



## DEMOGRAPHICS AND EMPLOYMENT IN THE UNITED STATES

In the wake of the Great Recession of 2009, there has been a good deal of focus on employment statistics, one of the most important metrics policymakers use to gauge the overall strength of the economy. In the United States, the government measures unemployment using the Current Population Survey (CPS), which collects demographic and employment information from a wide range of Americans each month. In this exercise, we will employ the topics reviewed in the lectures as well as a few new techniques using the September 2013 version of this rich, nationally representative dataset (available [online](#)).

The observations in the dataset represent people surveyed in the September 2013 CPS who actually completed a survey. While the full dataset has 385 variables, in this exercise we will use a more compact version of the dataset, [CPSData.csv](#), which has the following variables:

**PeopleInHousehold:** The number of people in the interviewee's household.

**Region:** The census region where the interviewee lives.

**State:** The state where the interviewee lives.

**MetroAreaCode:** A code that identifies the metropolitan area in which the interviewee lives (missing if the interviewee does not live in a metropolitan area). The mapping from codes to names of metropolitan areas is provided in the file [MetroAreaCodes.csv](#).

**Age:** The age, in years, of the interviewee. 80 represents people aged 80-84, and 85 represents people aged 85 and higher.

**Married:** The marriage status of the interviewee.

**Sex:** The sex of the interviewee.

**Education:** The maximum level of education obtained by the interviewee.

**Race:** The race of the interviewee.

**Hispanic:** Whether the interviewee is of Hispanic ethnicity.

**CountryOfBirthCode:** A code identifying the country of birth of the interviewee. The mapping from codes to names of countries is provided in the file [CountryCodes.csv](#).

**Citizenship:** The United States citizenship status of the interviewee.

**EmploymentStatus:** The status of employment of the interviewee.

**Industry:** The industry of employment of the interviewee (only available if they are employed).

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### PROBLEM 1.1 - LOADING AND SUMMARIZING THE DATASET (1/1 point)

Load the dataset from [CPSData.csv](#) into a data frame called CPS, and view the dataset with the `summary()` and `str()` commands.

**EXPLANATION**

You can load the data with:

```
CPS = read.csv("CPSData.csv")
```

How many interviewees are in the dataset?

**Answer:** 131302

**EXPLANATION**

From `str(CPS)`, we can read that there are 131302 interviewees.

Hide Answer

*You have used 1 of 3 submissions*

**PROBLEM 1.2 - LOADING AND SUMMARIZING THE DATASET** (1/1 point)

Among the interviewees with a value reported for the Industry variable, what is the most common industry of employment? Please enter the name exactly how you see it.

**Answer:** Educational and health services

**EXPLANATION**

The output of `summary(CPS)` orders the levels of a factor variable like Industry from largest to smallest, so we can see that "Educational and health services" is the most common Industry. `table(CPS$Industry)` would have provided the breakdown across all industries.

Hide Answer

*You have used 1 of 2 submissions*

**PROBLEM 1.3 - LOADING AND SUMMARIZING THE DATASET** (2/2 points)

Recall from the homework assignment "The Analytical Detective" that you can call the `sort()` function on the output of the `table()` function to obtain a sorted breakdown of a variable. For instance, `sort(table(CPS$Region))` sorts the regions by the number of interviewees from that region.

Which state has the fewest interviewees?

**Answer:** New Mexico

Which state has the largest number of interviewees?

**Answer:** California

**EXPLANATION**

These can be read from `sort(table(CPS$State))`

[Hide Answer](#)

You have used 1 of 3 submissions

**PROBLEM 1.4 - LOADING AND SUMMARIZING THE DATASET** (1/1 point)

What proportion of interviewees are citizens of the United States?

**Answer:** 0.942

**EXPLANATION**

From `table(CPS$Citizenship)`, we see that 123,712 of the 131,302 interviewees are citizens of the United States (either native or naturalized). This is a proportion of  $123712/131302=0.942$ .

[Hide Answer](#)

You have used 1 of 3 submissions

**PROBLEM 1.5 - LOADING AND SUMMARIZING THE DATASET** (1/1 point)

The CPS differentiates between race (with possible values American Indian, Asian, Black, Pacific Islander, White, or Multiracial) and ethnicity. A number of interviewees are of Hispanic ethnicity, as captured by the Hispanic variable. For which races are there at least 250 interviewees in the CPS dataset of Hispanic ethnicity? (Select all that apply.)

- ☒ American Indian ✓
- ☐ Asian
- ☒ Black ✓
- ☒ Multiracial ✓
- ☐ Pacific Islander
- ☒ White ✓

**EXPLANATION**

The breakdown of race and Hispanic ethnicity can be obtained with `table(CPS$Race, CPS$Hispanic)`.

[Hide Answer](#)

You have used 1 of 2 submissions

**PROBLEM 2.1 - EVALUATING MISSING VALUES** (1/1 point)

Which variables have at least one interviewee with a missing (NA) value? (Select all that apply.)

- ☐ PeopleInHousehold
- ☐ Region
- ☐ State

- ☒ MetroAreaCode ✓
- ☐ Age
- ☒ Married ✓
- ☐ Sex
- ☒ Education ✓
- ☐ Race
- ☐ Hispanic
- ☐ CountryOfBirthCode
- ☐ Citizenship
- ☒ EmploymentStatus ✓
- ☒ Industry ✓

**EXPLANATION**

This can be read from the output of `summary(CPS)`.

[Hide Answer](#)

You have used 1 of 2 submissions

**PROBLEM 2.2 - EVALUATING MISSING VALUES** (1 point possible)

Often when evaluating a new dataset, we try to identify if there is a pattern in the missing values in the dataset. We will try to determine if there is a pattern in the missing values of the Married variable. The function `is.na(CPS$Married)` returns a vector of TRUE/FALSE values for whether the Married variable is missing. We can see the breakdown of whether Married is missing based on the reported value of the Region variable with the function `table(CPS$Region, is.na(CPS$Married))`. Which is the most accurate:

- ☐ The Married variable being missing is related to the Region value for the interviewee.
- ☐ The Married variable being missing is related to the Sex value for the interviewee.
- ☒ The Married variable being missing is related to the Age value for the interviewee. ✓
- ☐ The Married variable being missing is related to the Citizenship value for the interviewee.
- ☐ The Married variable being missing is not related to the Region, Sex, Age, or Citizenship value for the interviewee. ✗

**EXPLANATION**

We can test the relationship between these four variable values and whether the Married variable is missing with the following commands:

```
table(CPS$Region, is.na(CPS$Married))
```

```
table(CPS$Sex, is.na(CPS$Married))
```

```
table(CPS$Age, is.na(CPS$Married))
```

```
table(CPS$Citizenship, is.na(CPS$Married))
```

For each possible value of Region, Sex, and Citizenship, there are both interviewees with missing and non-missing Married values. However, Married is missing for all interviewees Aged 0-14 and is present for all interviewees aged 15 and older. This is because the CPS does not ask about marriage status for interviewees 14 and younger.

[Hide Answer](#)*You have used 2 of 2 submissions*

### PROBLEM 2.3 - EVALUATING MISSING VALUES (2/2 points)

As mentioned in the variable descriptions, MetroAreaCode is missing if an interviewee does not live in a metropolitan area. Using the same technique as in the previous question, answer the following questions about people who live in non-metropolitan areas.

How many states had all interviewees living in a non-metropolitan area (aka they have a missing MetroAreaCode value)? For this question, treat the District of Columbia as a state (even though it is not technically a state).

**Answer: 2**

How many states had all interviewees living in a metropolitan area? Again, treat the District of Columbia as a state.

**Answer: 3**

#### EXPLANATION

The breakdown of missing MetroAreaCode by State can be obtained with `table(CPS$State, is.na(CPS$MetroAreaCode))`. Alaska and Wyoming have no interviewees living in a metropolitan area, and the District of Columbia, New Jersey, and Rhode Island have all interviewees living in a metro area.

[Hide Answer](#)*You have used 2 of 3 submissions*

### PROBLEM 2.4 - EVALUATING MISSING VALUES (1 point possible)

Which region of the United States has the largest proportion of interviewees living in a non-metropolitan area?

- ☐ Midwest 
- ☒ Northeast 
- ☐ South
- ☐ West

#### EXPLANATION

To evaluate the number of interviewees not living in a metropolitan area, broken down by region, we can run `table(CPS$Region, is.na(CPS$MetroAreaCode))`. We can then compute the proportion of interviewees in each region that live in a non-metropolitan area: 34.8% in the Midwest, 21.6% in the Northeast, 23.8% in the South, and 24.4% in the West.

[Hide Answer](#)*You have used 1 of 1 submissions*

**PROBLEM 2.5 - EVALUATING MISSING VALUES** (4 points possible)

While we were able to use the `table()` command to compute the proportion of interviewees from each region not living in a metropolitan area, it was somewhat tedious (it involved manually computing the proportion for each region) and isn't something you would want to do if there were a larger number of options. It turns out there is a less tedious way to compute the proportion of values that are TRUE. The `mean()` function, which takes the average of the values passed to it, will treat TRUE as 1 and FALSE as 0, meaning it returns the proportion of values that are true. For instance, `mean(c(TRUE, FALSE, TRUE, TRUE))` returns 0.75. Knowing this, use `tapply()` with the `mean` function to answer the following questions:

Which state has a proportion of interviewees living in a non-metropolitan area closest to 30%?

**Answer:** Wisconsin

Which state has the largest proportion of non-metropolitan interviewees, ignoring states where all interviewees were non-metropolitan?

**Answer:** Montana**EXPLANATION**

The correct way to invoke `tapply` to answer these questions is:

```
tapply(is.na(CPS$MetroAreaCode), CPS$State, mean)
```

It is actually easier to answer this question if the proportions are sorted, which can be accomplished with:

```
sort(tapply(is.na(CPS$MetroAreaCode), CPS$State, mean))
```

From this output, we can see that Wisconsin is the state closest to having 30% of its interviewees from a non-metropolitan area (it has 29.933% non-metropolitan interviewees) and Montana is the state with highest proportion of non-metropolitan interviewees without them all being non-metropolitan, at 83.608%.

Answering each of these questions would have been tedious using the `table()` output.

[Hide Answer](#)*You have used 4 of 4 submissions***PROBLEM 3.1 - INTEGRATING METROPOLITAN AREA DATA** (2/2 points)

Codes like `MetroAreaCode` and `CountryOfBirthCode` are a compact way to encode factor variables with text as their possible values, and they are therefore quite common in survey datasets. In fact, all but one of the variables in this dataset were actually stored by a numeric code in the original CPS datafile.

When analyzing a variable stored by a numeric code, we will often want to convert it into the values the codes represent. To do this, we will use a dictionary, which maps the the code to the actual value of the variable. We have provided dictionaries [MetroAreaCodes.csv](#) and [CountryCodes.csv](#), which respectively map `MetroAreaCode` and `CountryOfBirthCode` into their true values. Read these two dictionaries into data frames `MetroAreaMap` and `CountryMap`.

How many observations (codes for metropolitan areas) are there in `MetroAreaMap`?

**Answer:** 271

**EXPLANATION**

This can be read from `str(MetroAreaMap)` or `nrow(MetroAreaMap)`.

How many observations (codes for countries) are there in `CountryMap`?

**Answer:** 149**EXPLANATION**

This can be read from `str(CountryMap)` or `nrow(CountryMap)`.

[Hide Answer](#)

*You have used 1 of 3 submissions*

**PROBLEM 3.2 - INTEGRATING METROPOLITAN AREA DATA** (2/2 points)

To merge in the metropolitan areas, we want to connect the field `MetroAreaCode` from the CPS data frame with the field `Code` in `MetroAreaMap`. The following command merges the two data frames on these columns, overwriting the CPS data frame with the result:

```
CPS = merge(CPS, MetroAreaMap, by.x="MetroAreaCode", by.y="Code", all.x=TRUE)
```

The first two arguments determine the data frames to be merged (they are called "x" and "y", respectively, in the subsequent parameters to the merge function). `by.x="MetroAreaCode"` means we're matching on the `MetroAreaCode` variable from the "x" data frame (CPS), while `by.y="Code"` means we're matching on the `Code` variable from the "y" data frame (`MetroAreaMap`). Finally, `all.x=TRUE` means we want to keep all rows from the "x" data frame (CPS), even if some of the rows' `MetroAreaCode` doesn't match any codes in `MetroAreaMap` (for those familiar with database terminology, this parameter makes the operation a left outer join instead of an inner join).

Review the new version of the CPS data frame with the `summary()` and `str()` functions. What is the name of the variable that was added to the data frame by the `merge()` operation?

**Answer:** MetroArea

How many interviewees have a missing value for the new metropolitan area variable? Note that all of these interviewees would have been removed from the merged data frame if we did not include the `all.x=TRUE` parameter.

**Answer:** 34238**EXPLANATION**



From `summary(CPS)`, we see that the variable `MetroArea` was added to the CPS data frame, and that it is missing 34238 values.

[Hide Answer](#)

*You have used 1 of 3 submissions*

**PROBLEM 3.3 - INTEGRATING METROPOLITAN AREA DATA** (1 point possible)

Which of the following metropolitan areas has the largest number of interviewees?

- ☐ Atlanta-Sandy Springs-Marietta, GA
- ☐ Baltimore-Towson, MD
- ☒ Boston-Cambridge-Quincy, MA-NH 
- ☐ San Francisco-Oakland-Fremont, CA 

**EXPLANATION**

From table(CPS\$MetroArea), we can read that Boston-Cambridge-Quincy, MA-NH has the largest number of interviewees of these options, with 2229.

[Hide Answer](#)*You have used 1 of 1 submissions***PROBLEM 3.4 - INTEGRATING METROPOLITAN AREA DATA** (2/2 points)

Which metropolitan area has the highest proportion of interviewees of Hispanic ethnicity? Hint: Use `tapply()` with `mean`, as in the previous subproblem. Calling `sort()` on the output of `tapply()` could also be helpful here.

**Answer:** Laredo, TX**EXPLANATION**

The correct application of `tapply` here is

```
tapply(CPS$Hispanic, CPS$MetroArea, mean)
```

It will be easiest to obtain the maximum by actually using the sorted output:

```
sort(tapply(CPS$Hispanic, CPS$MetroArea, mean))
```

As we can see, 96.6% of the interviewees from Laredo, TX, are of Hispanic ethnicity, the highest proportion among metropolitan areas in the United States.

[Hide Answer](#)*You have used 1 of 5 submissions***PROBLEM 3.5 - INTEGRATING METROPOLITAN AREA DATA** (2/2 points)

Remembering that `CPS$Race == "Asian"` returns a TRUE/FALSE vector of whether an interviewee is Asian, determine the number of metropolitan areas in the United States from which at least 20% of interviewees are Asian.

**Answer:** 4**EXPLANATION**

As in the previous problem, we want the following command:

```
sort(tapply(CPS$Race == "Asian", CPS$MetroArea, mean))
```



We can read from the sorted output that Honolulu, HI; San Francisco-Oakland-Fremont, CA; San Jose-Sunnyvale-Santa Clara, CA; and Vallejo-Fairfield, CA had at least 20% of their interviewees of the Asian race.

[Hide Answer](#)

You have used 1 of 5 submissions

### PROBLEM 3.6 - INTEGRATING METROPOLITAN AREA DATA (1/1 point)

Normally, we would look at the sorted proportion of interviewees from each metropolitan area who have not received a high school diploma with the command:

```
sort(tapply(CPS$Education == "No high school diploma", CPS$MetroArea, mean))
```

However, none of the interviewees aged 14 and younger have an education value reported, so the mean value is reported as NA for each metropolitan area. To get mean (and related functions, like sum) to ignore missing values, you can pass the parameter na.rm=TRUE. Passing na.rm=TRUE to the tapply function, determine which metropolitan area has the smallest proportion of interviewees who have received no high school diploma.

**Answer:** Iowa City, IA

#### EXPLANATION

To obtain the sorted list of proportions by metropolitan area, we run:

```
sort(tapply(CPS$Education == "No high school diploma", CPS$MetroArea, mean, na.rm=TRUE))
```

We can see that Iowa City, IA had 2.9% of interviewees not finish high school, the smallest value of any metropolitan area.


[Hide Answer](#)

You have used 1 of 3 submissions

### PROBLEM 4.1 - INTEGRATING COUNTRY OF BIRTH DATA (2/2 points)

Just as we did with the metropolitan area information, merge in the country of birth information from the CountryMap data frame, replacing the CPS data frame with the result. If you accidentally overwrite CPS with the wrong values, remember that you can restore it by re-loading the data frame from CPSData.csv and then merging in the metropolitan area information using the command provided in the previous subproblem.

What is the name of the variable added to the CPS data frame by this merge operation?

**Answer:** Country

How many interviewees have a missing value for the new country of birth variable?

**Answer:** 176

#### EXPLANATION

The merge operation in this case is

```
CPS = merge(CPS, CountryMap, by.x="CountryOfBirthCode", by.y="Code", all.x=TRUE)
```

From summary(CPS), we can read that Country is the name of the added variable, and that it has 176 missing values.

[Hide Answer](#)

You have used 1 of 3 submissions

#### PROBLEM 4.2 - INTEGRATING COUNTRY OF BIRTH DATA (2/2 points)

Among all interviewees born outside of North America, which country was the most common place of birth?

**Answer:** Philippines

##### EXPLANATION

From the summary(CPS) output, or alternately sort(table(CPS\$Country)), we see that the top two countries of birth were United States and Mexico, both of which are in North America. The third highest value, 839, was for the Philippines.

[Hide Answer](#)

You have used 2 of 5 submissions

#### PROBLEM 4.3 - INTEGRATING COUNTRY OF BIRTH DATA (2/2 points)

What proportion of the interviewees from the "New York-Northern New Jersey-Long Island, NY-NJ-PA" metropolitan area have a country of birth that is not the United States? For this computation, don't include people from this metropolitan area who have a missing country of birth.

**Answer:** 0.309

##### EXPLANATION


From table(CPS\$MetroArea == "New York-Northern New Jersey-Long Island, NY-NJ-PA", CPS\$Country != "United States"), we can see that 1668 of interviewees from this metropolitan area were born outside the United States and 3736 were born in the United States (it turns out an additional 5 have a missing country of origin). Therefore, the proportion is  $1668/(1668+3736)=0.309$ .

[Hide Answer](#)

You have used 2 of 5 submissions

#### PROBLEM 4.4 - INTEGRATING COUNTRY OF BIRTH DATA (2/3 points)

Which metropolitan area has the largest number (note -- not proportion) of interviewees with a country of birth in India? Hint -- remember to include na.rm=TRUE if you are using tapply() to answer this question.

- ☐ Boston-Cambridge-Quincy, MA-NH
- ☐ Minneapolis-St Paul-Bloomington, MN-WI
- ☒ New York-Northern New Jersey-Long Island, NY-NJ-PA 
- ☐ Washington-Arlington-Alexandria, DC-VA-MD-WV

In Brazil?

- ☒ Boston-Cambridge-Quincy, MA-NH ✓
- ☐ Minneapolis-St Paul-Bloomington, MN-WI
- ☐ New York-Northern New Jersey-Long Island, NY-NJ-PA
- ☐ Washington-Arlington-Alexandria, DC-VA-MD-WV

In Somalia?

- ☐ Boston-Cambridge-Quincy, MA-NH
- ☒ Minneapolis-St Paul-Bloomington, MN-WI ✓
- ☐ New York-Northern New Jersey-Long Island, NY-NJ-PA
- ☐ Washington-Arlington-Alexandria, DC-VA-MD-WV

#### EXPLANATION

To obtain the number of TRUE values in a vector of TRUE/FALSE values, you can use the `sum()` function. For instance, `sum(c(TRUE, FALSE, TRUE, TRUE))` is 3. Therefore, we can obtain counts of people born in a particular country living in a particular metropolitan area with:

```
sort(tapply(CPS$Country == "India", CPS$MetroArea, sum, na.rm=TRUE))
```

```
sort(tapply(CPS$Country == "Brazil", CPS$MetroArea, sum, na.rm=TRUE))
```

```
sort(tapply(CPS$Country == "Somalia", CPS$MetroArea, sum, na.rm=TRUE))
```

We see that New York has the most interviewees born in India (96), Boston has the most born in Brazil (18), and Minneapolis has the most born in Somalia (17).

Hide Answer

*You have used 1 of 1 submissions*

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