# Final Report

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## 1 Prototype System Introduction

### 1.1 Functions

*introduction*、*notice*、*for_help*、*information*: These functions are designed for help users to use this program.

*popup*、*on_click*: These function are designed for buttons.

*ideal_gas*: This function is the main body of this program, which generate all the data that we need to draw the pictures.

*Final_Molecule_Velocity*、*Demon_Energy*、*show_systemenergy*、*Lab*: These functions are designed to show us the final results.

### 1.2 Running Environment

Windows 10

### 1.3 Developing Environment

PyCharm professional 2016.3.1

Python 3.4.3

## 2 Task Allocation

Xie Fan: user interface, system architecture, system implementation, system debugging, integration and system testing

## 3 System Architecture

## 3.1 Users Interface Component

root:

The left part of this interface is the variables that we want users to set for the simulation at first and there are also two buttons for users to get something more.

The right part of this interface is the graphs which are generated from the simulation.

menu:

This is an item which can help users to use this program.

win5:

It will confirm that whether the user choose a wrong N for the system or the user want to plot a new graph.

win:

Users can get data from this part.

## 3.2 Simulation Component

Simulation component consists of two parts. The first part is the *ideal_gas* function which simulate the collision in theory. The second part is the *Lab* function which generates an animation which can give users a direct experience of the collision.

## 3.3 Visualization Component

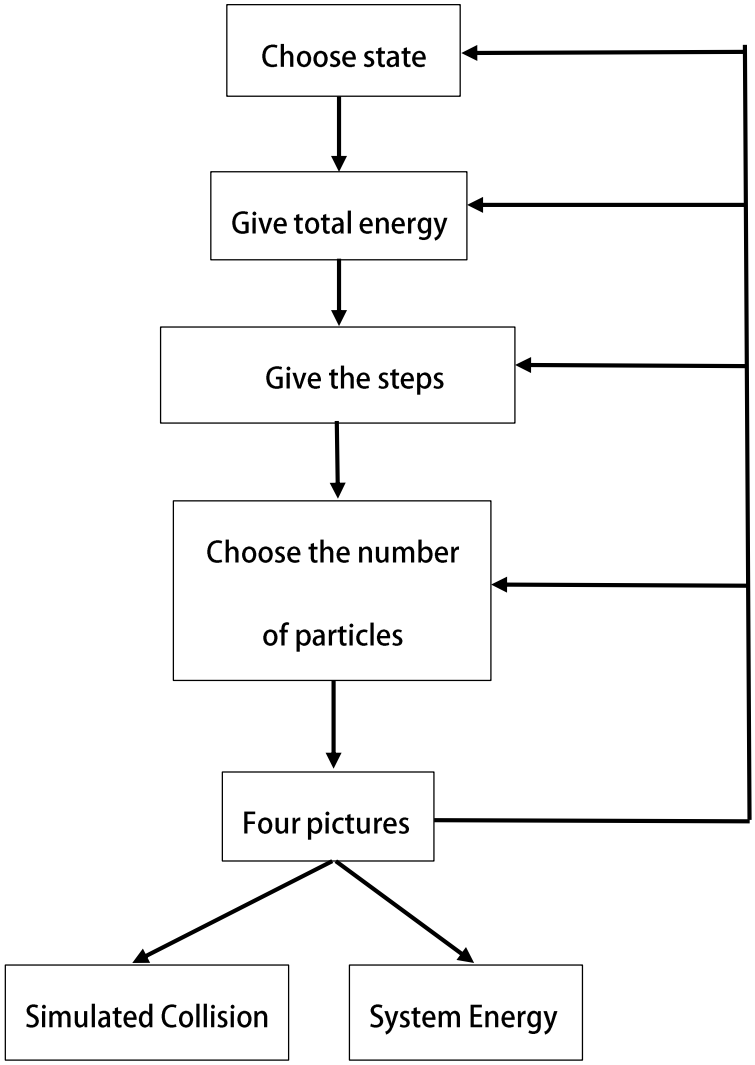
Visualization component is made of four graphs and one animation.

Four graphs: Final Particle Velocity Distribution、The Step Demon Energies Over Time、Demon Energy Histogram、N vs. Energy

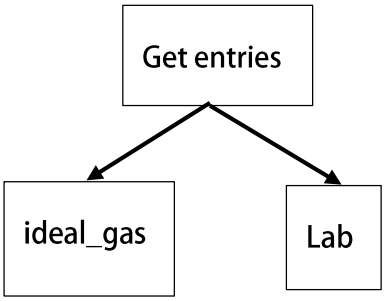
Animation: an animation of simulation of collision

# 4 Algorithm Description

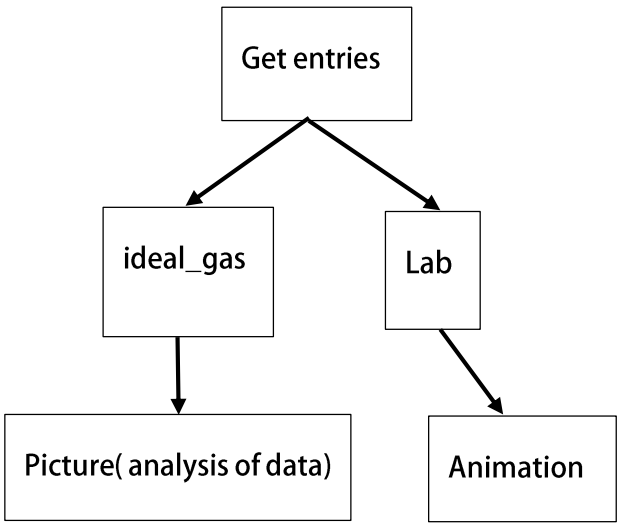
## 4.1 Users Interface Component




## 4.2 Simulation Component



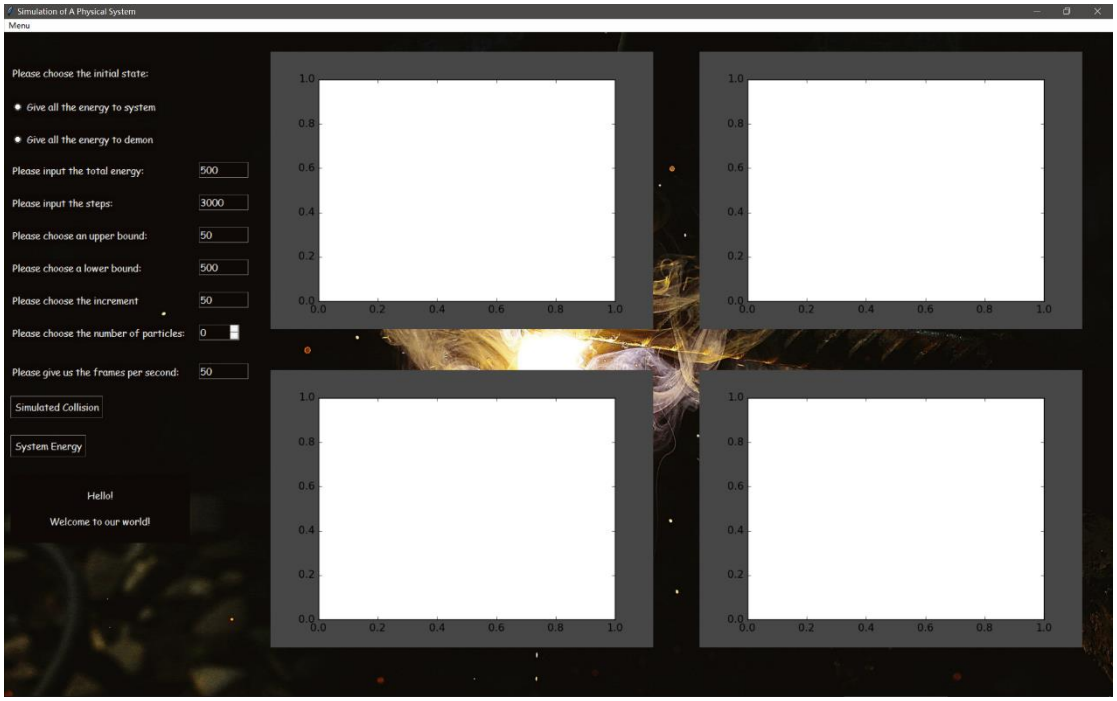
## 4.3 Visualization Component



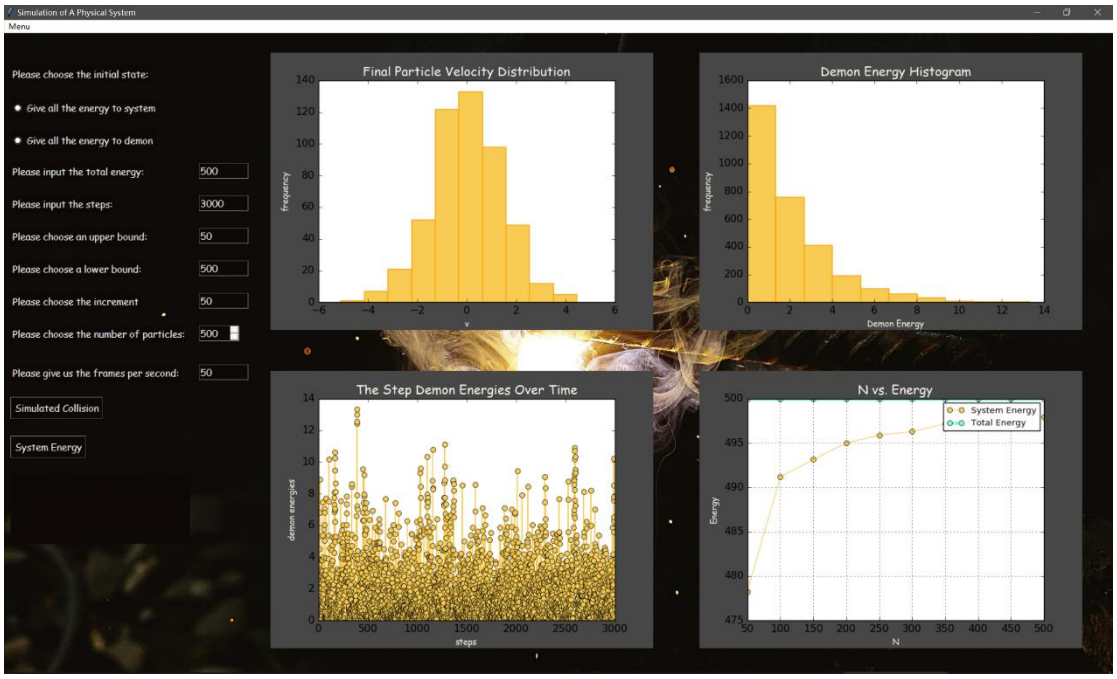

# 5 Demo and Testing Result

## 5.1 Screenshots

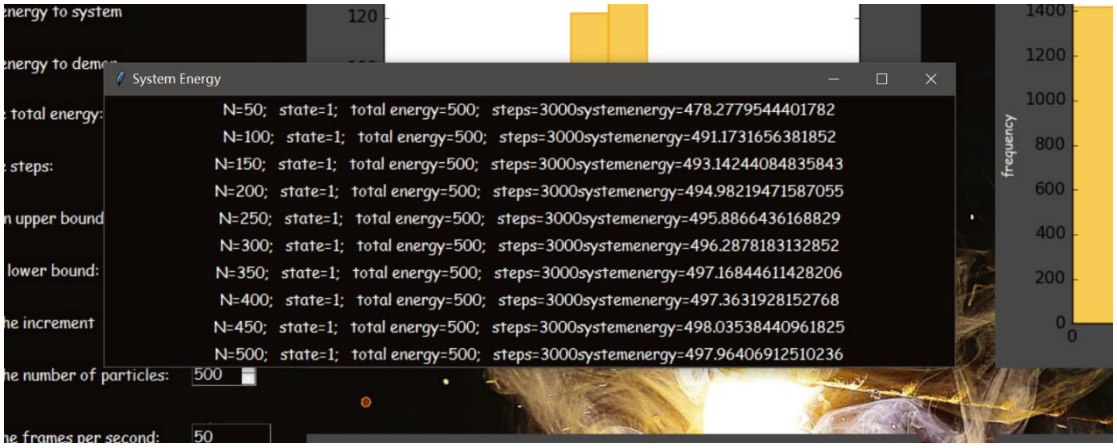
This is an initial window:



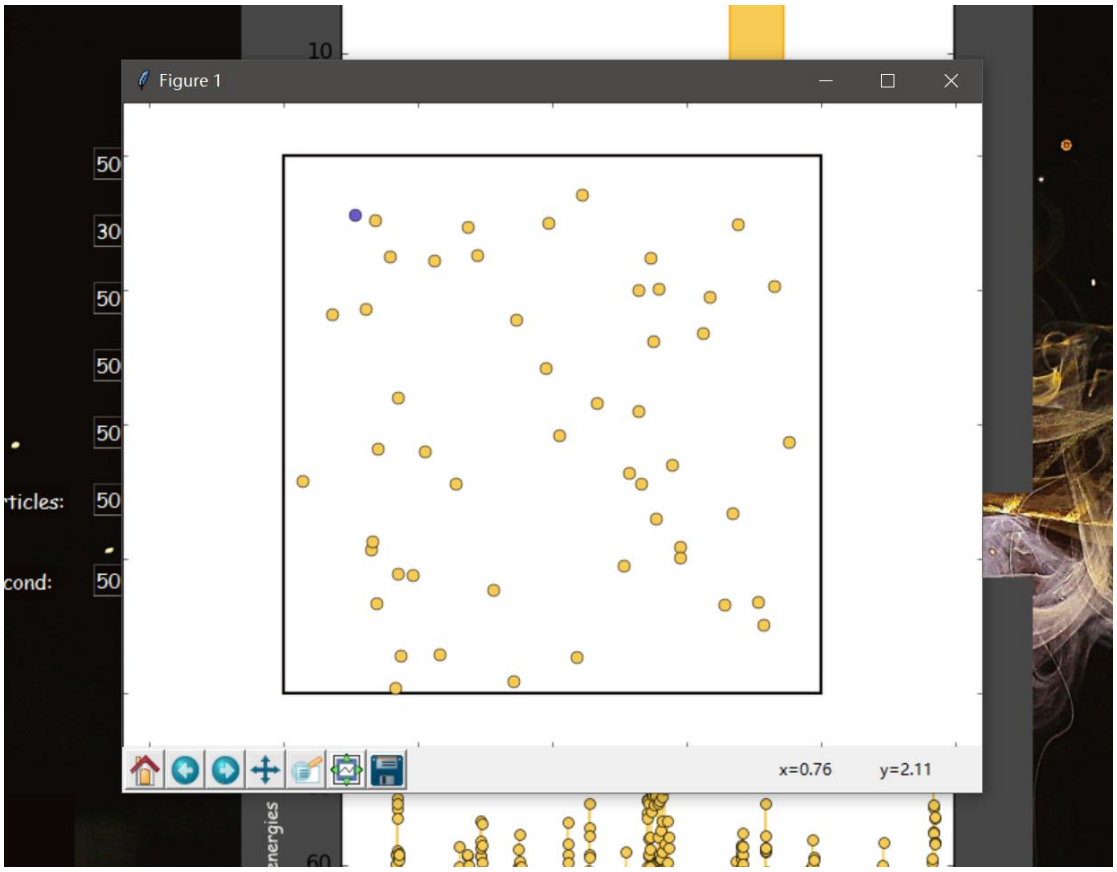

This is the window when we finish a simulation:



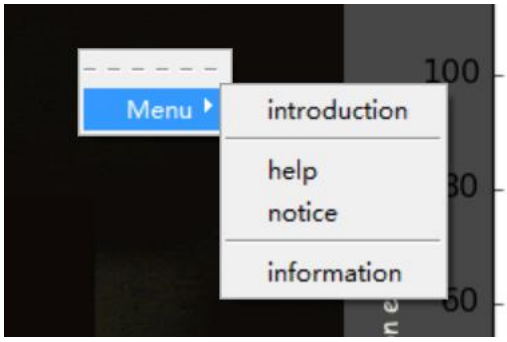

This is the screenshot when we get the data of the final system:



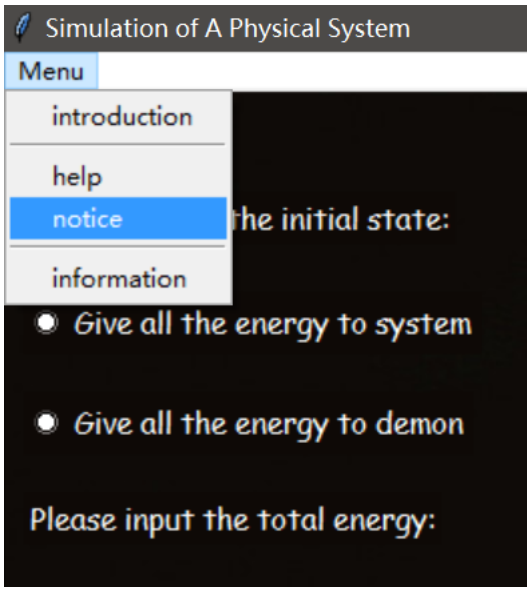

This is a graph which is simulating the collision between particles:



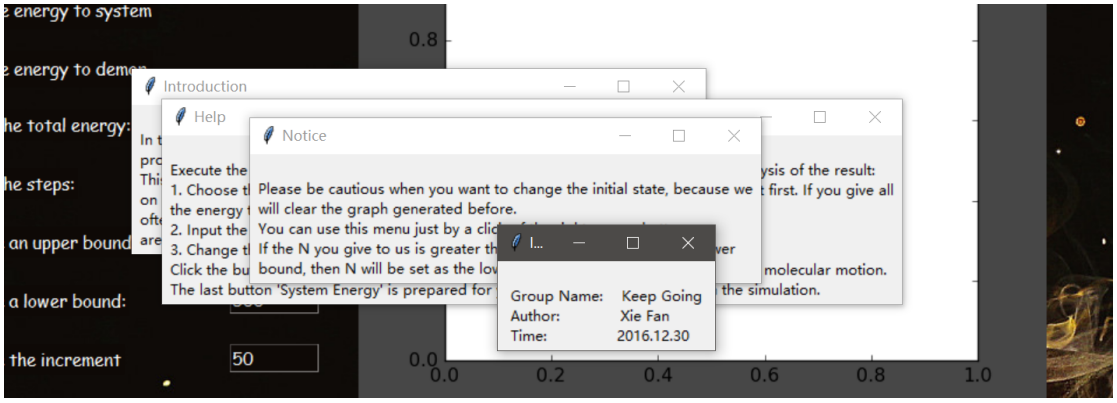

This is the menu we can get by a click of our right mouse button:



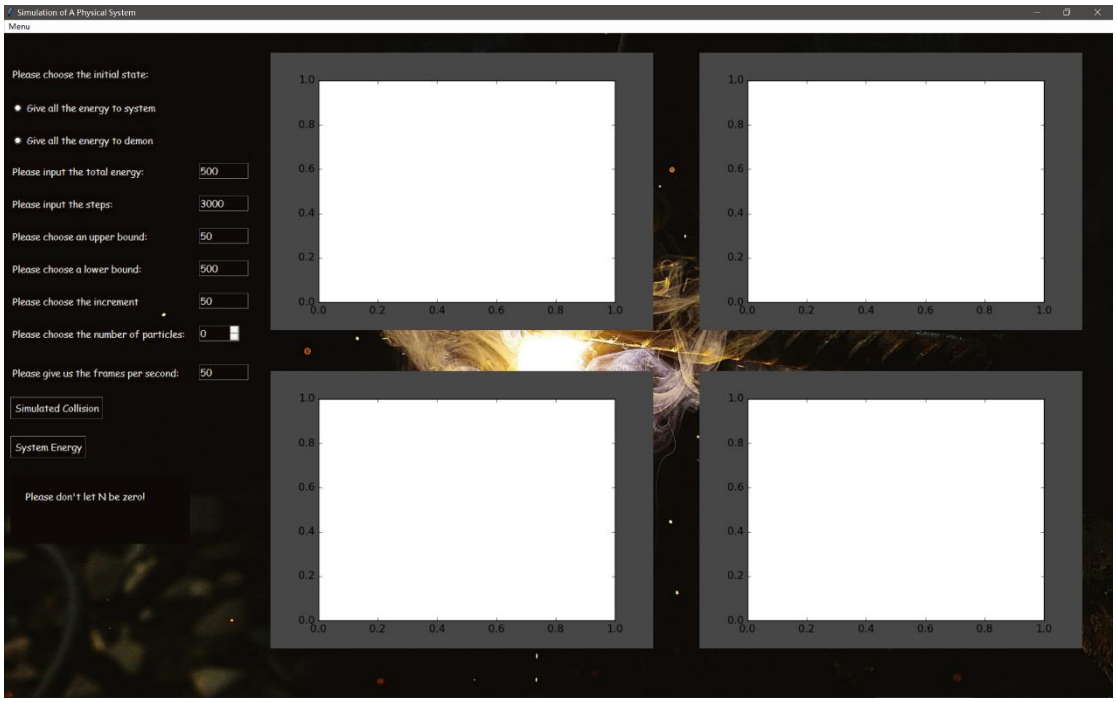

This is the menu which is put on the upper left corner of the window:



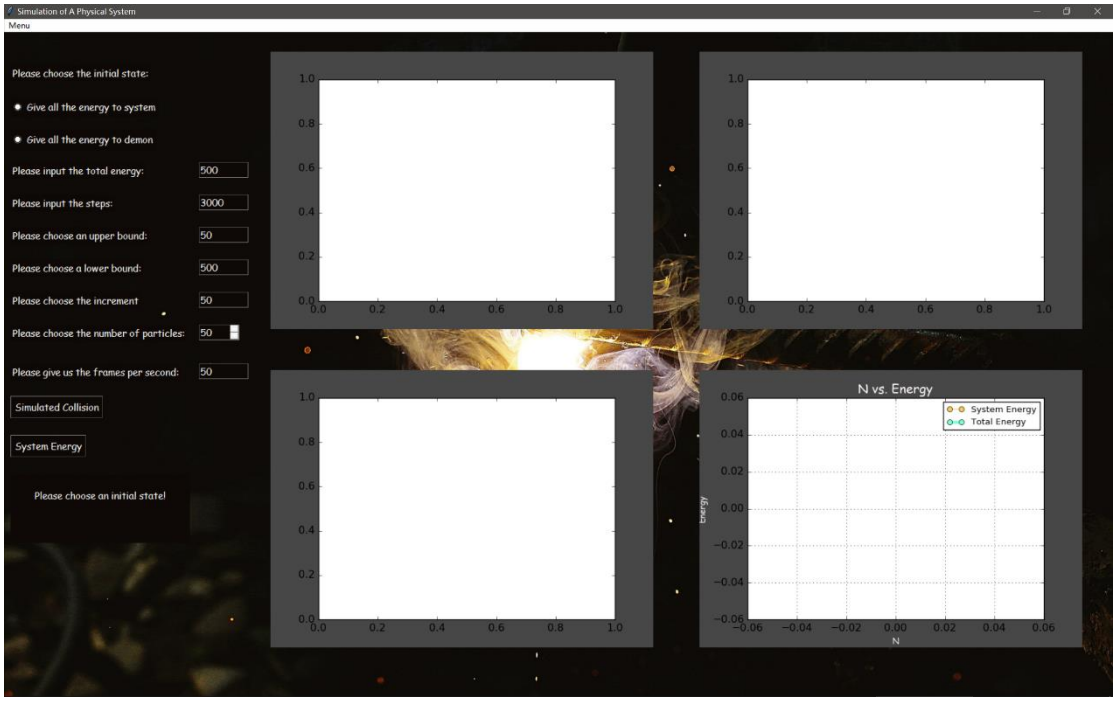

There are something we can get from the menu:



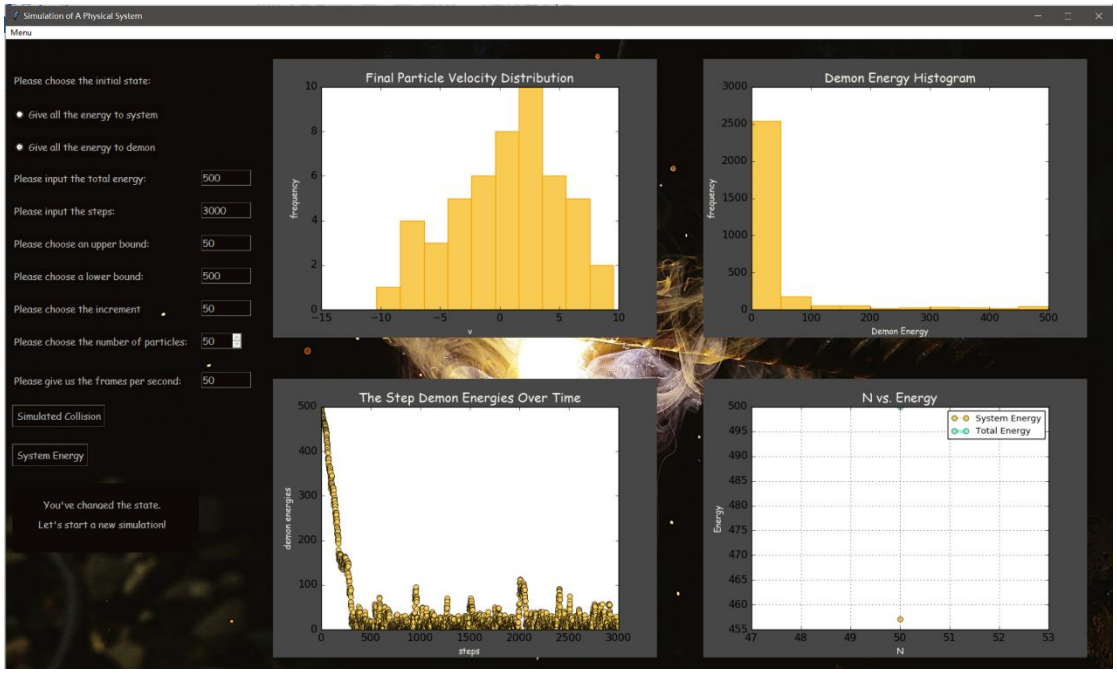

This is the screenshot when you want to see the animation for the simulation but you don’ t choose N for the system:



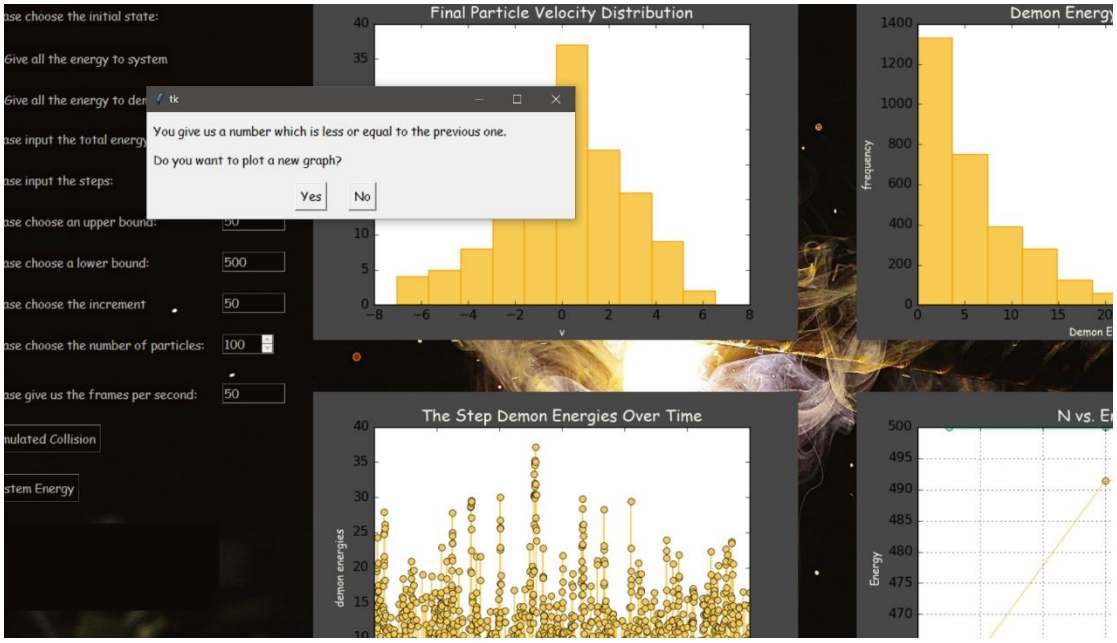

This is the condition when you only choose N but don’ t choose the initial state at first:




This is the situation when you change the state of the system:




This is the situation when the N you’ ve chosen is less or equal to the N you’ ve chosen before:




## 5.2 Testing Procedure, Data and Result

Explanation, testing data and result table, and result analysis

| Times | State | Total Energy | Steps | The Number of particles | System Energy |
|---|---|---|---|---|---|
| 1 | 1 | 500 | 3000 | 50 | 478.2951561306531 |
| 2 | 1 | 500 | 3000 | 100 | 488.1632854230923 |
| 3 | 1 | 500 | 3000 | 150 | 493.2312361788872 |
| 4 | 1 | 500 | 3000 | 200 | 495.2472756846647 |
| 5 | 1 | 500 | 3000 | 250 | 495.81547766567377 |
| 6 | 1 | 500 | 3000 | 300 | 496.6825073549098 |
| 7 | 1 | 500 | 3000 | 350 | 497.1143914791213 |

| | | | | | |
|---|---|---|---|---|---|
| 8 | 1 | 500 | 3000 | 400 | 497.5663477863696 |
| 9 | 1 | 500 | 3000 | 450 | 497.73453400665846 |
| 10 | 1 | 500 | 3000 | 500 | 498.0602964429174 |
| 11 | 2 | 500 | 3000 | 50 | 460.24629739665704 |
| 12 | 2 | 500 | 3000 | 100 | 464.72447417668224 |
| 13 | 2 | 500 | 3000 | 150 | 472.7362027356492 |
| 14 | 2 | 500 | 3000 | 200 | 465.9784578422893 |
| 15 | 2 | 500 | 3000 | 250 | 473.78105320378836 |
| 16 | 2 | 500 | 3000 | 300 | 473.51741278159085 |
| 17 | 2 | 500 | 3000 | 350 | 472.71444820264423 |
| 18 | 2 | 500 | 3000 | 400 | 473.1553719707528 |
| 19 | 2 | 500 | 3000 | 450 | 473.7627368471023 |
| 20 | 2 | 500 | 3000 | 500 | 471.7786160554356 |

Because we obtained system energy by arranging random number to demon, the polyline may be not monotonic. But we can find that as the increase of the number of particles, the system energy approaches the total energy. Despite of the difference of the initial state, the system energy is not change much.

## 6 Conclusion

- My experience and lesson on this project is that sometimes we

needn′ t consider a system too carefully, we can have a roughly thought. For example, in this project, we generate a number randomly, and arrange it to a particle randomly.

- In graph N versus Energy, the actual system energy is at most ten percent less than total energy.
- As the increase of N, the system energy has the trend which approaches the total energy.
- State 1 is more steep than state 2 and it is closer to total energy.
- In histogram *Final_Particle_Velocity*, We can see that if we give all the energy to system, the velocity will be more concentrated around 0, and if we give all the energy to demon, the velocity will be distributed more dispersed, that is, there are more particles have larger velocity.
- There are velocities of 2/5 of particles roughly equal to sqrt(2*totalEnergy/N).
- In histogram *Demon_Energy*, when N is small, if over 5/6 of the demon energy in 3000 steps are close to 0, then the demon energy comes from the total energy; if less than 8/15 of the demon energy in 3000 steps are close to 0, then the demon energy comes from the collision.
- When the initial state is equal to 1, the points of the graph *Demon_Energy_Time* are more dispersed. When the initial state of is

equal to 2, the demon energy dcreased obviously from 500 to 80 when the number of step is less than 500.