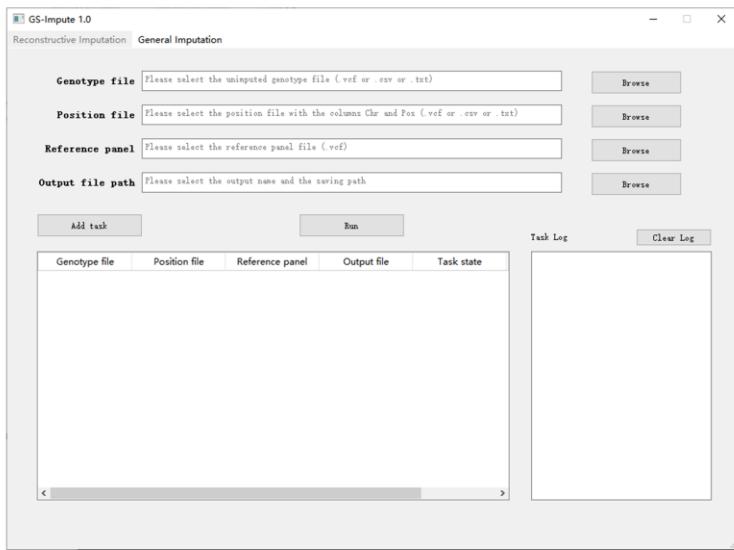


**Fig. 2. Software interface of GS-Impute 1.0 with general imputation tasks added**

If all tasks have been added, you can click the “Run” button to execute the tasks. GS-Impute will execute tasks in the order of the task list.

During task execution, the task log on the right shows real-time progress and detailed information of the tasks.

You can also click the “Reconstructive Imputation” button to perform your reconstructive imputation (Fig. 3).

**A****B** Genotype file

***.vcf (or ***.csv)					
#CHROM	POS	... A003	A005	A006	...
1	151132	... 0/0	./.	0/0	
1	151180	... 0/0	0/0	0/0	
1	175540	... 0/0	0/0	0/0	
1	216928	... 0/0	0/0	0/0	
1	217119	... 0/0	0/0	0/0	
1	228672	... 0/0	0/0	0/0	
1	237585	... 0/0	0/0	0/0	
1	464437	... 1/1	1/1	0/0	
1	464447	... 1/1	1/1	1/1	
1	466225	... 0/0	0/0	0/0	
1	563043	... 0/1	1/1	0/0	
1	616495	... 0/0	0/0	0/0	
1	649941	... 0/0	0/0	0/0	

\*\*\*.hmp.txt

OR

#CHROM	POS	... A003	A005	A006	...
1	151132	... 0/0	./.	0/0	
1	175540	... 0/0	0/0	0/0	
1	216928	... 0/0	0/0	0/0	
1	217119	... 0/0	0/0	0/0	
1	228672	... 0/0	0/0	0/0	
1	237585	... 0/0	0/0	0/0	
1	464437	... 1/1	1/1	0/0	
1	464447	... 1/1	1/1	1/1	
1	466225	... 0/0	0/0	0/0	
1	563043	... 0/1	1/1	0/0	
1	616495	... 0/0	0/0	0/0	
1	649941	... 0/0	0/0	0/0	

**C** Position file

\*\*\*.vcf

#CHROM	POS	...
1	151132	...
1	175540	...
1	216928	...
1	217119	...
1	389574	...
1	466225	...
1	563043	...
1	616495	...
1	649941	...

\*\*\*.hmp.txt

...	chrom	pos	...
...	1	151132	...
...	1	175540	...
...	1	216928	...
...	1	217119	...
...	1	389574	...
...	1	466225	...
...	1	563043	...
...	1	616495	...
...	1	649941	...

\*\*\*.csv

chrom	pos
1	151132
1	175540
1	216928
1	217119
1	389574
1	466225
1	563043
1	616495
1	649941

**D** Reference panel

\*\*\*.vcf

#CHROM	POS	...	030-1	08-64	1101	1121	1127
1	151132	...	0/1	1/1	0/0	0/0	0/0
1	175540	...	1/1	1/1	0/0	0/0	0/0
1	216928	...	0/1	1/1	0/0	0/0	0/0
1	217119	...	1/1	1/1	0/0	1/1	1/1
1	228672	...	0/0	0/0	0/0	0/0	1/1
1	237585	...	1/0	0/0	0/0	0/0	1/1
1	464437	...	1/1	1/1	0/0	0/0	0/0
1	464447	...	1/1	1/1	1/1	1/1	1/1
1	466225	...	0/0	0/0	0/0	0/0	1/1
1	563043	...	0/1	1/1	0/0	0/0	0/0
1	616495	...	1/1	1/1	0/0	1/1	1/1
1	649941	...	0/0	0/0	0/0	1/1	0/0
1	703209	...	0/0	0/0	0/0	1/1	0/0

**E** Output file

\*\*\*.csv

ID	CHROM	POS	REF	ALT	A003	A005	A006
1_151132	1	151132	G	T	1	1	1
1_175540	1	175540	G	A	1	1	1
1_216928	1	216928	A	G	1	1	1
1_217119	1	217119	T	A	1	1	1
1_237585	1	237585	A	G	1	3	1
1_464437	1	464437	A	G	1	1	1
1_464447	1	464447	T	G	3	1	1
1_466225	1	466225	G	A	1	1	1
1_563043	1	563043	G	A	1	1	1
1_616495	1	616495	A	T	3	1	3
1_649940	1	649940	A	T	1	1	3
1_649941	1	649941	G	A	1	1	3

**Fig. 3. Software interface on Windows system and input/output format examples of GS-Impute 1.0 for reconstructive imputation. (A)** The user interface of GS-Impute 1.0 for reconstructive imputation on Windows system. **(B)** The format example of the genotype file input for reconstructive imputation, where "... " represents some non-critical information. The file is allowed to contain markers of multiple chromosomes. For a genotype file in CSV or TXT format, the head of the column before valid genotype data must be ref, alt, or QCcode. **(C)** The format example of the position file input for reconstructive imputation. It is allowed to contain position information of multiple chromosomes. A genotype file containing chromosome and position information can also serve as the position file. **(D)** The format example of the reference panel input for reconstructive imputation. The panel should be a VCF file of a single chromosome, and only markers on the chromosome can be imputed. Missing markers are not permitted on the panel. **(E)** The format example of the output file for reconstructive imputation. The genotype values of 1 and 3 represent homozygous variants with two reference alleles and two alternate alleles, respectively. The genotype value of 2 represents a heterozygous variant that has one copy of the reference allele and one copy of the alternate allele.

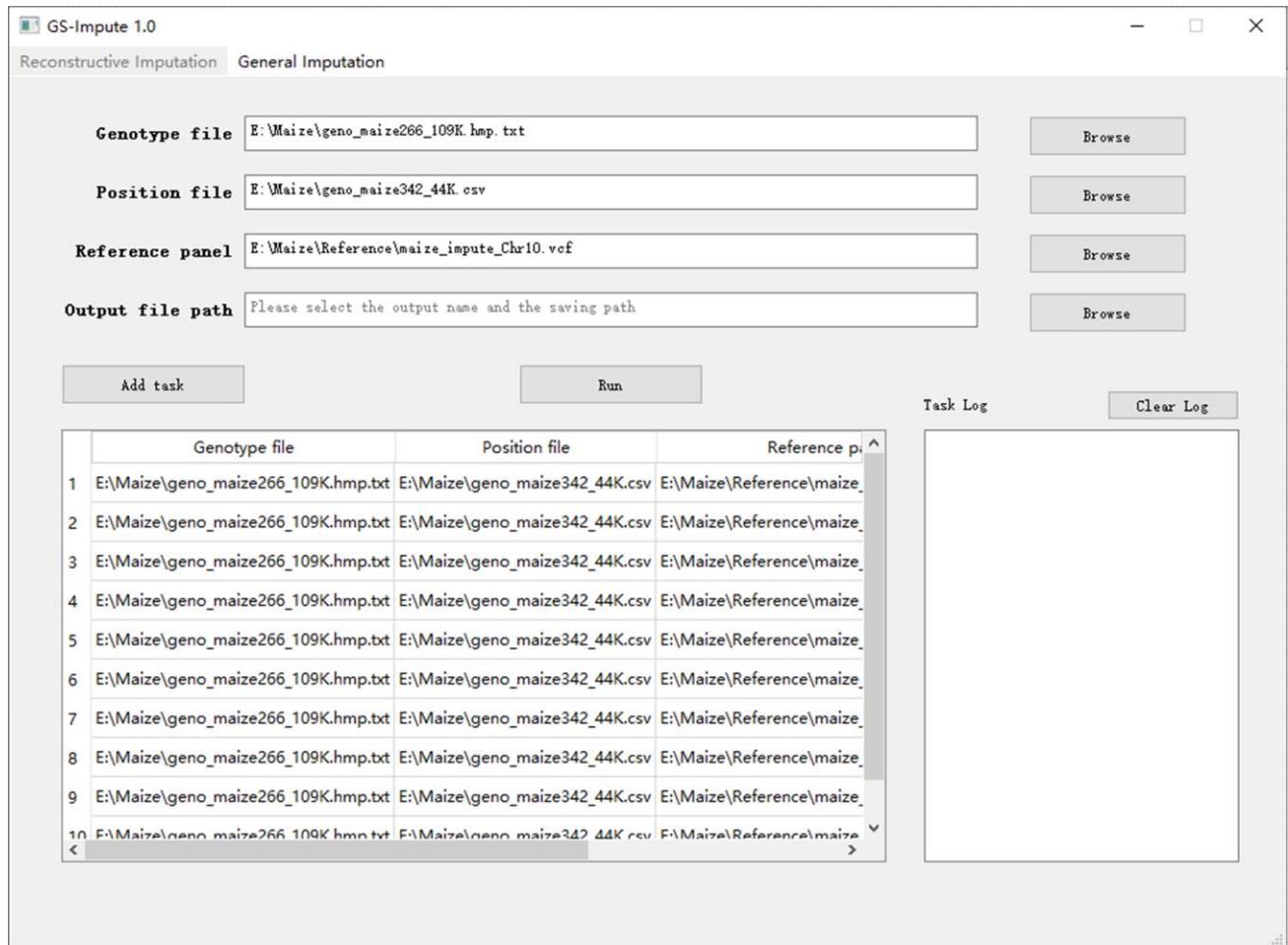


Fig. 4. Software interface of GS-Impute 1.0 with reconstructive imputation tasks added

### 3.2 For the Linux operating system

A typical GS-Impute command for the general imputation is as follows:

*gsi -i -geno unimputed\_genotype\_file.vcf -panel panel\_file.vcf*

Or

*gsi -i -geno unimputed\_genotype\_file.csv -panel panel\_file.vcf*

Or

*gsi -i -geno unimputed\_genotype\_file.hmp.txt -panel panel\_file.vcf*

A typical GS-Impute command for the reconstructive imputation is as follows:

*gsi -r -geno unimputed\_genotype\_file.vcf -pos position\_file.vcf -panel panel\_file.vcf*

Or

*gsi -r -geno unimputed\_genotype\_file.csv -pos position\_file.vcf -panel panel\_file.vcf*

Or

*gsi -r -geno unimputed\_genotype\_file.hmp.txt -pos position\_file.vcf -panel panel\_file.vcf*

Or

*gsi -r -geno unimputed\_genotype\_file.vcf -pos position\_file.hmp.txt -panel panel\_file.vcf*

Or

*gsi -r -geno unimputed\_genotype\_file.csv -pos position\_file.hmp.txt -panel panel\_file.vcf*

Or

*gsi -r -geno unimputed\_genotype\_file.hmp.txt -pos position\_file.hmp.txt -panel panel\_file.vcf*

Or

```
gsi -r -geno unimputed_genotype_file.vcf -pos position_file.csv -panel panel_file.vcf
```

Or

```
gsi -r -geno unimputed_genotype_file.csv -pos position_file.csv -panel panel_file.vcf
```

Or

```
gsi -r -geno unimputed_genotype_file.hmp.txt -pos position_file.csv -panel panel_file.vcf
```

The file names of *unimputed\_genotype\_file*, *position\_file* and *panel\_file* (listed above) can be freely defined, but their formats must strictly conform to the requirements specified in Fig. 1 and Fig. 3.

GS-Impute allows batch execution of imputation tasks via shell scripts in Linux. Please store the unimputed genotype files and the reference panels in the same directory, and then create a shell script file, such as *gsi.sh*. Type the imputation commands following the example below, and then save it.

```
gsi -i -geno unimputed_genotype_file1.vcf -panel panel_file1.vcf -out outputfile1
```

```
gsi -i -geno unimputed_genotype_file2.vcf -panel panel_file2.vcf -out outputfile2
```

Open the terminal in the current directory. Activate the virtual environment “pytorch” and use the bash command to execute the shell script.

```
bash gsi.sh
```

The program will perform the imputation tasks in the order of the shell script, and the imputed files will be output in the current directory.