COURSE: PROBABILITY AND STATISTICS

Experiment: 3

Name: Riya Dhakaan	Roll no: A044	Batch B-Tech IT
Year II Sem IV	Date 28.01.2026	Grade:

Objective:

- **Understand and apply discrete probability distributions using R.**
- **Learn to use R functions to compute probabilities, cumulative probabilities, and simulate random values for discrete distributions.**

Code for installing packages:
install.packages(e1071)

Code to load and use package:

library(e1071)
library(distr)
Code to remove package after use:
detach("stats", unload = TRUE)

Syntax for working with discrete data is as follows:

ddiscrete(x, probs, values =
1:length(probs)) pdiscrete(q, probs, values
= 1:length(probs)) qdiscrete(p, probs,
values = 1:length(probs)) rdiscrete(n,
probs, values = 1:length(probs), ...)

where
x, q vector or array of quantiles.
p vector or array of
probabilities. n number of
observations.
Probs probabilities of the
distribution. values values of the
distribution.

... ignored (only there for backwards compatibility)
These functions provide information about the discrete distribution where the

probability of the elements of values is proportional to the values given in probs, which are normalized to sum up to 1. ddiscrete gives the density, pdiscrete gives the distribution function, qdiscrete gives the quantile function and rdiscrete generates random deviates.

X=c(0,1,2,3,4) P=c(0.1,0.15,0.2,0.55) XP=X*P
data.frame(X,P,XP)

mean=sum(XP)

TO FIND THE MISSING VALUE IN A PROBABILITY DISTRIBUTION

convert the question of solving the equation to finding the root of a function and use the following steps:]
For example to find root for 0.6+6x=1, use the
following code: f <- function(x) (0.6+6*x-1)
uniroot(f, lower=0, upper=1)$root

TO FIND THE DISTRIBUTION OF A NEW VARIABLE GIVEN AS A FUNCTION OF RANDOM VARIABLE:

x=c(-1,0,1,2)

y=x*

x+1

y

prob = rep(1/4,4)

tapply(prob,y,sum)

```
#Install package
install.packages("stats")
```

```
#To remove package after
use

detach("stats", unload = TRUE)

#Load library to load and use
package library(e1071)

library(distr)
```

#Prefix used

- p for "probability", the cumulative distribution function (c. d. f.)
- q for "quantile", the inverse c. d. f.
1. d for "density", the density function (p. f. or p. d. f.)
- r for "random", a random variable having the specified distribution

```
#Frequency table

random=sample(1:10, size=1000, replace = TRUE)
t=table(random)

barplot(t)

#How to enter data

rdiscrete( 30, c('0.2','0.5','0.3') )

rdiscrete( 100, c('0.2','0.5','0.3'), c("A","B","C"))


#Example

y= rdiscrete( 100, c(1/4,2/4,1/4), c(0,1,2))
factor(y)

levels(factor(y))
table((factor(y)))

#To find probability associated to any random variable for
example x=1

ddiscrete(1, c(1/4,2/4,1/4), c(0,1,2))


#Example of rolling of die

# generate the vector of probabilities

probability <- rep(1/6, 6)


# plot the probabilities

barplot(probability, xlab = "outcomes", main = "Probability
Distribution")

# generate the vector of cumulative probabilities
```

```
cum_probability <- cumsum(probability)


# plot the probabilites

barplot(cum_probability, xlab = "outcomes", main = "Cumulative
Probability Distribution")

Note: Plots must be customized by using the knowledge of
Practical 2.

#Mean and variance
X=c(0,1,2,3,4)
P=c(0.1,0.15,0.2,0.55)
XP=X*P

data.frame(X,P,XP)
mean=sum(XP)


#Find unknown for 0.6+6x=1

f <- function(x)  (0.6+6*x-1)
uniroot(f, lower=0, upper=1)$root
```

Task 1:

PDF of random variable X is:

X	1	2	3	4	5	6	7
P(X)	k	2k	3k	k^2	k^2+k	$2k^2$	$4k^2$

Find $k, P(X<5), P(1\le X\le 5), E(x)$ and $V(x)$

Write an R program for the above problem. Also, write an R program to plot the probability distribution and cumulative distribution function.

Hint: For creating a vector with cumulative sum of another vector's elements in R use: cumsum(vectorname

Task 1 – Mean (Expected Value) of X

If I repeat this experiment many times, what value of X do I expect on average?

k+2k+3k+k2+(k2+k)+2k2+4k2=1

8k2+7k−1=0

K =1/8

P(x<5)= 58/64

Mean = 201/64

$$k = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$k = \frac{-7 \pm \sqrt{49 + 32}}{16}$$

$$k = \frac{-7 \pm \sqrt{81}}{16}$$

$$k = \frac{-7 \pm 9}{16}$$

$$\boxed{k = \frac{1}{8}}$$

Mean:

$$E(X) = \sum x \cdot P(X = x)$$

$$\frac{8 + 32 + 72 + 4 + 45 + 12 + 28}{64} = \frac{201}{64}$$

$$\boxed{E(X) = \frac{201}{64} \approx 3.14}$$

Variance=10607/4096

Variance tells us how spread out the values are from the mean

$$\text{Var}(X) = E(X^2) - [E(X)]^2$$

$$E(X^2) = \frac{8 + 64 + 216 + 16 + 225 + 72 + 196}{64} = \frac{797}{64}$$

$$[E(X)]^2 = \left(\frac{201}{64}\right)^2 = \frac{40401}{4096}$$

$$E(X^2) = \frac{797}{64} = \frac{51008}{4096}$$

$$\text{Var}(X) = \frac{51008 - 40401}{4096} = \frac{10607}{4096}$$

$$\boxed{\text{Var}(X) = \frac{10607}{4096} \approx 2.59}$$

CDF (Cumulative Distribution Function)

What is the probability that X is less than or equal to a value?

$$F(x) = P(X \leq x)$$

install.packages("e1071")

library ("e1071")

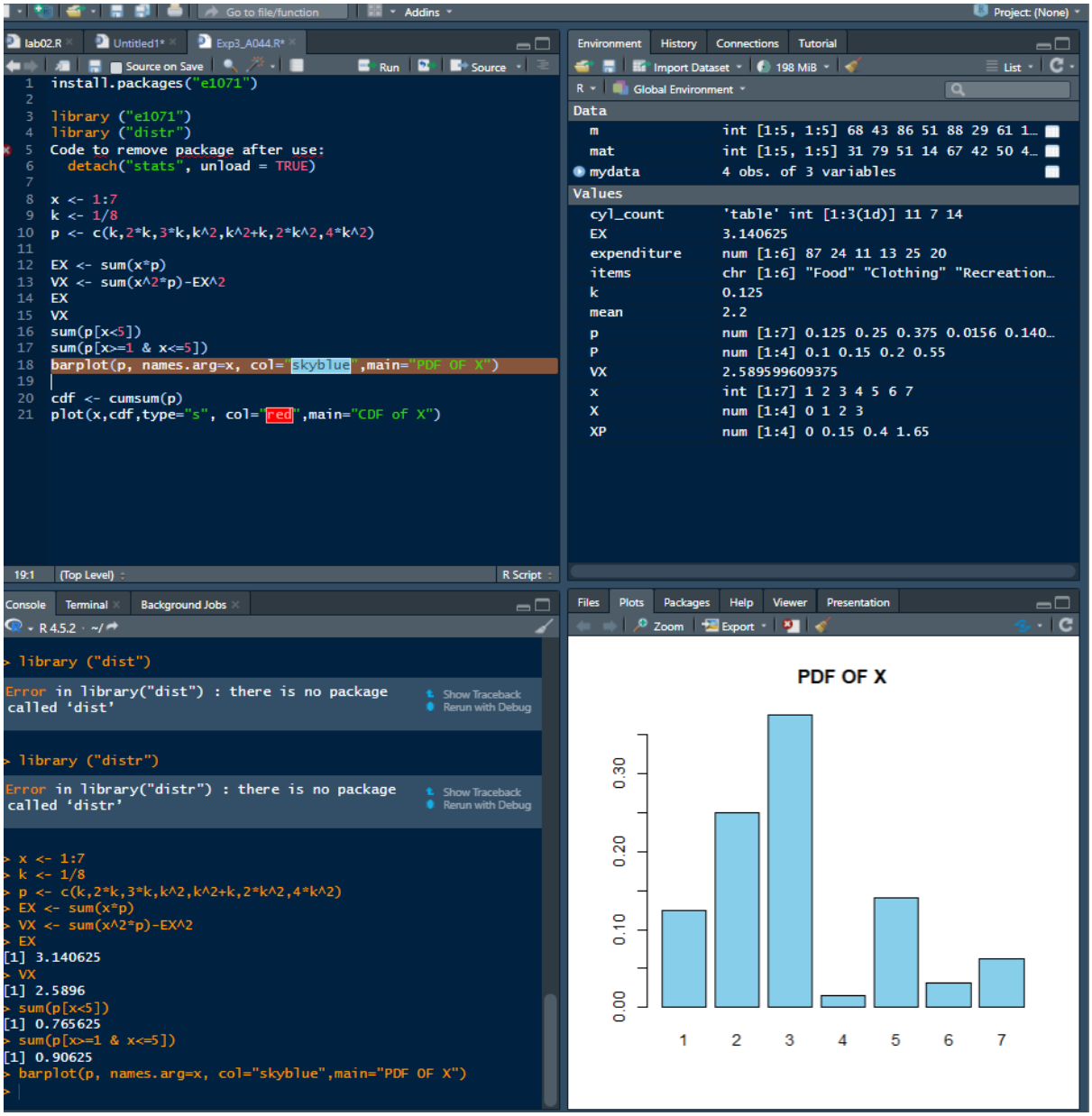
library ("distr")

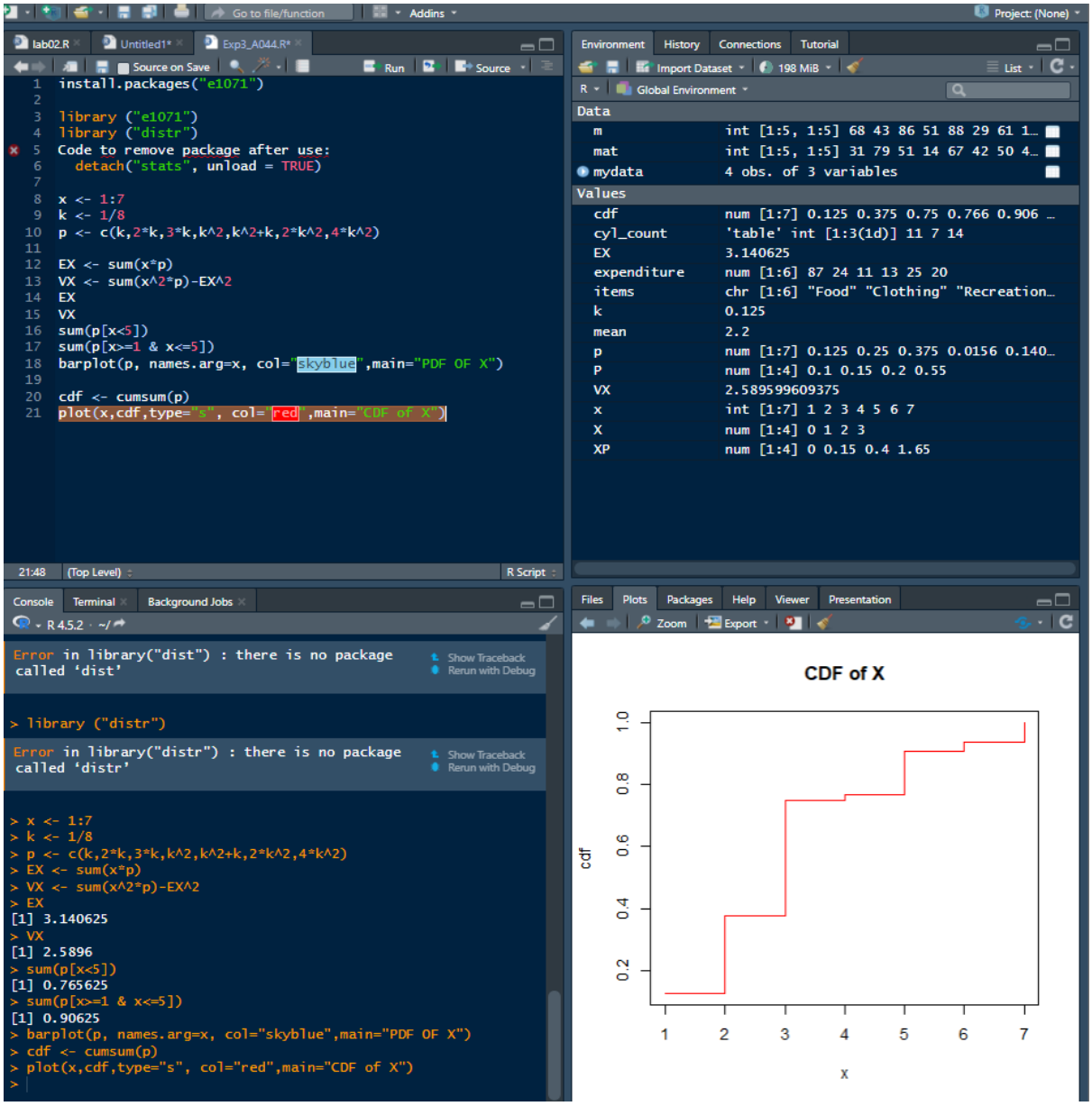
Code to remove package after use:

detach("stats", unload = TRUE)

```
x <- 1:7
k <- 1/8
p <- c(k,2*k,3*k,k^2,k^2+k,2*k^2,4*k^2)

EX <- sum(x*p)
VX <- sum(x^2*p)-EX^2
EX
VX
sum(p[x<5])
sum(p[x>=1 & x<=5])
barplot(p, names.arg=x, col="skyblue",main="PDF OF X")

cdf <- cumsum(p)
plot(x,cdf,type="s", col="red",main="CDF of X")
```

COURSE: PROBABILITY AND STATISTICS





Task 2:

A random variable X has the following pdf:

X	-2	-1	0	1	2	3
P(X)	0.1	k	0.2	2k	0.3	3k

Find k, P (X <2), cdf, mean and variance of X.

Write an R program for the above problem. Also, write an R program to plot the probability

distribution and cumulative distribution function.

$$\sum P(X = x) = 1$$

$$0.1 + k + 0.2 + 2k + 0.3 + 3k = 1$$

$$\boxed{k = \frac{1}{15}}$$

Find $P(X < 2)$

$$P(X < 2) = 0.1 + \frac{1}{15} + 0.2 + \frac{2}{15}$$

$$\boxed{P(X < 2) = 0.3 + 0.2 = 0.5}$$

CDF (Cumulative Distribution Function)

$$F(x) = P(X \leq x)$$

X	-2	-1	0	1	2	3	
F(X)	0.1	1/6	11/30		1/2	0.8	1

Mean (Expected Value)

$$E(X) = \sum x \cdot P(X)$$

$$E(X) = \frac{20}{15} - \frac{4}{15} = \frac{16}{15}$$

$$\boxed{E(X) = \frac{16}{15}}$$

Variance of X

$$\text{Var}(X) = E(X^2) - [E(X)]^2$$

$$E(X^2) = \sum x^2 P(X)$$

$$E(X^2) = \frac{6}{15} + \frac{1}{15} + 0 + \frac{2}{15} + \frac{18}{15} + \frac{27}{15}$$

$$= \frac{54}{15}$$

$$[E(X)]^2 = \left(\frac{16}{15}\right)^2 = \frac{256}{225}$$

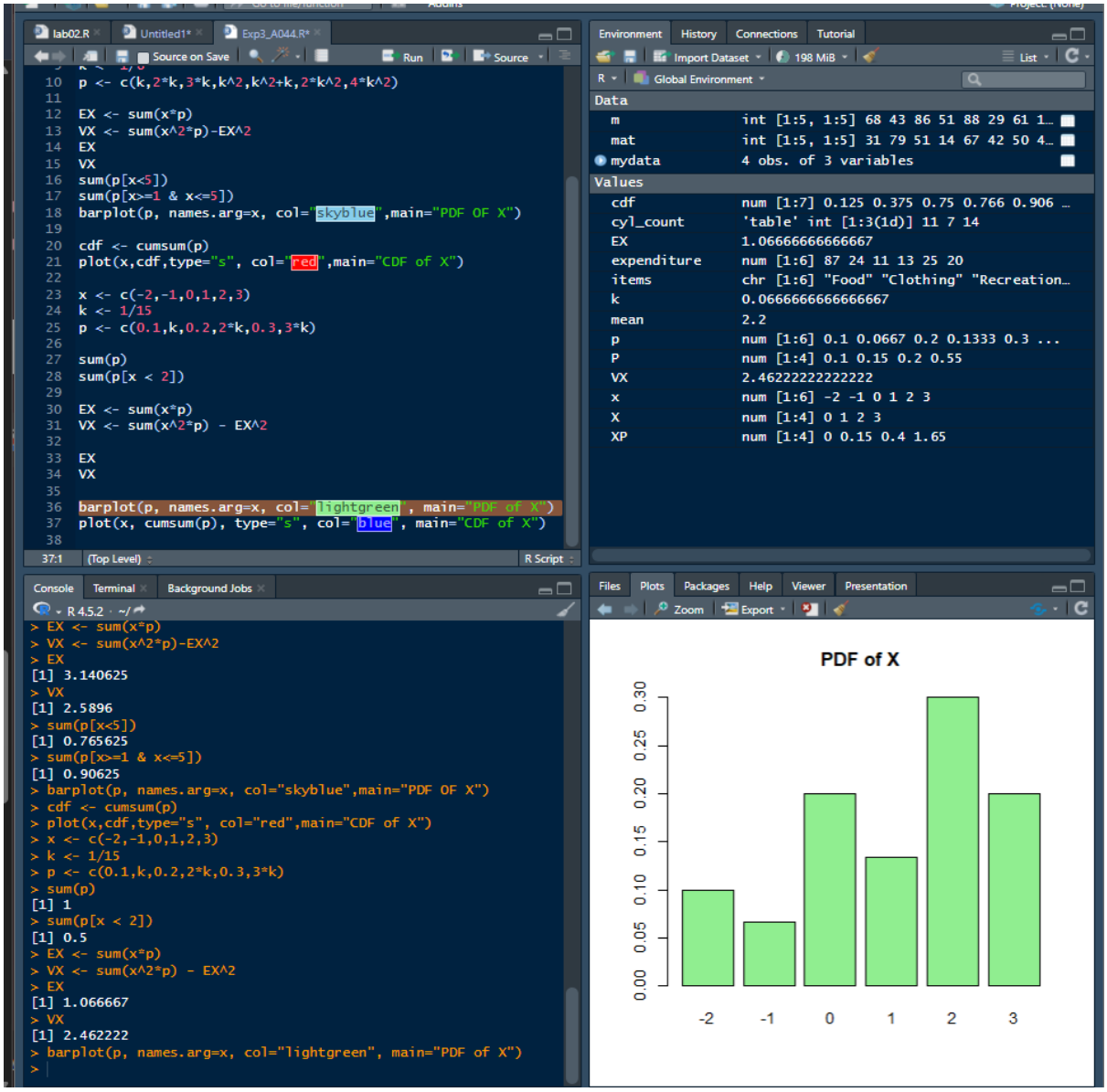
$$\frac{54}{15} = \frac{810}{225}$$

$$\text{Var}(X) = \frac{810}{225} - \frac{256}{225} = \frac{554}{225}$$

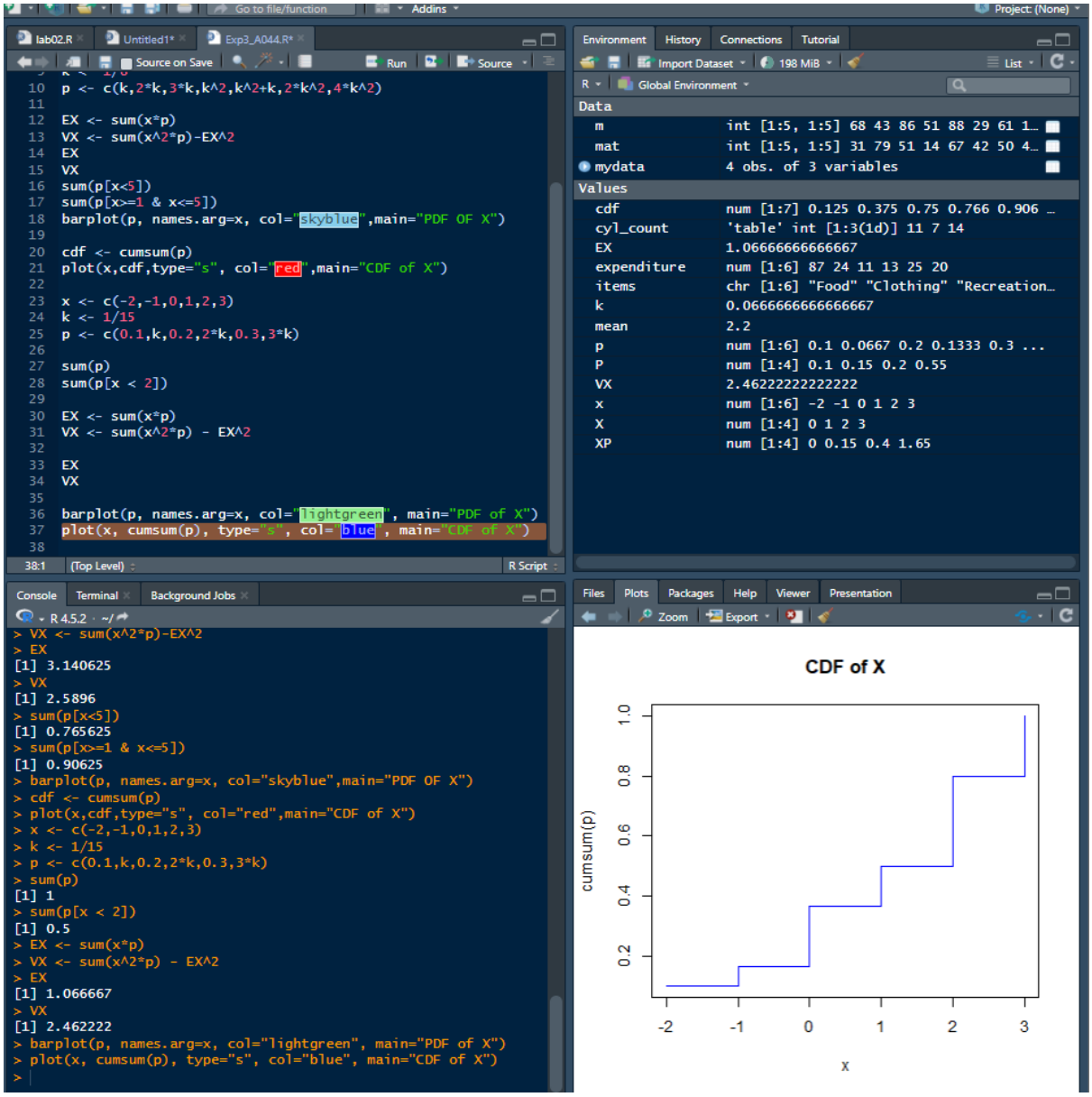
$$\boxed{\text{Var}(X) = \frac{554}{225}}$$

```
x <- c(-2,-1,0,1,2,3)
k <- 1/15
p <- c(0.1,k,0.2,2*k,0.3,3*k)

sum(p)
sum(p[x < 2])

EX <- sum(x*p)
VX <- sum(x^2*p) - EX^2

EX
VX

barplot(p, names.arg=x, col="lightgreen", main="PDF of X")
plot(x, cumsum(p), type="s", col="blue", main="CDF of X")
```

COURSE: PROBABILITY AND STATISTICS



Riya Dhakaan A044



Task 3:

A RV X has the following probability distribution:

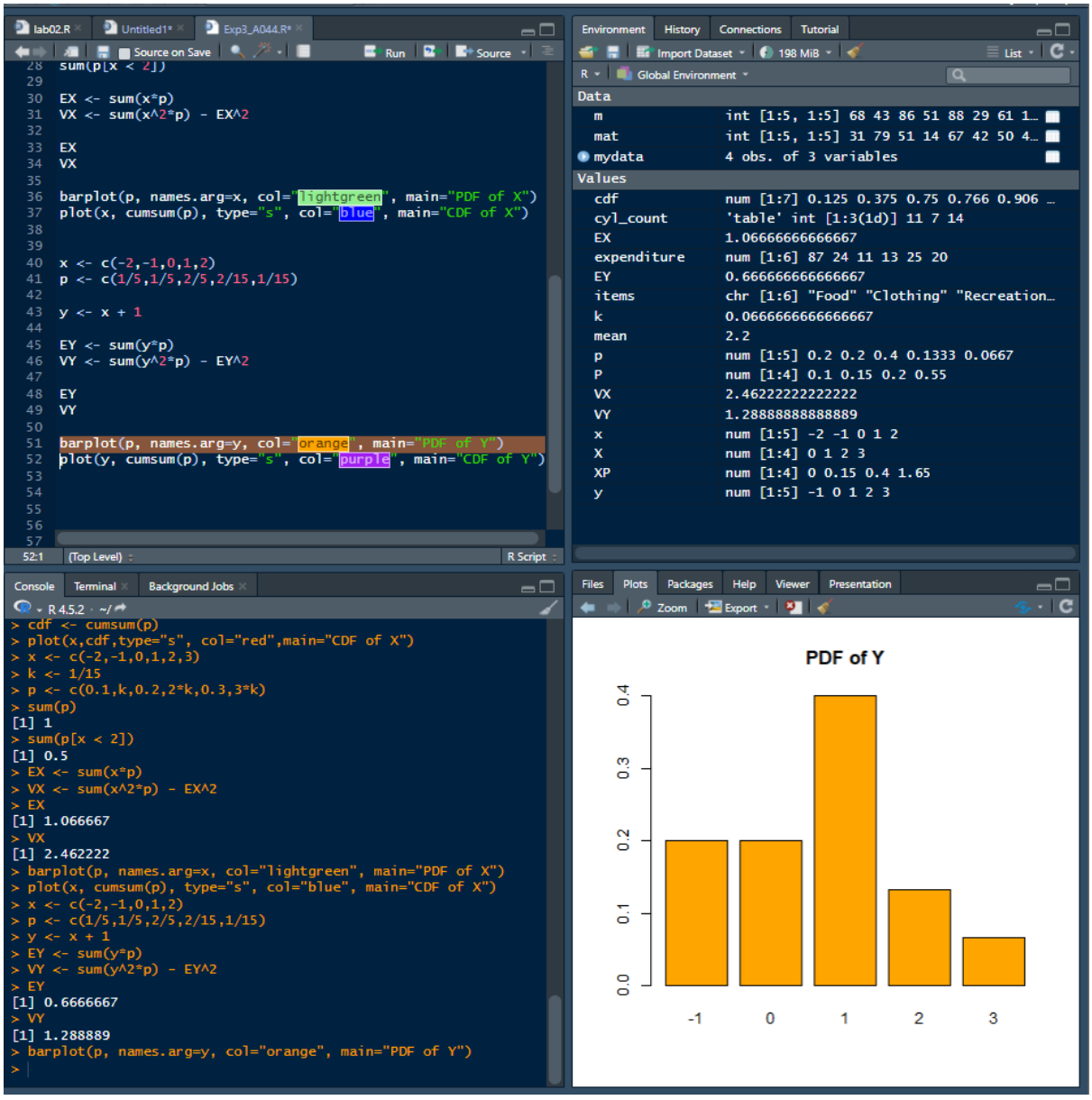
X	-2	-1	0	1	2
P(X=x)	1/5	1/5	2/5	2/15	1/15

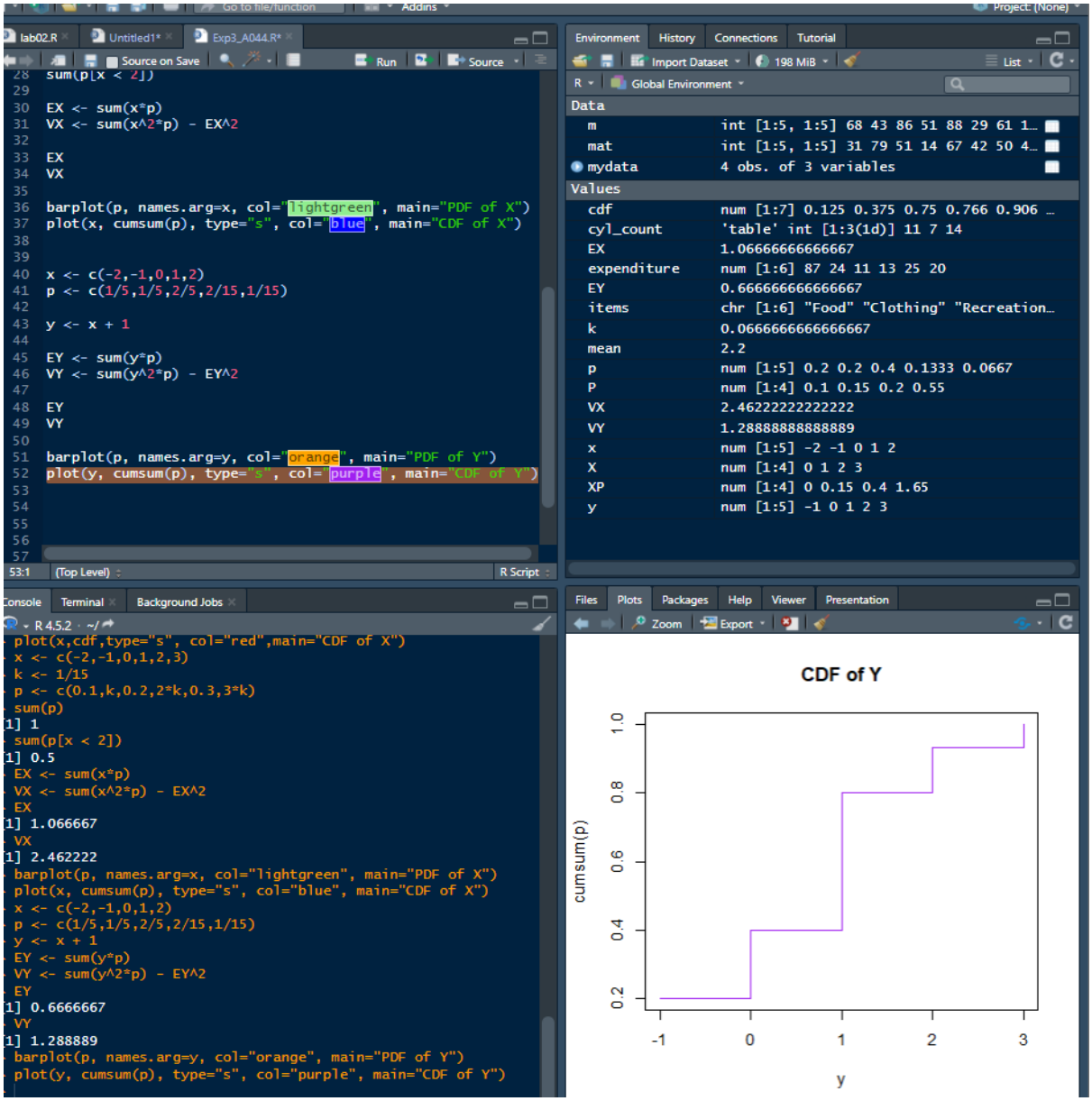
Find the probability distribution of $Y= X^2+1$. Also find mean and variance of Y.

Write an R program for the above problem. Also, write an R program to plot the probability distribution and cumulative distribution function.

X	X^2	Y = X^2 + 1
-2	4	5
-1	1	2
0	0	1
1	1	2
2	4	5

COURSE: PROBABILITY AND STATISTICS





Task 4:

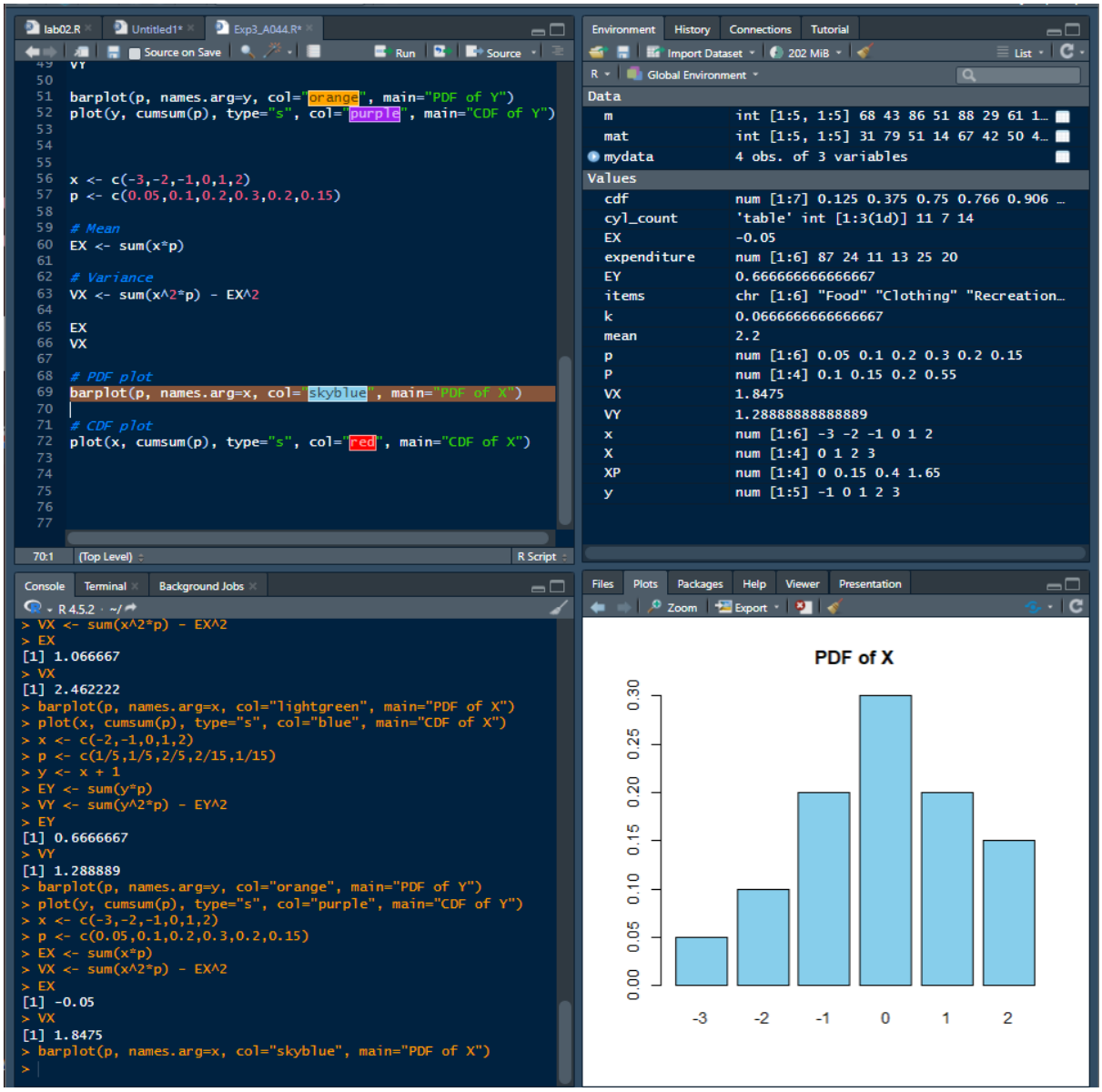
Given the following distribution:

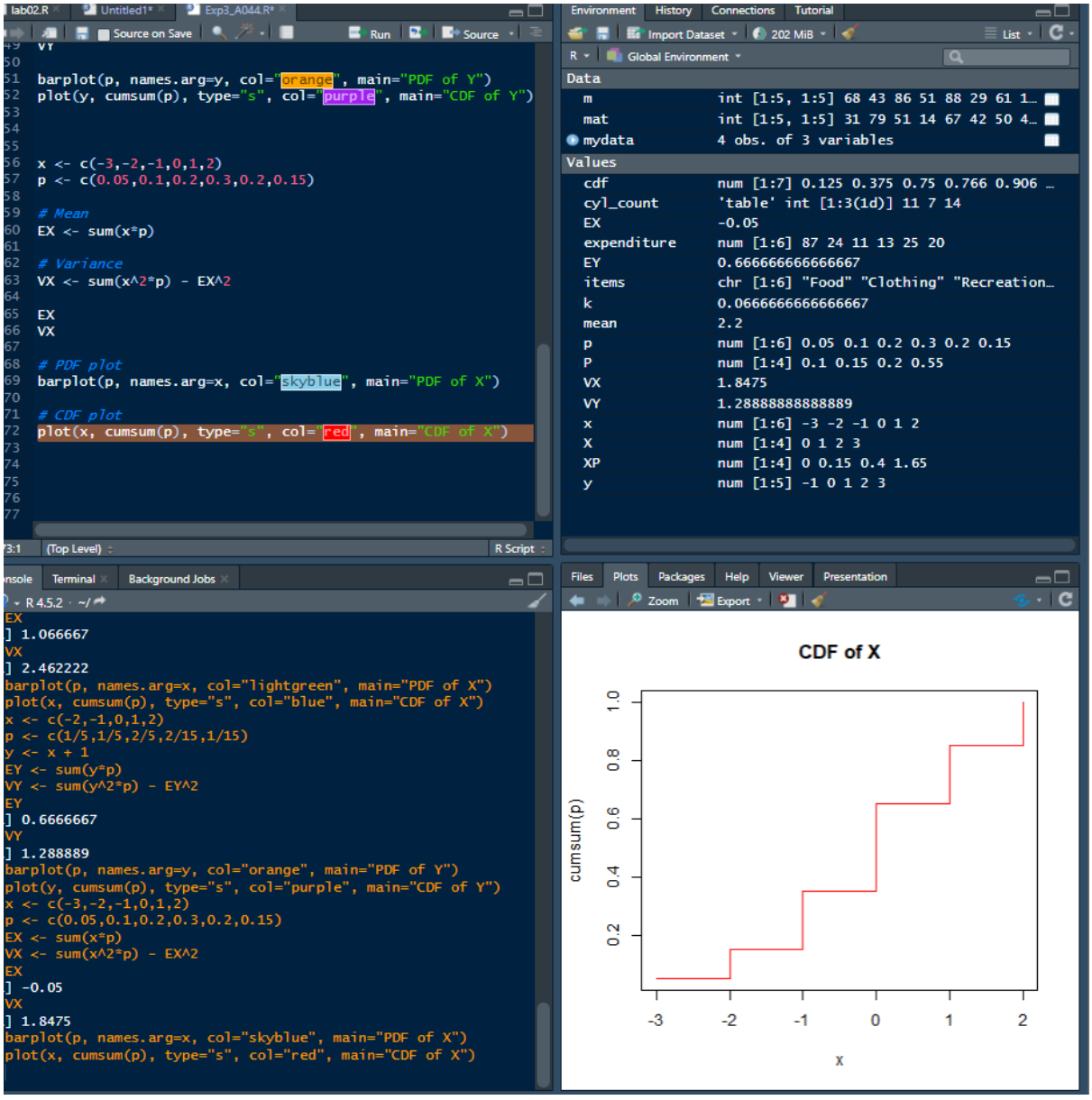
X	-3	-2	-1	0	1	2
P(X=x)	0.05	0.1	0.2	0.3	0.2	0.15

Find Mean and Variance.

Write an R program for the above problem.

COURSE: PROBABILITY AND STATISTICS



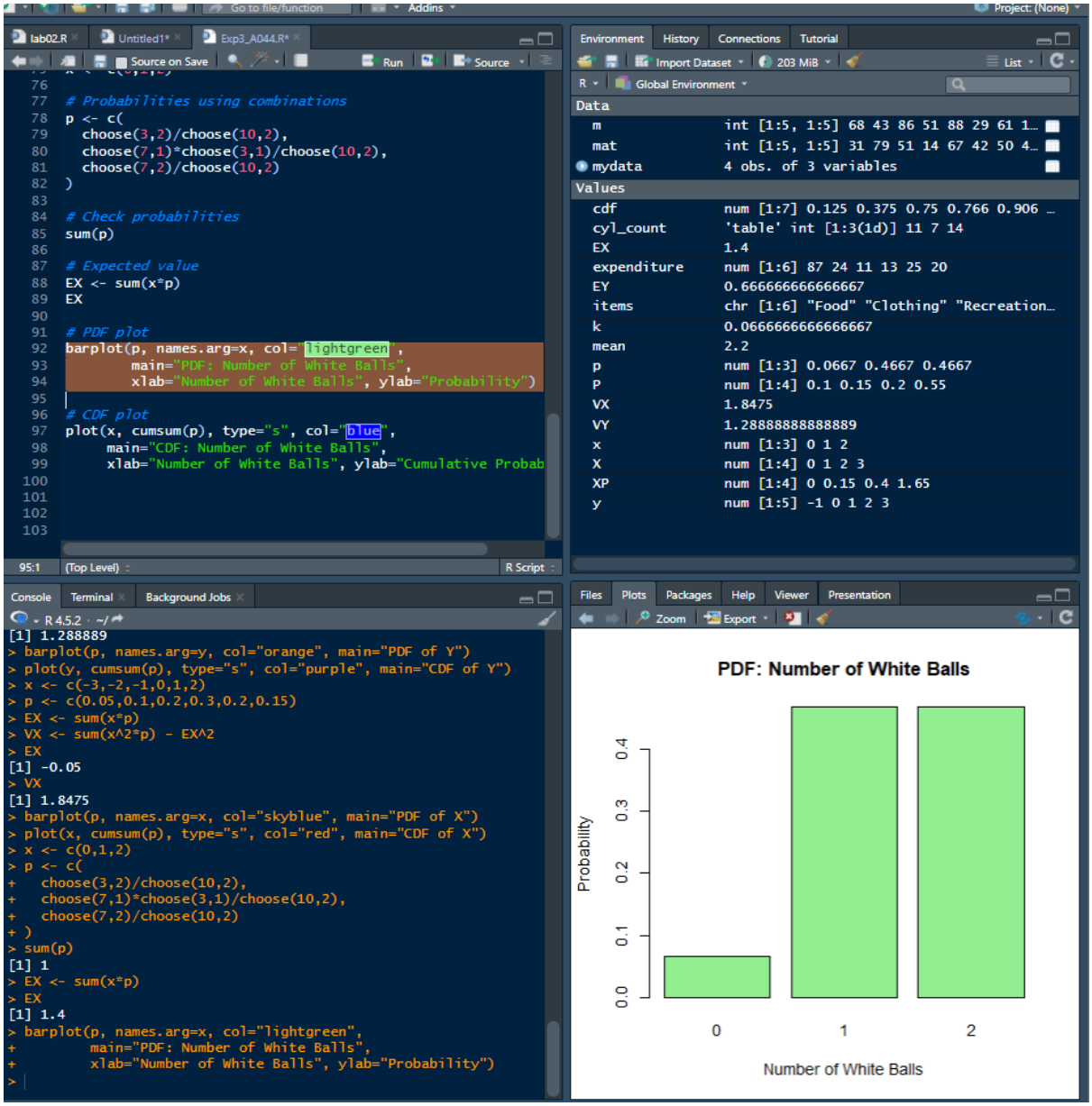


Task 5:

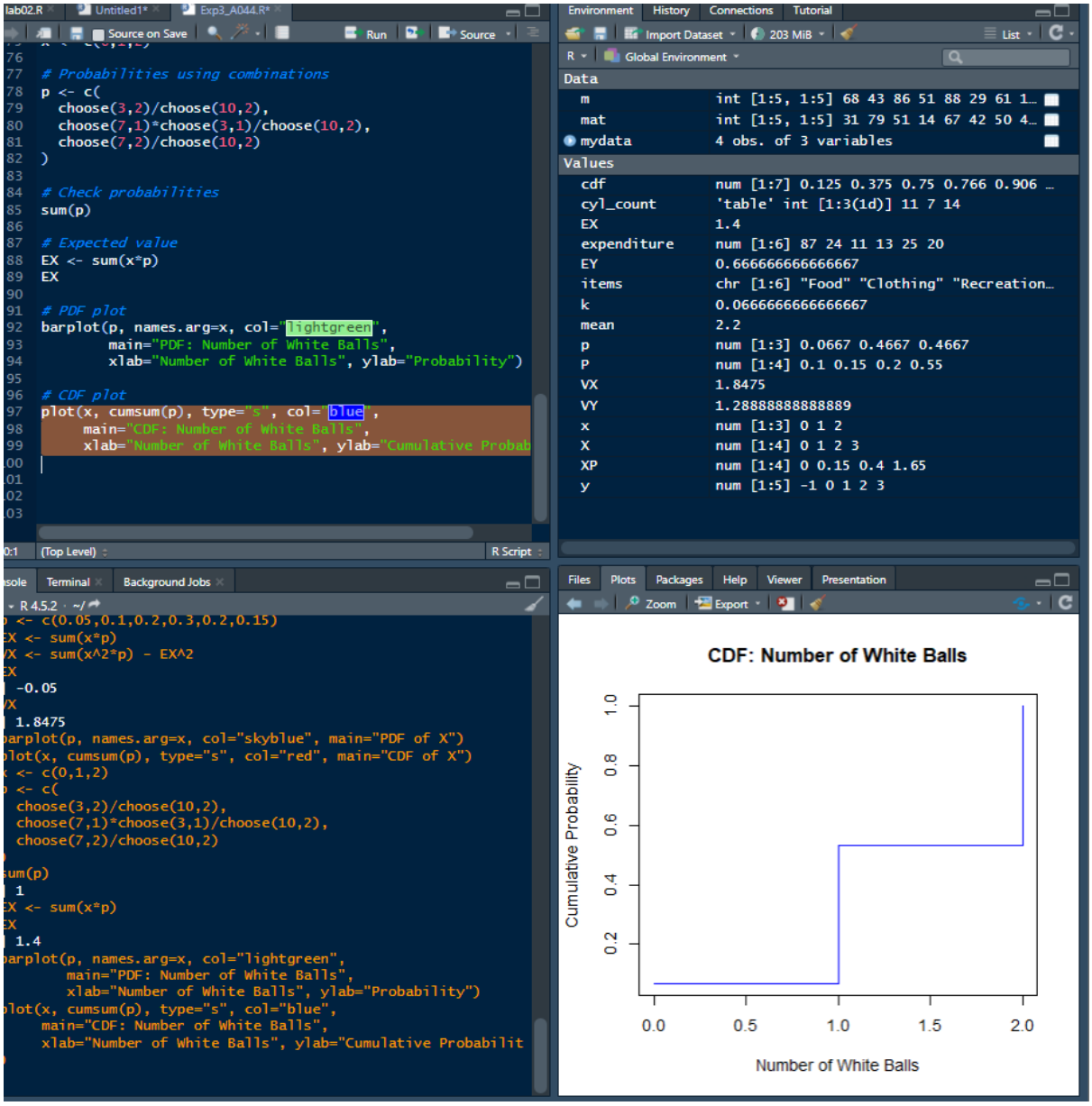
An urn contains 7 white and 3 red balls. Two balls are drawn together, at random from this urn. Compute the expected number of white balls drawn.

Using an R program, find the expectation of the above problem. Also write a program to plot probability distribution and cumulative probability distribution. Hint: For calculating combination in R use: choose(n,r)

COURSE: PROBABILITY AND STATISTICS



COURSE: PROBABILITY AND STATISTICS



Home Work Questions:

Solve all the above questions manually.