Problem 3: Dietary Survey

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Question 1

Solution:

```r
diet <- read.csv("calories.csv", header = TRUE)
daily_diet <- colMeans(diet)
# Combined mean
x_bar <- mean(daily_diet)
n_sam <- dim(diet)[1]
week <- dim(diet)[2]
# polled SD
SD <- sqrt((n_sam-1)*sum(apply(diet, 2, var))/(week*n_sam-week))
SE <- SD / sqrt(n_sam)
t<-qt((1-0.05/2),df=n_sam-1)
up_CI <- x_bar + t * SE
low_CI <- x_bar - t * SE
data.frame(x_bar, SD, SE, low_CI, up_CI)

##       x_bar      SD        SE    low_CI    up_CI
## 1 1797.846 660.523 132.1046 1525.195 2070.496
```

The average daily energy consumption for all individuals in Britain is 1798 and the 95% CI is (1525 , 2070).

Question 2

Solution:

Suppose that the estimated average daily energy consumption is $\bar{x}$ and we want a 95% confidence interval of $(\bar{x} - 20, \bar{x} + 20)$ for the population average μ. This can be calculated from slandered error formula as follows:

$$
\begin{aligned}
n\ &> \left(\frac{sd}{SE}\right)^2 \\
&> \left(\frac{sd}{|X_{CL} - \mu|/t_{crit}}\right)^2 \\
&> \left(\frac{sd \times t_{crit}}{|X_{CL} - \mu|}\right)^2
\end{aligned}
$$

```r
#  CI = [x_bar-20, x_bar+20]
t_crit <- round(qt((1 - 0.05/2),df=n_sam-1))
SE_est <- 20/ t_crit
n_est <- round((SD/SE_est)^2)
```

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Therefore, require sample size is 4363.

Question 3

Solution:

Since we have sample mean, we can estimate total daily food consumption by all individuals in the United Kingdom from the following formula:

$$Y = N\bar{x}$$

and the standard error of population total is calculated from the formula:

$$SE = \sqrt{(N^2 \times (1 - n/N) \times s^2/n)}$$

Given that the UK population is approximately 67 million, i.e., $N = 67000000$.

```
N <- 67000000
total_diet <- N * x_bar
SE_total <- sqrt(N^2*(1-n_sam/N)* SD^2/n_sam)
up_CI.total <- total_diet + t * SE_total
low_CI.total <- total_diet - t * SE_total
```

Therefore, the estimated total daily food consumption by all individuals in the United Kingdom is 1.2045566^{11} and the 95% CI is (102188082708 , 138723243006).

Question 4

Solution:

Given that the estimated total energy value of all food produced/imported for human consumption in the UK is 84×10^{12} kcal per year. Using the given sample the estimated daily total energy consumption in the UK is 1.2045566^{11} and 4.3966317^{13} yearly.

```
waste_prop<- (84*10^12 - 365*total_diet)/ (84*10^12)
s2 <- n_sam/(n_sam-1)* waste_prop * (1-waste_prop)
SE_prop<- sqrt(s2/n_sam)
up_CI.prop <-  waste_prop + t * SE_prop
low_CI.prop <- waste_prop - t * SE_prop
```

The percentage of wasted food is 48% and the 95% CI is (27% , 69%).