Research Report
"Exploring Different Patterns and Hidden Aspects of Laughter Events in Phone Calls"
by Sofiia Kononovych
for the course COMPSCI4080 Computational Social Intelligence
University of Glasgow

Description of The Data

The data (file "laughter-corpus.csv") is a collection of laughter events observed during 60 phone conversations between 120 unacquainted speakers. For every laughter event, the following information is available:

- Gender of the person that laughs: "Male" or "Female";
- Role of the person that laughs: "Caller" or "Receiver";
- Duration of the laughter event in seconds.

Out of 120 speakers, 57 are male and 63 are female. In terms of roles, 60 speakers are callers, and 60 receivers.

Research questions

Q1. Is the number of laughter events higher for women than for men?

Research Hypothesis:

H1: The number of laughter events higher for women than for men.

Null Hypothesis:

H0: There is no difference in the number of laughter events depending on gender of speaker.

Description of the data:

Gender distribution of Speakers – Male Subjects: 57 out of 120 speakers, Female Subjects: 63 out of 120 speakers. Number of Laughter Occurrences – Male Subjects: 346 occurrences; Female Subjects: 496 occurrences.

Statistical tests selection: Chi-square test.

Explanation of test selection:

Taking into account nature of observations, they seem to be independent of one another; we observe the existence of relation between number of laughter events and gender of observer, thus comparing the proportions of laughter events between two independent groups (male and female).

The Chi-square test determine whether two categorical or nominal variables are likely to be related or not (number of laughter events and gender). That is exactly what we need to find out based on our null hypothesis.

Test implementation:

Using Python, first extract the data from *laughter-corpus.csv* in variables *laughs_male* and *laughs_female* – frequencies of all male and female laughs *(Appendix 1, 2)*.

Define statistical test in function *chi_square_male_female*.

Calculate proportions *p1 for male, p2 for female*, so that we can confirm superiority of one gender's number of laugher events over another, *p1 = 6.07, p2 = 7.87.*

To make calculations simpler, we do not directly create tables for observed and expected results, but assume that these are 2*2 tables with observed and expected values inside (rows for male/female; columns for number of observers and number of laughs).

Thus, *degrees_of_freedom = (rows - 1)*(columns - 1) = 1.*

To find out expected number of laugher events for male and female we first calculate *pooled_sample* and multiply it by number of observers from each group, thus receiving *expected_male* and *expected_female*.

chi_square – calculated according to the formula of The Chi Square.

Then find critical value corresponding to n = 1 degrees of freedom from chi-square distibution table for alpha = 0,05 (confidence level). *critical_value = 3.841. (Appendix 3)*

Finally, compare our obtained and table values: *13.862 > 3.841.* It means we reject the null hypothesis(H0) with 95 percent confidence level. *(Appendix 4)*

Results:

Since our obtained value *chi_square* is greater than *critical_value,* we reject the null hypothesis with 95 percent confidence level, stating that there is relation between laughter events and gender, so that the number of laughter events is higher for female subjects to a statistically significant extent. *Female subjects tend to laugh more than male ones*.

Test is set up to one-tailed because we are looking for a significant difference only in one direction based on provided data (the number of laughter events, which depend on gender, is higher for women than for men).

Q2. Is the number of laughter events higher for callers than for receivers?

Research Hypothesis:

H1: The number of laughter events higher for callers than for receivers.

Null Hypothesis:

H0: There is no difference in the number of laughter events depending on the role of speaker.

Description of the data:

Role distribution of speakers – Caller Subjects: 60 out of 120 speakers, Receiver Subjects: 60 out of 120 speakers. Number of Laughter Occurrences – Caller Subjects: 505 occurrences; Receiver Subjects: 337 occurrences.

Statistical tests selection: Chi-square test.

Explanation of selection:

Performing the test similar to the Question 1 report. Observations are independent of one another; we observe the existence of relation between number of laughter events and role of speaker, compare the proportions of laughter events between two independent groups (callers and receivers).

The Chi-square test determine whether two categorical or nominal variables are likely to be related or not (number of laughter events and role). That is exactly what we need to find out based on our null hypothesis.

Test implementation:

Using Python, first extract the data from *laughter-corpus.csv* in variables *laughs_ caller* and *laughs_ receiver* – frequencies of all callers and receivers laughs. *(Appendix 1, 2)*

Define chi-squared statistical test in function *chi_square_callers_receivers*.

Calculate proportions *p_caller, p_receiver*, so that we can confirm superiority of one role's number of laughter events over another. *p_caller = 6.07, p_receiver = 7.87.*

To make calculations simpler, we do not directly create tables for observed and expected results, but assume that these are 2*2 tables with observed and expected values inside (rows for caller/receiver; columns for number of speakers and number of laughs). Thus, *degrees_of_freedom* = (rows-1)*(coumns-1) = 1.

To find out expected number of laugher events for callers and receiver we calculate *pooled_sample* as well and multiply it by number of observers from each group thus receiving *expected_callers* and *expected_receivers*.

chi_square – calculated according to the formula of The Chi Square.

Then find critical value corresponding to n = 1 degrees of freedom from chi-square distibution table for alpha = 0,05 (confidence level). *critical_value = 3.84. (Appendix 5)*

Finally, compare our obtained and table value: *13.862 > 3.841.* It means we reject the null hypothesis with 95 percent confidence level. *(Appendix 6)*

Results:

Since our obtained value *chi_square* is greater than *critical_value,* we reject the null hypothesis with 95 percent confidence level, stating that there is relation between the role of participant and number of laughter events, so the number of laughter events is higher for caller subjects to a statistically significant extent. *Callers tend to laugh more than receivers*.

Chosen test is one-tailed because we are looking for a significant difference only in one direction (example of directional hypothesis that the number of laughter events higher for callers than for receivers).

Q3. Are laughter events longer for women?

Research Hypothesis:

H1: The duration of laughter events is longer for female speakers than for male speakers during phone conversations.

Null Hypothesis:

H0: There is no significant difference in the duration of laughter events between male speakers and female speakers during phone conversations.

Description of the data:

We are given laughter length corresponding either to male or female subject. Having performed additional calculations, we have next values (rounded to 3 digits): average of laugher length (in seconds) for male = 0.606, for female = 0.710; variance of laughter length for male = 0.164, for female = 0.195.

Statistical tests selection: Two independent samples test (Student's T Test).

Explanation of selection:

The aim is to test the difference between the means of 2 independent groups: male speakers and female speakers. The estimated value is duration of speaker`s laugh. Two independent samples test is the ideal choice judging from the data provided.

Test implementation:

Firstly, let`s state an alpha (significance) level: 0.05

Using Python, first extract the data from *laughter-corpus.csv* in *durations_female* and *durations_male* - arrays consisting of laughter durations corresponding to male and female subjects. *(Appendix 1, 2)*.

Define two independent samples statistical test in function *students_t_gender*.

Then calculate average of laugher length for male and female subjects by dividing sum of the elements in each list by its length (*male_mean, female_mean*).

Next step is to calculate variance of laughter length for male and female subjects according to variance formula (var_male, var_female).

degrees_of_freedom for independent samples t-test are calculated by formula:

df = (n1 - 1) + (n2 - 1), where n1, n2 are lengths of our sample lists*, df = 840* in our case.

The critical t-value for a two-tailed test with significance level (alpha) = 0.05 can be found in t-test table and equals *1.647*.

Finally, calculate t according to the t-equation, but before calculate necessary values of pooled variance (*sp_squared*) and *sum_of_sqrt. (Appendix 7)*

So, our absolute value of t is equal to *3.460* which is greater than stated critical value *1.647,* so we reject the null hypothesis. *(Appendix 8)*

Results:

We can conclude that there is a significant difference in the duration of laughter events between male speakers and female speakers during phone conversations in advantage of female speakers. *t = 3.460* with 95 percent confidence level. We have found enough evidence in sample data to support the claim made in the research hypothesis. *Female speakers tend to laugh longer than male ones.*

One-tailed test is used. This is because we are interested to determine whether there is a significant difference between values specifying the direction (we have a directional hypothesis that male speakers have longer laughter events).

Q4. Are laughter events longer for callers?

Research Hypothesis:

H1: The duration of laughter events is longer for callers compared to receivers during phone conversations.

Null Hypothesis:

H0: There is no significant difference in the duration of laughter events between callers and receivers during phone conversations.

Description of the data:

We are given laugher length corresponding either to caller or receiver subject. Having performed additional calculations, we have next values (rounded to 3 digits): average of laugher length (in seconds) for callers = 0.746, for receivers = 0.549; variance of laughter length for callers = 0.213, for receivers = 0.120.

Statistical tests selection: Two independent samples test (Student's T Test).

Explanation of selection:

Performing the test analogically to the previous one, to test the difference between the means of 2 independent groups: callers and receivers. The estimated value is duration of speaker`s laugh. Two independent samples test is the ideal choice judging from the provided data.

Test implementation:

Firstly, let`s state an alpha (significance) level: 0.05.

Using Python, first extract the data from *laughter-corpus.csv* in *durations_caller* and *durations_receiver* - arrays consisting of laughter durations corresponding to caller and receiver subjects. *(Appendix 1, 2)*.

Define two independent samples statistical test in function *students_t_role*.

Then calculate average of laugher length for male and female subjects by dividing sum of the elements in each list by its length (caller*_mean, receiver_mean*).

Next step is to calculate variance of laughter length for male and female subjects according to variance formula (var_caller, var_receiver).

degrees_of_freedom for independent samples t-test are calculated by formula:

df = (n1 - 1) + (n2 - 1), where n1, n2 are lengths of our sample lists*, df = 840* in our case.

The critical t-value for a two-tailed test with significance level (alpha) = 0.05 can be found in t-test table and equals *1.647*. *(Appendix 9)*

Finally, calculate t according to the t-equation, but before calculate necessary values of pooled variance (*sp_squared*) and *sum_of_sqrt.*

So, our absolute value of t is equal to *6.664* which is greater than stated critical value *1.647,* so we reject the null hypothesis. *(Appendix 10)*

Results:

We can conclude that there is significant difference in the duration of laughter events between callers and receivers during phone conversations in advantage of callers. *t = 6.664* with 95 percent confidence level. Enough have been found in sample data to support the claim made in the research hypothesis. *Callers in general tend to laugh longer than the receivers of the call.*

Same as mentioned in the previous test, one-tailed test is used. We are interested to determine whether there is a significant difference between values specifying a direction (having directional hypothesis that callers have longer laughter events).

Appendix: Analysis software

1. **Stating data.**

```
# Given data
observers_male = 57
observers_female = 63
number_callers = 60
number_receivers = 60
laughs_male = 0
laughs_female = 0
laughs_caller = 0
laughs_receiver = 0
durations_female = []
durations_male = []
durations_caller = []
durations_receiver = []

```

2. **Data Processing.**

```
# Taking data from laugher-corpus.csv
with open("laughter-corpus.csv", 'r') as file:
    header = file.readline()
    for line in file:
        columns = line.strip().split(',')
        gender = columns[0]
        caller_receiver = columns[1]
        duration = float(columns[2])

        if gender == 'Male':
            laughs_male += 1
            durations_male.append(duration)
        elif gender == 'Female':
            laughs_female += 1
            durations_female.append(duration)

        if caller_receiver == "Receiver":
            laughs_receiver += 1
            durations_receiver.append(duration)
        elif caller_receiver == 'Caller':
            laughs_caller += 1
            durations_caller.append(duration)

```

3. **Q1.**

```
def chi_square_male_female():
    # Calculate proportions
    p1 = laughs_male / observers_male
    p2 = laughs_female / observers_female

    # Calculate pooled sample proportion
    pooled_sample = (laughs_male + laughs_female) / (observers_male + observers_female)

    # Calculate expected frequencies
    expected_male = observers_male * pooled_sample
    expected_female = observers_female * pooled_sample

    # Calculate the chi-square test statistic
    chi_square = ((laughs_male - expected_male) ** 2 / expected_male) + ((laughs_female - expected_female) ** 2 / expected_female)

    # Degrees of freedom
    degrees_of_freedom = 1
    #Critical value corresponding to df from chi-square distibution table for alpha = 0.05
    critical_value = 3.841

    if chi_square > critical_value:
        print(
            "Reject the null hypothesis: number of laughter events is associated with the role (caller or receiver).")
    else:
        print("Fail to reject the null hypothesis.")

    print(f"Chi-squared statistic: {chi_square}")
    print(f"Degrees of freedom: {degrees_of_freedom}")
    print(f"Proportions for male / female: {p1} / {p2}")

```

4. **Q1** test performed.

```
Python 3.10.9 | packaged by Anaconda, Inc. | (main, Mar  1 2023, 18:18:15) [MSC v.1916 64 bit (AMD64)]
Chi-squared statistic: 13.861744622839753
Degrees of freedom: 1
Proportions for male / female: 6.0701754385964914 / 7.873015873015873
Reject the null hypothesis.
None
```

5. **Q2**.

```python
def chi_square_callers_receivers():
    # Calculate proportions
    p_caller = laughs_caller / number_callers
    p_receiver = laughs_receiver / number_receivers

    # Calculate pooled sample proportion
    pooled_sample = (laughs_caller + laughs_receiver) / (number_callers + number_receivers)

    # Calculate expected frequencies
    expected_callers = number_callers * pooled_sample
    expected_receivers = number_receivers * pooled_sample

    # Calculate the chi-square test statistic
    chi_square = ((laughs_caller - expected_callers) ** 2 / expected_callers) + (
            (laughs_receiver - expected_receivers) ** 2 / expected_receivers)

    # Degrees of freedom
    degrees_of_freedom = 1
    # Critical value corresponding to df from chi-square distibution table for alpha = 0,05
    critical_value = 3.841

    print(f"Chi-squared statistic: {chi_square}")
    print(f"Degrees of freedom: {degrees_of_freedom}")
    print(f"Proportions for caller / receiver: {p_caller} / {p_receiver}")

    # Make a decision
    if chi_square > critical_value:
        print("Reject the null hypothesis.")
    else:
        print("Fail to reject the null hypothesis.")
```

6. **Q2** test performed.

```
Python 3.10.9 | packaged by Anaconda, Inc. | (main, Mar  1 2023, 18:18:15) [MSC v.1916 64 bit (AMD64)]
Chi-squared statistic: 33.52019002375297
Degrees of freedom: 1
Proportions for caller / receiver: 8.416666666666666 / 5.616666666666666
Reject the null hypothesis.
```

7. **Q3**.

Part 1.

```python
def students_t_gender():
    male_mean = sum(durations_male) / len(durations_male)
    female_mean = sum(durations_female) / len(durations_female)

    #Calculate the variance of a list
    var_male = sum((x - male_mean) ** 2 for x in durations_male) / (len(durations_male) - 1)
    var_female = sum((x - female_mean) ** 2 for x in durations_female) / (len(durations_female) - 1)

    #Define number of elements in each list
    n_male = len(durations_male)
    n_female = len(durations_female)

    # Calculate the degrees of freedom
    df = n_male + n_female - 2

    #Process of calculating the t-statistic
    sp_squared = (((n_male - 1) * var_male + (n_female - 1) * var_female) / df)

    sum_of_sqrt = ((sp_squared / n_male) + (sp_squared / n_female)) ** 0.5

    t = abs((male_mean - female_mean) / sum_of_sqrt)

    #Find the critical t-value for a two-tailed test with significance level (alpha) = 0.05
    critical_t_value = 1.647   # For alpha = 0.05 and degrees of freedom = 840
    print(t)
    print(f"Degrees of freedom: {df}")
    # Compare the t-statistic to the critical value
```

Part 2.

```
print(f"Degrees of freedom: {df}")
# Compare the t-statistic to the critical value

print(f"Average of laugher length for male/female subjects: {male_mean} / {female_mean}")
print(f"Variance of laughter length for male/female subjects: {var_male} / {var_female}")

# Make a decision
if t > critical_t_value:
    print(
        "Reject the null hypothesis.")
else:
    print(
        "Fail to reject the null hypothesis.")
```

8. **Q3** test performed.

```
Python 3.10.9 | packaged by Anaconda, Inc. | (main, Mar  1 2023, 18:18:15) [MSC v.1916 64 bit (AMD64)]
3.460357864388052
Degrees of freedom: 840
Average of laugher length for male/female subjects: 0.6062312138728323 / 0.7096854838709694
Variance of laughter length for male/female subjects: 0.16375125653011646 / 0.19502413118279563
Reject the null hypothesis.
```

9. **Q4.**

Part 1.

```
def students_t_role():

    caller_mean = sum(durations_caller) / len(durations_caller)
    receiver_mean = sum(durations_receiver) / len(durations_receiver)

    # Calculate the variance of a list
    var_caller = sum((x - caller_mean) ** 2 for x in durations_caller) / (len(durations_caller) - 1)
    var_receiver = sum((x - receiver_mean) ** 2 for x in durations_receiver) / (len(durations_receiver) - 1)

    # Define number of elements in each list
    n1 = len(durations_caller)
    n2 = len(durations_receiver)

    # Calculate the degrees of freedom
    df = n1 + n2 - 2

    # Process of calculating the t-statistic
    sp_squared = (((n1 - 1) * var_caller + (n2 - 1) * var_receiver) / df)

    sum_of_sqrt = ((sp_squared / n1) + (sp_squared / n2)) ** 0.5

    t = abs((caller_mean - receiver_mean) / sum_of_sqrt)

    # Find the critical t-value for a two-tailed test with significance level (alpha) = 0.05
    critical_t_value = 1.647  # For alpha = 0.05 and degrees of freedom = 840
```

Part 2.

```
    print(t)
    print(f"Degrees of freedom: {df}")
    # Compare the t-statistic to the critical value
    print(f"Average of laughter length for caller/receiver subjects: {caller_mean} / {receiver_mean}")
    print(f"Variance of laughter length for caller/receiver subjects: {var_caller} / {var_receiver}")

    # Make a decision
    if t > critical_t_value:
        print(
            "Reject the null hypothesis.")
    else:
        print(
            "Fail to reject the null hypothesis.")
```

10. **Q4** test performed.

```
Python 3.10.9 | packaged by Anaconda, Inc. | (main, Mar  1 2023, 18:18:15) [MSC v.1916 64 bit (AMD64)]
6.663974870111473
Degrees of freedom: 840
Average of laughter length for caller/receiver subjects: 0.7457663366336641 / 0.5494005934718107
Variance of laughter length for caller/receiver subjects: 0.2126547944994499 / 0.11976459202345631
Reject the null hypothesis.
```