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## Questions 5 and 6: Insurance rates, part 3

Question 5, which has 4 parts, continues the pandemic scenario from Questions 3 and 4.

Suppose that there is a massive demand for life insurance due to the pandemic, and the company wants to find a premium cost for which the probability of losing money is under 5%, assuming the death rate stays stable at  $p = 0.015$ .

### Question 5a

1.0/1.0 point (graded)

Calculate the premium required for a 5% chance of losing money given  $n = 1000$  loans, probability of death  $p = 0.015$ , and loss per claim  $l = -150000$ . Save this premium as  for use in further questions.

✓ Answer: 3268

### Explanation

The premium can be calculated using the following code:

```
p <- .015
n <- 1000
l <- -150000
z <- qnorm(.05)
x <- -l*( n*p - z*sqrt(n*p*(1-p)))/ ( n*(1-p) + z*sqrt(n*p*(1-p)))
x
```

Submit

You have used 2 of 10 attempts

**i** Answers are displayed within the problem

## Question 5b

1.0/1.0 point (graded)

What is the expected profit per policy at this rate?

✓ Answer: 969

### Explanation

The expected profit can be calculated using the following code:

```
l*p + x*(1-p)
```

You have used 2 of 10 attempts

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**i** Answers are displayed within the problem

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## Question 5c

1.0/1.0 point (graded)

What is the expected profit over 1,000 policies?

✓ Answer: 969042

### Explanation

The expected profit can be calculated using the following code:

```
mu <- n*(l*p + x*(1-p))  
mu
```

You have used 1 of 10 attempts

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**i** Answers are displayed within the problem

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## Question 5d

1.0/1.0 point (graded)

Run a Monte Carlo simulation with `B=10000` to determine the probability of losing money on 1,000 policies given the new premium `x`, loss on a claim of \$150,000, and probability of claim  $p = .015$ . Set the seed to 28 before running your simulation.

(IMPORTANT! If you use R 3.6 or later, you will need to use the command `set.seed(x, sample.kind = "Rounding")` instead of `set.seed(x)`. Your R version will be printed at the top of the Console window when you start RStudio.)

What is the probability of losing money here?

✓ Answer: 0.0554

### Explanation

The probability can be calculated using the following code:

```
set.seed(28)
B <- 10000
profit <- replicate(B, {
  draws <- sample(c(x, 1), n,
                  prob=c(1-p, p), replace = TRUE)
  sum(draws)
})

mean(profit < 0)
```

Submit

You have used 2 of 10 attempts

**i** Answers are displayed within the problem

The company cannot predict whether the pandemic death rate will stay stable. Set the seed to 29, then write a Monte Carlo simulation that for each of  $B = 10000$  iterations:

- randomly changes  $p$  by adding a value between -0.01 and 0.01 with `sample(seq(-0.01, 0.01, length = 100), 1)`
- uses the new random  $p$  to generate a sample of  $n = 1,000$  policies with premium  $x$  and loss per claim  $l = -150000$
- returns the profit over  $n$  policies (sum of random variable)

(IMPORTANT! If you use R 3.6 or later, you will need to use the command `set.seed(x, sample.kind = "Rounding")` instead of `set.seed(x)`. Your R version will be printed at the top of the Console window when you start RStudio.)

The outcome should be a vector of  $B$  total profits. Use the results of the Monte Carlo simulation to answer the following three questions.

(Hint: Use the process from lecture for modeling a situation for loans that changes the probability of default for all borrowers simultaneously.)

## Question 6a

0.0/1.0 point (graded)

What is the expected value over 1,000 policies?

989687

✖ Answer: 968306

989687

### Explanation

This code will run the Monte Carlo simulation:

```
# n, p, l and x as defined in the problem information
set.seed(29) # in R 3.6, set.seed(29, sample.kind="Rounding")

profit <- replicate(B, {
  new_p <- p + sample(seq(-0.01, 0.01, length = 100), 1)
  draws <- sample(c(x, l), n,
                  prob=c(1-new_p, new_p), replace = TRUE)
  sum(draws)
})
```

This code gives the expected value for the profit:

```
mean(profit)
```

Submit

You have used 10 of 10 attempts

**i** Answers are displayed within the problem

## Question 6b

0.0/1.0 point (graded)

What is the probability of losing money?

✖ Answer: 0.191

**Explanation**

This probability can be calculated using this code:

```
mean(profit < 0)
```

You have used 10 of 10 attempts

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**i** Answers are displayed within the problem

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**Question 6c**

0.0/1.0 point (graded)

What is the probability of losing more than \$1 million?

✖ Answer: 0.0424

**Explanation**

This probability can be calculated using this code:

```
mean(profit < -1*10^6)
```

You have used 10 of 10 attempts

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**i** Answers are displayed within the problem

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