

# Exercise 10

Introduction to Computational Astrophysics, SoSe 2024

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## Task 1. Probability distributions

**Solution.** (a) First,  $p(x) = \frac{1}{b-a}$ , where  $a \leq x \leq b$ . Then  $P(x) = \frac{x-a}{b-a}$  and  $r = \frac{x-a}{b-a}$ . Finally,  $x = P^{-1}(r) = (b-a)r + a$ . ☐

**Solution.** (b)  $z_i = \sigma(x_i - \mu)$ . ☐

**Solution.** (c) See Figure 1.

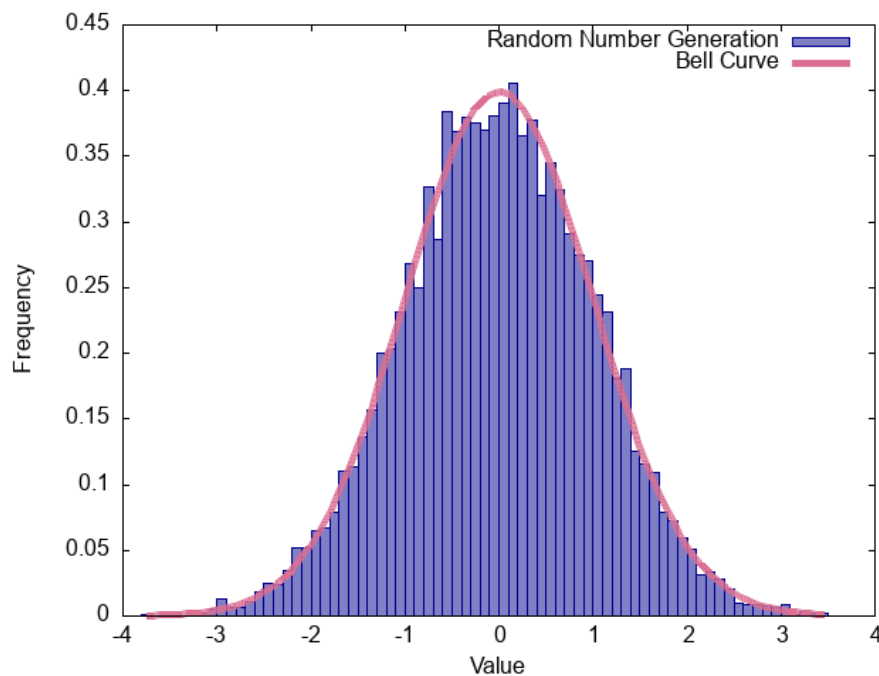


Figure 1: Task 1c

☐

## Task 2. Elastic neutron scattering

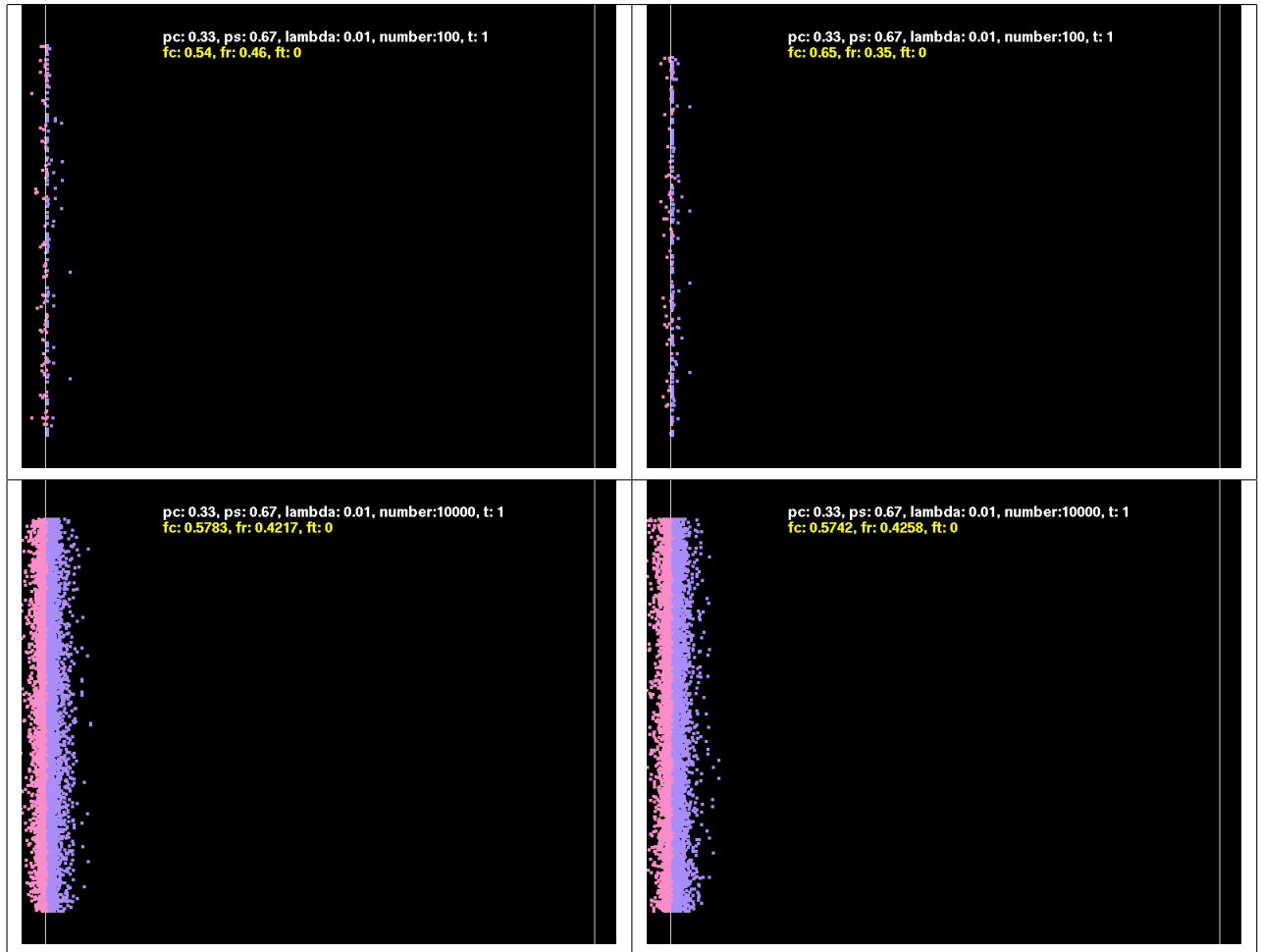


Table 1: Task 2b-1

**Solution.** After repeated trials, I decided to use 10000 for the number of neutrons for the simulation. Compared to 100, this number yields relatively constant results, as seen from Table 1. As the mean free path increases, it can be observed that more neutrons travel through the medium, finally reaching to the other side. When the probabilities of capture and reflection are the same, as opposed to 1:2 as in a), there is noticeable increase in the fraction of capture, from 0.5795 to 0.7035. Also, regardless of the specific values of  $\lambda$  and  $t$ , the result is quite consistent as long as the ratio  $\frac{\lambda}{t}$  are the same. The values of parameters are shown in the figures.  $\square$

### Task 3. A flawless Fortran program

**Solution.** The shortest possible program is as following:

---

```
1      END
```

---

It is 9 bytes. Unfortunately the ldd command did not work. One thing worth noting was that gfortran compiler worked only after conda environment was deactivated, as seen from the screenshot.

$\square$

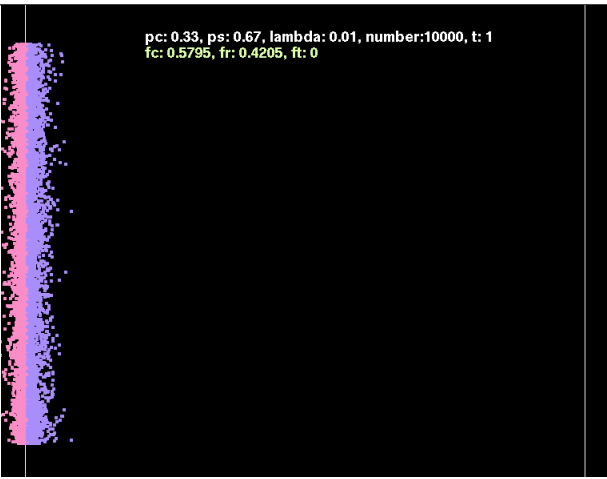
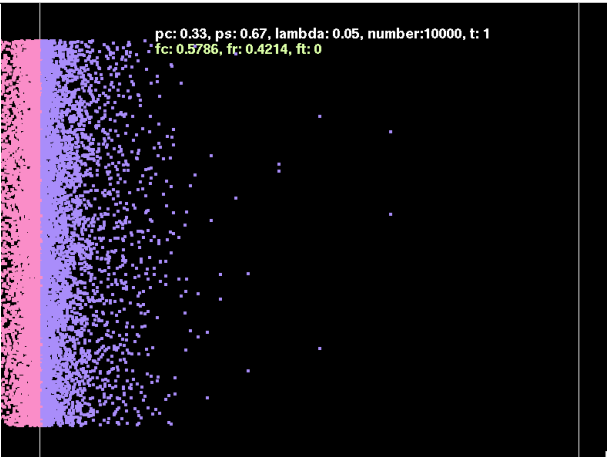
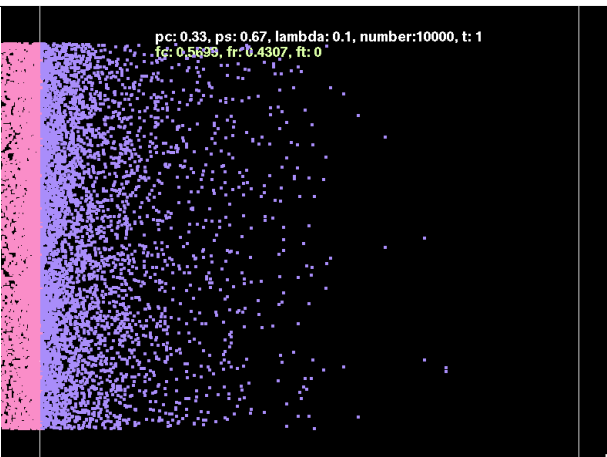
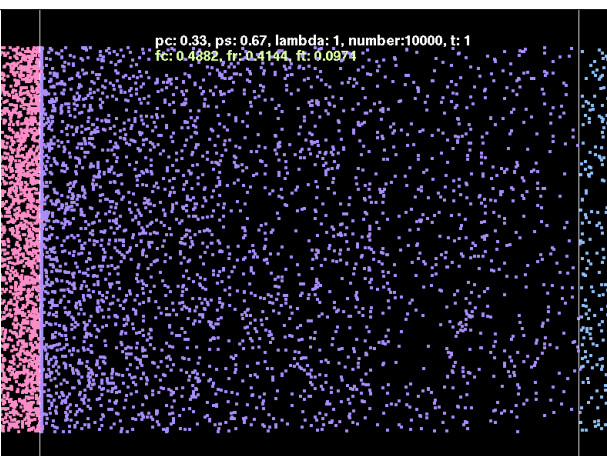

	Result
0.01	 <p>pc: 0.33, ps: 0.67, lambda: 0.01, number:10000, t: 1 fc: 0.5795, fr: 0.4205, ft: 0</p>
0.05	 <p>pc: 0.33, ps: 0.67, lambda: 0.05, number:10000, t: 1 fc: 0.5786, fr: 0.4214, ft: 0</p>
0.1	 <p>pc: 0.33, ps: 0.67, lambda: 0.1, number:10000, t: 1 fc: 0.5699, fr: 0.4307, ft: 0</p>
1	 <p>pc: 0.33, ps: 0.67, lambda: 1, number:10000, t: 1 fc: 0.4682, fr: 0.5318, ft: 0.0974</p>
10	

Table 2: Task 2b-2

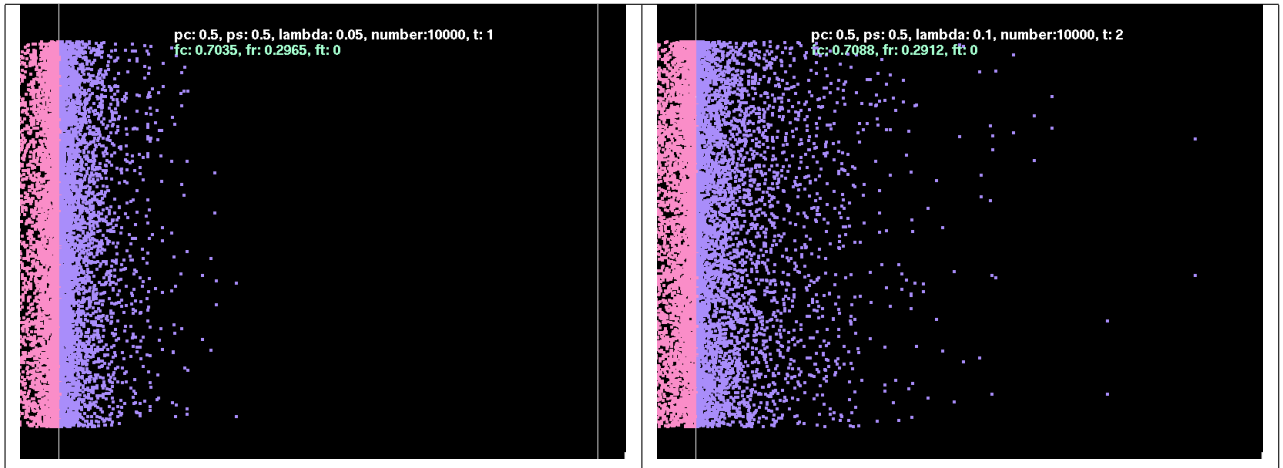


Table 3: Task 2d & 2e

```

sehalee@Jikimis-MacBookPro CA1_ex10 % conda activate
(base) sehalee@Jikimis-MacBookPro CA1_ex10 % gfortran -o output task3.f
ld: unsupported tapi file type '!tapi-tbd' in YAML file '/Library/Developer/Comm
andLineTools/SDKs/MacOSX14.sdk/usr/lib/libSystem.tbd' for architecture x86_64
collect2: error: ld returned 1 exit status
(base) sehalee@Jikimis-MacBookPro CA1_ex10 % conda deactivate
sehalee@Jikimis-MacBookPro CA1_ex10 % gfortran -o output task3.f
sehalee@Jikimis-MacBookPro CA1_ex10 % ./output
sehalee@Jikimis-MacBookPro CA1_ex10 % █

```

Figure 2: Task 3-1

```

sehalee@Jikimis-MacBookPro CA1_ex10 % make
gfortran -o task3 task3.f
./task3
sehalee@Jikimis-MacBookPro CA1_ex10 % ls -l task3.f
-rw-r--r--  1 sehalee  staff   9 Jun 29 21:00 task3.f
sehalee@Jikimis-MacBookPro CA1_ex10 % ldd task3.f
zsh: command not found: ldd
sehalee@Jikimis-MacBookPro CA1_ex10 % ldd task3
zsh: command not found: ldd
sehalee@Jikimis-MacBookPro CA1_ex10 % nm task3
0000000100000efd t __MAIN__
                 U __gfortran_set_args
                 U __gfortran_set_options
0000000100000000 T __mh_execute_header
0000000100000f04 T _main
0000000100000f50 s _options.0.0
sehalee@Jikimis-MacBookPro CA1_ex10 % █

```

Figure 3: Task 3-2