Assignment: Goodness of Fit Test
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1. Test an octahedral die whether it is unbiased or not with following data using goodness of fit test:

Score	1	2	3	4	5	6	7	8
Frequency	7	10	11	9	12	10	14	7

Solution:

Null hypothesis: H_0 : Die is unbiased
Alternative hypothesis: H_1 : Die is not unbiased

If the die is fair, the probability of each face should be the same or $1/8$. From 80 rolls, each face to have about 10 appearances.

$Score$	$Observed\ frequency$	$Expected\ frequency$
1	7	10
2	10	10
3	11	10
4	9	10
5	12	10
6	10	10
7	14	10
8	7	10

$$\chi^2 = sum\ of \frac{(Observed\ frequency - Expected\ frequency)^2}{Expected\ frequency}$$

$$\chi^2 = \sum_{k=1}^{n} \frac{(O_k - E_k)^2}{E_k}$$

$$\begin{aligned}\chi^2 = \sum_{k=1}^{8} \frac{(O_k - E_k)^2}{E_k} &= \frac{(7-10)^2}{10} + \frac{(10-10)^2}{10} + \frac{(11-10)^2}{10} + \frac{(9-10)^2}{10} \\ &\quad + \frac{(12-10)^2}{10} + \frac{(10-10)^2}{10} + \frac{(14-10)^2}{10} + \frac{(7-10)^2}{10} \\ &= 4\end{aligned}$$

$degrees\ of\ freedom = n - 1 = 8 - 1 = 7$

Script:

```
#!/usr/bin/env Rscript

obsfreq <- c(7, 10, 11, 9, 12, 10, 14, 7)
expfreq <- 1/length(obsfreq) * sum(obsfreq)

chisq = sum((obsfreq - expfreq)**2/10)
dof = length(obsfreq) - 1
pval = 1 - pchisq(chisq, dof)

print(paste("X-squared =", chisq, "df =", dof, "p-value =", round(pval,4)))
```

Output:

```
[1] "X-squared = 4 df = 7 p-value = 0.7798"
```

Script:

```
#!/usr/bin/env Rscript

score <- c(1, 2, 3, 4, 5, 6, 7, 8)
obsfreq <- c(7, 10, 11, 9, 12, 10, 14, 7)
proportion <- c(1/8, 1/8, 1/8, 1/8, 1/8, 1/8, 1/8, 1/8)

chisq.test(obsfreq, p = proportion)
```

Output:

```

    Chi-squared test for given probabilities

data:  obsfreq
X-squared = 4, df = 7, p-value = 0.7798
```

The value of χ^2 is 4 and the degrees of freedom are $8 - 1 = 7$. The calculated p-value is 0.7798 so we have no reason to reject the hypothesis that the die is unbiased.