6.6

(a)

False. A confidence interval is constructed to estimate the population proportion, not the sample proportion.

(b)

True. Because the 95% confidence interval is $46\% \pm 3\%$. The confidence interval is constructed to estimate the population proportion.

(c)

True. By the definition of the confidence level. We are 95% confident that between 43% and 49% of Americans support the decision of the U.S. Supreme Court on the 2010 healthcare law. So in terms of many random samples of the population, 95% of those samples will agree to the confidence interval $46\% \pm 3\%$.

(d)

True. The margin of error at a 90% confidence level would be higher than 3% since the Z^* will be higher for a 90% confidence interval. Margin of error = $Z^* * SE$. SE remains the same.

6.12

(a)

48% is a sample statistic because it is the proportion of the 1259 respondents which constitute the sample. We do not know the proportion of the whole US residents for this issue.

(b)

1259 respondents are a small proportion of the whole US residents and we can assume they are independent. 1259*0.48 = 604.32 > 10, 1259*(1-0.48) = 654.68 > 10. The sampling distribution are approximate to normal distribution. $SE = \sqrt{\frac{0.48*(1-0.48)}{1259}}$, $Z^* * SE = 1.96 * SE = 0.0276$. So the 95% confidence interval is 0.48 ± 0.03, i.e. $(0.45, 0.51)$. It means we are 95% confident that the proportion of all US residents who think marijuana should be made legal is between 45% and 51%.

(c)

It is true for these data. Because the SE is calculated based on the assumption that the sampling distribution is approximate to normal distribution. If the data is obviously skewed, the 95% confidence interval calculated above will not be accurate.

(d)

It is not justified because the 95% confidence interval is between 45% and 51%, which covers the proportion lower than 50%. So it does not mean the majority will think so.

6.14

(a)

This is an appropriate setting for a hypothesis test. $H_0: p = 0.5$, $H_A: p > 0.5$. This is a simple random sample of adults less than 10% of all the Americans. And 1507*0.56 > 10, 1507*(1-0.56) > 10.

So both independence and the success-failure condition are satisfied. The sampling distribution can be regarded as normal distribution. $SE = \sqrt{\frac{0.56*(1-0.56)}{1507}}$, $Z = \frac{0.56-0.5}{SE} = 4.69$.

```
> pnorm(4.69, mean = 0, sd = 1, lower.tail = FALSE)
[1] 1.366025e-06
```

So p-value = 1.366×10^{-6}. It is approximate to 0. We can reject the null hypothesis. So we can determine that these data provide strong evidence that the majority of the Americans think the Civil War is still relevant.

(b)

P-value means the probability that observations are higher than the Z value (4.69) of the standard normal distribution given that the null hypothesis (p=0.5) is true. P-value is a conditional probability.

(c)

$Z^* * SE = 1.645 * SE = 0.021$. So the 90% confidence interval is 0.56 ± 0.02, i.e. (0.54, 0.58). It means that we are 90% confident that 54% to 58% Americans think the Civil War is still relevant to American politics and political life. So the confidence interval agrees with the conclusion of the hypothesis test. The lower limit of the 90% confidence interval is greater than 0.5.

6.16

(a)

This is an appropriate setting for a hypothesis test. $H_0: p = 0.5$, $H_A: p < 0.5$. This is a simple random sample of adults less than 10% of all the Americans who do not have a four-year college degree. And 331*0.48 > 10, 331*(1-0.48) > 10. So both independence and the success-failure condition are satisfied. The sampling distribution can be regarded as normal distribution. $SE = \sqrt{\frac{0.48*(1-0.48)}{331}}$,

$Z = \frac{0.48-0.5}{SE} = -0.728$.

```
> pnorm(-0.728, mean = 0, sd = 1, lower.tail = TRUE)
[1] 0.2333068
```

So p-value = 0.233. It is much larger than 0.1. We are failed to reject the null hypothesis. So we can determine that the data does not provide strong evidence that the minority of the Americans who decide not to go to college do so because they cannot afford it.

(b)

I would expect a confidence interval for the proportion of American adults who decide not to go to college because they cannot afford it to include 0.5. Because based on the result of the hypothesis test above, the null hypothesis (p=0.5) could probably be true. So the confidence interval should include 0.5. For a 95% confidence interval, $Z^* * SE = 1.96 * SE = 0.05$, so CI: 0.48 ± 0.05.

6.18

(a)

This is a simple random sample of adults less than 10% of all the Americans who do not have a four-year college degree. And 331*0.48 > 10, 331*(1-0.48) > 10. So both independence and the success-failure condition are satisfied. The sampling distribution can be regarded as normal distribution.

$SE = \sqrt{\frac{0.48*(1-0.48)}{331}}$, $Z^* * SE = 1.645 * SE = 0.045$. So the 90% confidence interval is 0.48 ± 0.05, i.e. (0.43, 0.53). It means that we are 90% confident that 43% to 53% Americans who decide to not go to college because they cannot afford it.

(b)

Margin of error = $Z^* * SE = 1.645 * \sqrt{\frac{p(1-\mathrm{p})}{n}} = 1.645 * \sqrt{\frac{0.48*(1-0.48)}{n}} \leq 0.015$, then $n \geq 3001.9$. So I would recommend a survey of 3002 Americans who decide to not go to college.

6.20

For a 95% confidence interval, the margin of error = $Z^* * SE = 1.96 * \sqrt{\frac{p(1-\mathrm{p})}{n}}$, if $1.96 * \sqrt{\frac{0.48*(1-0.48)}{n}} \leq 0.02$ then $n \geq 2397.2$. So 2398 Americans would need to survey.

6.24

The patients entering the program were officially designated instead of randomly sampled. And it is unclear whether people would be mentally affected by the treatment. Patients who did not receive a heart transplant might feel depressed and it may affect the survival rate. That is, independence may not hold. Additionally, there are only 4 alive patients in the control group, so the success-failure condition does not hold. Even if we consider a hypothesis test where we pool the proportions, the success-failure condition will not be satisfied. Since one condition is questionable and the other is not satisfied, the difference in sample proportions will not follow a nearly normal distribution. So we cannot construct a confidence interval using the normal approximation.

If we constructed the confidence interval despite this problem, the result might be unreasonable because of the skewed of the sample distribution. And the conclusion of the hypothesis test might go wrong.

6.26

(a)

True. The entire confidence interval is above 0. So the data provide convincing evidence of a difference.

(b)

False. The entire confidence interval is above 0. So we are 95% confident that the proportion of college graduates who watch The Daily Show is 7% to 15% higher than the proportion of people with a high school degree or less who watch The Daily Show.

(c)

False. The random samples should be sampled among the whole population who are whether college graduates or with a high school degree or less. Then 95% of random samples will produce differences between 7% and 15%.

(d)

False. A 90% confidence interval will be narrower since we are less confident in terms of a narrower confidence interval. The Z* for a 90% confidence interval is smaller than that of 95% CI.

(e)

True. It is simply the negated and reordered values: (-0.15, -0.07).

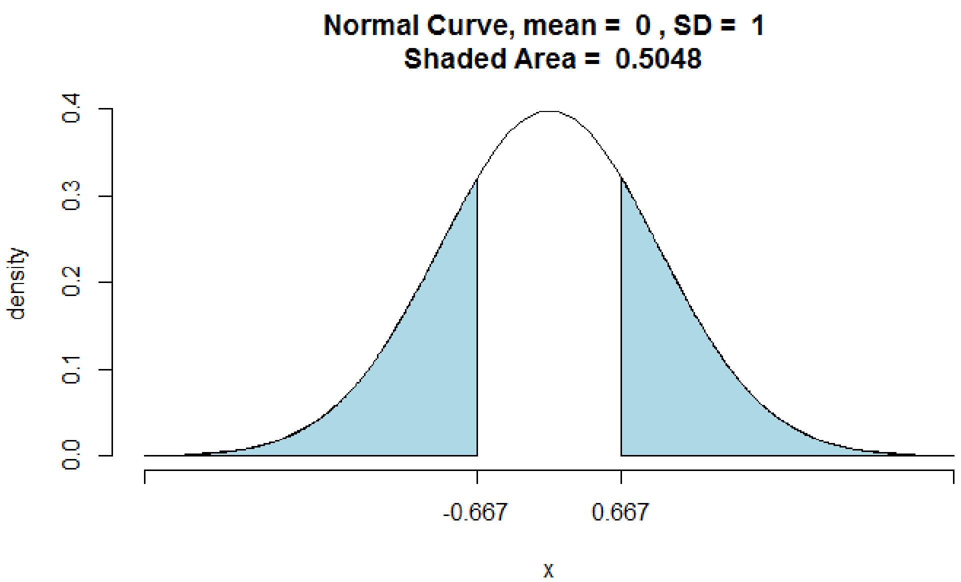
6.32

(a)

Let p_R and p_D represent the proportion of Republicans and Democrats who think the full-body scans should be applied in airports. For the hypothesis test, $H_0: p_R - p_D = 0$, $H_A: p_R - p_D \neq 0$. Independence is satisfied (random sample, < 10% of the population). For the success-failure condition, we would check using the pooled proportion. $\hat{p} = \frac{264+299}{318+369} = 0.82$. 0.82*687 > 10, and (1-0.82) *687 > 10, so it satisfied the success-failure condition. So it can be approximate to normal distribution. The point estimate is $\hat{p}_R - \hat{p}_D = \frac{264}{318} - \frac{299}{369} = 0.02$. $SE = \sqrt{\frac{\hat{p}(1-\hat{p})}{318} + \frac{\hat{p}(1-\hat{p})}{369}} = 0.03$.

$Z = \frac{\hat{p}_R - \hat{p}_D - 0}{SE} = 0.667$.

```
> library("tigerstats", lib.loc="C:/Program Files for operation/R-3.3.1/li
brary")
> pnormGC(c(-0.667,0.667),region = "outside",mean = 0,sd = 1,graph = TRUE)
[1] 0.5047721
```



So p-value = 0.5048. Since the p-value is much higher than 0.1, we fail to reject the null hypothesis. There is a no difference in the proportion of Republicans and Democrats who think the full-body scans should be applied in airports.

(b)

We think the null hypothesis is true based on the above test result but it may actually be false. If an error is made, it will be Type 2 Error.

6.40

(a)

True. The mean is equal to the degree of freedom.

(b)

True. From the chi-square probability table, we can find that χ^2 = 11.07 with df =5 and $\alpha = 0.05$ (5% significance level). If $\chi^2 = 10$, then the p-value is larger than 0.05. We would fail to reject the null hypothesis.

(c)

False. When finding the p-value of a chi-square test, we always shade the tail areas in upper tails. The chi-squared test is essentially always a one-sided test. It is a “goodness of fit” test.

(d)

False. Variability is equal to twice of df. As the degrees of freedom increases, the variability of the chi-square distribution increases.

6.42

(a)

For category (1), the number of respondents in 2010 is 38%*1019 = 387

For category (2), the number of respondents in 2010 is 16%*1019 = 163

For category (3), the number of respondents in 2010 is 40%*1019 = 408

For category (4), the number of respondents in 2010 is 6%*1019 = 61

(b)

H_0: Beliefs on the origin of human life did not change since 200. The observed counts only reflect natural sampling fluctuation.

H_A: Beliefs on the origin of human life changed since 2001.

(c)

For category (1), the expected number of respondents is 37%*1019 = 377

For category (2), the expected number of respondents is 12%*1019 = 122

For category (3), the expected number of respondents is 45%*1019 = 459

For category (4), the expected number of respondents is 6%*1019 = 61

(d)

Before conducting a chi-square test, we need to verify the conditions. First, independence. Each case that contributes a count to the table is independent of all the other cases in the table. Second, sample size / distribution. Each particular scenario (i.e. cell count) definitely have at least 5 expected cases. The conditions are all satisfied.

$$\sum_{i=1}^{4} Z_i^2 = \chi^2 = \frac{(387-377)^2}{377} + \frac{(163-122)^2}{122} + \frac{(408-459)^2}{459} + \frac{(61-61)^2}{61} = 19.71$$

Degree of freedom = 4 – 1 = 3

Based on the table, the p-value is much lower than 0.001. So we can reject the null hypothesis. We can conclude that beliefs on the origin of human life changed since 2001.

6.48

(a)

A chi-square test for independence in two-way tables is appropriate for evaluating the question. Before conducting a chi-square test, we need to verify the conditions. First, independence. Each case that contributes a count to the table is independent of all the other cases in the table. Second, sample size / distribution. Each particular scenario (i.e. cell count) definitely have at least 5 expected cases. They are all satisfied.

(b)

H_0: There is no association between coffee intake and depression.

H_A: There is an association between coffee intake and depression.

(c)

The overall proportion of women who do suffer from depression: $p_{depression} = \frac{2607}{50739} = 0.0514$

The overall proportion of women who do not suffer from depression: $p_{not\_depression} = \frac{48132}{50739} = 0.9486$

(d)

Expected count for the highlighted cell: $6617 * p_{depression} = 6617 * 0.0514 = 340$

The contribution of this cell: $Z_2^2 = \frac{(373-340)^2}{340} = 3.203$

(e)

df = (R-1)*(C-1) = 1*4 = 4

The p-value is less than 0.001 for df = 4 with $\chi^2 = 20.93$.

(f)

The p-value is much smaller than 0.001. So we can reject the null hypothesis. The conclusion is that there is an association between coffee intake and depression.

(g)

I agree with this judgement. We could not recommend women drink more coffee because there is an association between coffee intake and depression based on the hypothesis testing result. And the association is not clearly enough to draw any quantitative conclusion. The depression proportions of women who drink less than 1 cup coffee a day seem greater than the total average proportion based on the table. The depression proportions of women who drink more than 2-3 cups a day are less than the total average proportion. But the proportion actually increases from women who drink less than 1 cup a week to women who drink 2-6 cups per week. So we could not just recommend women load up on an extra coffee generally.