CSC 320 - Fall 2020
Instructor: Dr. Tu

MIPS Assembly Programming Project #2

(200 points)

Requirements:

- Name your source program **project2**.
- Email your code (text only) to tuh@easternct.edu . The subject of your email must be "MIPS Project #2".
- For each project, make sure the project #, your name, course, date, and description are displayed at the beginning of your program as shown below:

  # Programmer: your name
  # Project #2
  # Course: CSC320, fall 2020
  # Description: This program uses the Recursive Euclidean Algorithm to calculate GCD

- Make sure you use **comments** to describe what actions you are taking in your code. Points will be deducted on programs that are not well commented.

Problem Statement:

Write a MIPS assembly program that prompts the user for 2 positive integers (>0). Then it uses the Recursive Euclidean Algorithm to calculate GCD (the Greatest Common Divisor). Please see next 2 pages for the **Recursive Euclidean Algorithm in Java and C++.**

Sample Execution 1:

** Recursive Euclidean Algorithm to calculate GCD **
Type a positive integer for A: 35
Type a positive integer for B: 63
The GCD is 7

Sample Execution 2:

** Recursive Euclidean Algorithm to calculate GCD **
Type a positive integer for A: -2
Sorry, you must enter a positive integer (>0). Please try again.

Grading Rubric:

- If your program produces a correct answer without using function calls, the best grade you will receive is a "C".
- If your program produces a correct answer and uses function calls (but not **recursive** function calls), the best grade you will receive is a "B".
- To receive an "A", your program must produce a correct answer, uses **RECURSIVE** function calls, and is well commented.

```java
// Java: Euclidean Algorithm to calculate GCD
//

import java.util.Scanner;

public class FindGCD {

   public static void main(String[] args) {

       Scanner input = new Scanner(System.in);
       System.out.println("The Euclidean Algorithm to calculate GCD.\n");
       System.out.println("Enter a positive integer A: ");
       int A = input.nextInt();
       System.out.println("Enter a positive integer B: ");
       int B = input.nextInt();

       if (A < 1 || B < 1)
          System.out.println("\nError, please enter a positive (>0) integer.");
       else
       {
          if (A < B)
          {
              int temp = A;
              A = B;
              B = temp;
          }
          System.out.println("The GCD is :" + GCD(A, B));
       }
   }

   public static int GCD(int A, int B)
   {
       if (B == 0)
              return A;
       else
              return GCD(B, A % B);
   }

}
```

```cpp
// C++: Euclidean Algorithm to calculate GCD
//
#include <iostream>
using namespace std;


int GCD(int A, int B)
{
	if (B == 0)
		return A;
	else
		return GCD(B, A%B);
}


int main()
{
	int A, B;

	cout << "The Euclidean Algorithm to calculate GCD.\n";
	cout << "Enter a positive integer A: ";
	cin >> A;
	cout << "Enter a positive integer B: ";
	cin >> B;

	if (A < 1 || B < 1)
		cout << "\nError, please enter a positive (>0) integer.\n”;
	else
	{
		if (A < B)
		{
			int temp = A;
			A = B;
			B = temp;
		}
		cout << "The GCD is :" << GCD(A, B) << endl;
	}

	return 0;
}
```

CSC 450, Senior Research
Literature Review

1. Write a **literature review** (roughly two double-spaced pages, not including references) that contains background information about a computer science topic, discusses related work, and would support the research project you are pursuing. Your review should be written appropriately for a reader who has an undergraduate degree in computer science. **The literature review must have <u>at least 10 references, and at least 6 references must be *research* articles</u>**. *You must submit an export of your Zotero library with your literature review.* The literature review will serve as a basis for your proposal, will provide introductory material and discussion points for your final paper, and may also generate ideas regarding your project's methodology. However, the literature review does <u>not</u> describe your specific project, but instead describes background and work that has been done in related areas. Note that *related* work includes work related to any aspect of your project, whether it relates to the general topic, the specific question, or related methodologies.

You must submit this assignment through Blackboard by the due date to receive credit. The assignment will be submitted through SafeAssign. The assignment may be submitted once before the due date so that you can look at the SafeAssign Report, and make changes as necessary (you may need to ask me to clear your submission if this is the case). Work that is plagiarized will not be accepted. Late submissions will not be accepted. The literature review will be evaluated using the rubric on the following page:

Background information — 30 points

- Background is presented in a clear and organized manner
- Background is sufficient to understand the general topic, and describes key terms and concepts

Significance (importance) — 30 points

- Significance is presented in a clear and organized manner
- Significance includes why the research topic is important for its field and society as a whole
    - How does society benefit from studying this topic?

Related Work — 40 points

- Related work is presented in a clear, organized, and critical manner
- The methodology, major findings, significances, weaknesses, and limitations of related work are discussed.
- Related work includes articles with similar research questions, objectives, methods, or datasets.

Additional Requirements

- ***Title:*** The paper has a descriptive and specific title. For example, "Machine Learning" is too broad a topic, but "Machine Learning Methods" or "Machine Learning Applications" would be acceptable. [***5 point deduction if not met***]
- The paper does *not* describe your specific project (and therefore does not contain "I" or "we") ***[10 point deduction if not met]***
- ***References:*** The paper contains at least 10 references that are cited in the manuscript and included in the *References* section using IEEE format. References need to be cited in the body of the lit review, and not just appear at the end. You must use Zotero to manage your references, and submit your exported Zotero library with your Literature Review. [***paper is not acceptable if it does not contain any citations or any references; up to 10 point deduction of Zotero library is not submitted***]
- ***Format:*** The paper is approximately 2 pages (excluding references) and double-spaced with 1" margins. All paragraphs except for the first are indented. Arial (font size 11) or Times New Roman (font size 12) are used throughout. The paper includes a title in bold, followed by your name. The title may be one font size larger. At the end of the paper is a *References* section. The word *References* is bold, and the font size for the references section is 1 size less than the rest of the paper. [***up to 10 point deduction if not met***]
- ***Spelling and Grammar:*** The paper is well-written and contains few, if any spelling mistakes or grammatical mistakes that detract from the reader's ability to understand the paper [***up to 20 point deduction if not met***]

Editorial Expression of Concern and Correction

PSYCHOLOGICAL AND COGNITIVE SCIENCES

PNAS is publishing an Editorial Expression of Concern regarding the following article: "Experimental evidence of massive-scale emotional contagion through social networks," by Adam D. I. Kramer, Jamie E. Guillory, and Jeffrey T. Hancock, which appeared in issue 24, June 17, 2014, of *Proc Natl Acad Sci USA* (111:8788–8790; first published June 2, 2014; 10.1073/pnas.1320040111). This paper represents an important and emerging area of social science research that needs to be approached with sensitivity and with vigilance regarding personal privacy issues.

Questions have been raised about the principles of informed consent and opportunity to opt out in connection with the research in this paper. The authors noted in their paper, "[The work] was consistent with Facebook's Data Use Policy, to which all users agree prior to creating an account on Facebook, constituting informed consent for this research." When the authors prepared their paper for publication in PNAS, they stated that: "Because this experiment was conducted by Facebook, Inc. for internal purposes, the Cornell University IRB [Institutional Review Board] determined that the project did not fall under Cornell's Human Research Protection Program." This statement has since been confirmed by Cornell University.

Obtaining informed consent and allowing participants to opt out are best practices in most instances under the US Department of Health and Human Services Policy for the Protection of Human Research Subjects (the "Common Rule"). Adherence to the Common Rule is PNAS policy, but as a private company Facebook was under no obligation to conform to the provisions of the Common Rule when it collected the data used by the authors, and the Common Rule does not preclude their use of the data. Based on the information provided by the authors, PNAS editors deemed it appropriate to publish the paper. It is nevertheless a matter of concern that the collection of the data by Facebook may have involved practices that were not fully consistent with the principles of obtaining informed consent and allowing participants to opt out.

Inder M. Verma
Editor-in-Chief

www.pnas.org/cgi/doi/10.1073/pnas.1412469111

PSYCHOLOGICAL AND COGNITIVE SCIENCES

Correction for "Experimental evidence of massive-scale emotional contagion through social networks," by Adam D. I. Kramer, Jamie E. Guillory, and Jeffrey T. Hancock, which appeared in issue 24, June 17, 2014, of *Proc Natl Acad Sci USA* (111:8788–8790; first published June 2, 2014; 10.1073/pnas.1320040111).

The authors note that, "At the time of the study, the middle author, Jamie E. Guillory, was a graduate student at Cornell University under the tutelage of senior author Jeffrey T. Hancock, also of Cornell University (Guillory is now a postdoctoral fellow at Center for Tobacco Control Research and Education, University of California, San Francisco, CA 94143)." The author and affiliation lines have been updated to reflect the above changes and a present address footnote has been added. The online version has been corrected.

The corrected author and affiliation lines appear below.

Adam D. I. Kramer[a,1], Jamie E. Guillory[b,2], and Jeffrey T. Hancock[b,c]

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www.pnas.org/cgi/doi/10.1073/pnas.1412583111

CORRECTION

Experimental evidence of massive-scale emotional contagion through social networks

Adam D. I. Kramer[a,1], Jamie E. Guillory[b,2], and Jeffrey T. Hancock[b,c]

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Edited by Susan T. Fiske, Princeton University, Princeton, NJ, and approved March 25, 2014 (received for review October 23, 2013)

Emotional states can be transferred to others via emotional contagion, leading people to experience the same emotions without their awareness. Emotional contagion is well established in laboratory experiments, with people transferring positive and negative emotions to others. Data from a large real-world social network, collected over a 20-y period suggests that longer-lasting moods (e.g., depression, happiness) can be transferred through networks [Fowler JH, Christakis NA (2008) *BMJ* 337:a2338], although the results are controversial. In an experiment with people who use Facebook, we test whether emotional contagion occurs outside of in-person interaction between individuals by reducing the amount of emotional content in the News Feed. When positive expressions were reduced, people produced fewer positive posts and more negative posts; when negative expressions were reduced, the opposite pattern occurred. These results indicate that emotions expressed by others on Facebook influence our own emotions, constituting experimental evidence for massive-scale contagion via social networks. This work also suggests that, in contrast to prevailing assumptions, in-person interaction and nonverbal cues are not strictly necessary for emotional contagion, and that the observation of others' positive experiences constitutes a positive experience for people.

computer-mediated communication | social media | big data

Emotional states can be transferred to others via emotional contagion, leading them to experience the same emotions as those around them. Emotional contagion is well established in laboratory experiments (1), in which people transfer positive and negative moods and emotions to others. Similarly, data from a large, real-world social network collected over a 20-y period suggests that longer-lasting moods (e.g., depression, happiness) can be transferred through networks as well (2, 3).

The interpretation of this network effect as contagion of mood has come under scrutiny due to the study's correlational nature, including concerns over misspecification of contextual variables or failure to account for shared experiences (4, 5), raising important questions regarding contagion processes in networks. An experimental approach can address this scrutiny directly; however, methods used in controlled experiments have been criticized for examining emotions after social interactions. Interacting with a happy person is pleasant (and an unhappy person, unpleasant). As such, contagion may result from experiencing an interaction rather than exposure to a partner's emotion. Prior studies have also failed to address whether nonverbal cues are necessary for contagion to occur, or if verbal cues alone suffice. Evidence that positive and negative moods are correlated in networks (2, 3) suggests that this is possible, but the causal question of whether contagion processes occur for emotions in massive social networks remains elusive in the absence of experimental evidence. Further, others have suggested that in online social networks, exposure to the happiness of others may actually be depressing to us, producing an "alone together" social comparison effect (6).

Three studies have laid the groundwork for testing these processes via Facebook, the largest online social network. This research demonstrated that (*i*) emotional contagion occurs via text-based computer-mediated communication (7); (*ii*) contagion of psychological and physiological qualities has been suggested based on correlational data for social networks generally (7, 8); and (*iii*) people's emotional expressions on Facebook predict friends' emotional expressions, even days later (7) (although some shared experiences may in fact last several days). To date, however, there is no experimental evidence that emotions or moods are contagious in the absence of direct interaction between experiencer and target.

On Facebook, people frequently express emotions, which are later seen by their friends via Facebook's "News Feed" product (8). Because people's friends frequently produce much more content than one person can view, the News Feed filters posts, stories, and activities undertaken by friends. News Feed is the primary manner by which people see content that friends share. Which content is shown or omitted in the News Feed is determined via a ranking algorithm that Facebook continually develops and tests in the interest of showing viewers the content they will find most relevant and engaging. One such test is reported in this study: A test of whether posts with emotional content are more engaging.

The experiment manipulated the extent to which people (N = 689,003) were exposed to emotional expressions in their News Feed. This tested whether exposure to emotions led people to change their own posting behaviors, in particular whether exposure to emotional content led people to post content that was consistent with the exposure—thereby testing whether exposure to verbal affective expressions leads to similar verbal expressions, a form of emotional contagion. People who viewed Facebook in English were qualified for selection into the experiment. Two parallel experiments were conducted for positive and negative emotion: One in which exposure to friends' positive emotional content in their News Feed was reduced, and one in which exposure to negative emotional content in their News Feed was reduced. In these conditions, when a person loaded their News Feed, posts that contained emotional content of the relevant emotional valence, each emotional post had between a 10% and

Significance

We show, via a massive (N = 689,003) experiment on Facebook, that emotional states can be transferred to others via emotional contagion, leading people to experience the same emotions without their awareness. We provide experimental evidence that emotional contagion occurs without direct interaction between people (exposure to a friend expressing an emotion is sufficient), and in the complete absence of nonverbal cues.

Author contributions: A.D.I.K., J.E.G., and J.T.H. designed research; A.D.I.K. performed research; A.D.I.K. analyzed data; and A.D.I.K., J.E.G., and J.T.H. wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission.

Freely available online through the PNAS open access option.

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90% chance (based on their User ID) of being omitted from their News Feed for that specific viewing. It is important to note that this content was always available by viewing a friend's content directly by going to that friend's "wall" or "timeline," rather than via the News Feed. Further, the omitted content may have appeared on prior or subsequent views of the News Feed. Finally, the experiment did not affect any direct messages sent from one user to another.

Posts were determined to be positive or negative if they contained at least one positive or negative word, as defined by Linguistic Inquiry and Word Count software (LIWC2007) (9) word counting system, which correlates with self-reported and physiological measures of well-being, and has been used in prior research on emotional expression (7, 8, 10). LIWC was adapted to run on the Hadoop Map/Reduce system (11) and in the News Feed filtering system, such that no text was seen by the researchers. As such, it was consistent with Facebook's Data Use Policy, to which all users agree prior to creating an account on Facebook, constituting informed consent for this research. Both experiments had a control condition, in which a similar proportion of posts in their News Feed were omitted entirely at random (i.e., without respect to emotional content). Separate control conditions were necessary as 22.4% of posts contained negative words, whereas 46.8% of posts contained positive words. So for a person for whom 10% of posts containing positive content were omitted, an appropriate control would withhold 10% of 46.8% (i.e., 4.68%) of posts at random, compared with omitting only 2.24% of the News Feed in the negativity-reduced control.

The experiments took place for 1 wk (January 11–18, 2012). Participants were randomly selected based on their User ID, resulting in a total of ∼155,000 participants per condition who posted at least one status update during the experimental period.

For each experiment, two dependent variables were examined pertaining to emotionality expressed in people's own status updates: the percentage of all words produced by a given person that was either positive or negative during the experimental period (as in ref. 7). In total, over 3 million posts were analyzed, containing over 122 million words, 4 million of which were positive (3.6%) and 1.8 million negative (1.6%).

If affective states are contagious via verbal expressions on Facebook (our operationalization of emotional contagion), people in the positivity-reduced condition should be less positive compared with their control, and people in the negativity-reduced condition should be less negative. As a secondary measure, we tested for cross-emotional contagion in which the opposite emotion should be inversely affected: People in the positivity-reduced condition should express increased negativity, whereas people in the negativity-reduced condition should express increased positivity. Emotional expression was modeled, on a per-person basis, as the percentage of words produced by that person during the experimental period that were either positive or negative. Positivity and negativity were evaluated separately given evidence that they are not simply opposite ends of the same spectrum (8, 10). Indeed, negative and positive word use scarcely correlated [$r = -0.04$, $t(620{,}587) = -38.01$, $P < 0.001$].

We examined these data by comparing each emotion condition to its control. After establishing that our experimental groups did not differ in emotional expression during the week before the experiment (all $t < 1.5$; all $P > 0.13$), we examined overall posting rate via a Poisson regression, using the percent of posts omitted as a regression weight. Omitting emotional content reduced the amount of words the person subsequently produced, both when positivity was reduced ($z = -4.78$, $P < 0.001$) and when negativity was reduced ($z = -7.219$, $P < 0.001$). This effect occurred both when negative words were omitted (99.7% as many words were produced) and when positive words were omitted (96.7%). An interaction was also observed, showing that the effect was stronger when positive words were omitted ($z = -77.9$, $P < 0.001$).

As such, direct examination of the frequency of positive and negative words would be inappropriate: It would be confounded with the change in overall words produced. To test our hypothesis regarding emotional contagion, we conducted weighted linear regressions, predicting the percentage of words that were positive or negative from a dummy code for condition (experimental versus control), weighted by the likelihood of that person having an emotional post omitted from their News Feed on a given viewing, such that people who had more content omitted were given higher weight in the regression. When positive posts were reduced in the News Feed, the percentage of positive words in people's status updates decreased by $B = -0.1\%$ compared with control [$t(310{,}044) = -5.63$, $P < 0.001$, Cohen's $d = 0.02$], whereas the percentage of words that were negative increased by $B = 0.04\%$ ($t = 2.71$, $P = 0.007$, $d = 0.001$). Conversely, when negative posts were reduced, the percent of words that were negative decreased by $B = -0.07\%$ [$t(310{,}541) = -5.51$, $P < 0.001$, $d = 0.02$] and the percentage of words that were positive, conversely, increased by $B = 0.06\%$ ($t = 2.19$, $P < 0.003$, $d = 0.008$).

The results show emotional contagion. As Fig. 1 illustrates, for people who had positive content reduced in their News Feed, a larger percentage of words in people's status updates were negative and a smaller percentage were positive. When negativity was reduced, the opposite pattern occurred. These results suggest that the emotions expressed by friends, via online social networks, influence our own moods, constituting, to our knowledge, the first experimental evidence for massive-scale emotional contagion via social networks (3, 7, 8), and providing support for previously contested claims that emotions spread via contagion through a network.

These results highlight several features of emotional contagion. First, because News Feed content is not "directed" toward anyone, contagion could not be just the result of some specific interaction with a happy or sad partner. Although prior research examined whether an emotion can be contracted via a direct interaction (1, 7), we show that simply failing to "overhear" a friend's emotional expression via Facebook is enough to buffer

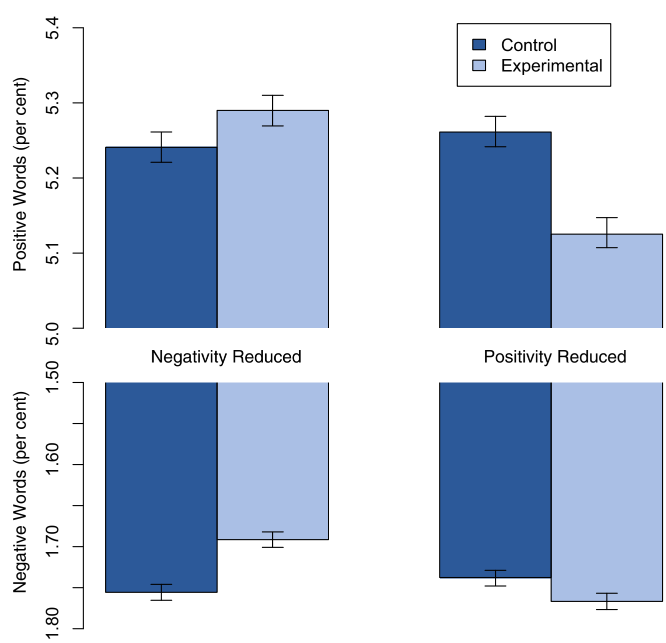

Fig. 1. Mean number of positive (*Upper*) and negative (*Lower*) emotion words (percent) generated people, by condition. Bars represent standard errors.

one from its effects. Second, although nonverbal behavior is well established as one medium for contagion, these data suggest that contagion does not require nonverbal behavior (7, 8): Textual content alone appears to be a sufficient channel. This is not a simple case of mimicry, either; the cross-emotional encouragement effect (e.g., reducing negative posts led to an increase in positive posts) cannot be explained by mimicry alone, although mimicry may well have been part of the emotion-consistent effect. Further, we note the similarity of effect sizes when positivity and negativity were reduced. This absence of negativity bias suggests that our results cannot be attributed solely to the content of the post: If a person is sharing good news or bad news (thus explaining his/her emotional state), friends' response to the news (independent of the sharer's emotional state) should be stronger when bad news is shown rather than good (or as commonly noted, "if it bleeds, it leads;" ref. 12) if the results were being driven by reactions to news. In contrast, a response to a friend's emotion expression (rather than news) should be proportional to exposure. A post hoc test comparing effect sizes (comparing correlation coefficients using Fisher's method) showed no difference despite our large sample size ($z = -0.36$, $P = 0.72$).

We also observed a withdrawal effect: People who were exposed to fewer emotional posts (of either valence) in their News Feed were less expressive overall on the following days, addressing the question about how emotional expression affects social engagement online. This observation, and the fact that people were more emotionally positive in response to positive emotion updates from their friends, stands in contrast to theories that suggest viewing positive posts by friends on Facebook may somehow affect us negatively, for example, via social comparison (6, 13). In fact, this is the result when people are exposed to less positive content, rather than more. This effect also showed no negativity bias in post hoc tests ($z = -0.09$, $P = 0.93$).

Although these data provide, to our knowledge, some of the first experimental evidence to support the controversial claims that emotions can spread throughout a network, the effect sizes from the manipulations are small (as small as $d = 0.001$). These effects nonetheless matter given that the manipulation of the independent variable (presence of emotion in the News Feed) was minimal whereas the dependent variable (people's emotional expressions) is difficult to influence given the range of daily experiences that influence mood (10). More importantly, given the massive scale of social networks such as Facebook, even small effects can have large aggregated consequences (14, 15): For example, the well-documented connection between emotions and physical well-being suggests the importance of these findings for public health. Online messages influence our experience of emotions, which may affect a variety of offline behaviors. And after all, an effect size of $d = 0.001$ at Facebook's scale is not negligible: In early 2013, this would have corresponded to hundreds of thousands of emotion expressions in status updates per day.

ACKNOWLEDGMENTS. We thank the Facebook News Feed team, especially Daniel Schafer, for encouragement and support; the Facebook Core Data Science team, especially Cameron Marlow, Moira Burke, and Eytan Bakshy; plus Michael Macy and Mathew Aldridge for their feedback. Data processing systems, per-user aggregates, and anonymized results available upon request.

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CSC 450, Senior Research
Journal Article Evaluation

Experimental evidence of massive-scale emotional contagion through social networks

Discuss these questions as a group, and select one person to type up your answers. Your answers should be e-mailed to dancikg@easternct.edu with the subject CSC-450: FB article

Directions:

1. Previous studies have shown that individuals who interact with happy individuals are happier than individuals who do not. Why is this not sufficient evidence for social contagion? That is, these studies do *not* show a person will become happier after interacting with happy people. Why not?

2. In this study, Facebook posts were determined to be positive or negative based on Linguistic Inquiry and Word Count software (LIWC2007), with the following reference given in the article:

    > Pennebaker JW, Chung CK, Ireland M, Gonzales A, Booth RJ (2007) The development and psychological properties of LIWC2007. Available at http://liwc.net/howliwcworks.php.

    According to Table 1 of the LIWC web page (currently at http://liwc.wpengine.com/), what are three words that are considered positive? Note: the website has recently been updated and the table is no longer available, but fortunately we can still view it thanks to the WayBack machine: https://web.archive.org/web/20141018044447/http://www.liwc.net/descriptiontable1.php

3. One of the major findings of this article is that "emotions expressed by others on Facebook influence our own emotions, constituting experimental evidence for massive-scale contagion via social networks." An experiment is conducted, and this claim is supported, in part, by the results presented in **Fig. 1**. What does the top half of **Fig. 1** show? Can you think of any reasons why this figure might be misleading?

4. What specific variable was being measured in this study (this is the variable plotted on the y-axis in **Fig. 1**)? Do you think this variable accurately reflects the emotions of a Facebook user? Why or why not?

5. In the abstract, the authors state that "These results indicate that emotions expressed by others on Facebook influence our own emotions". Based on your answers to 2-4, do you believe that the authors provide sufficient evidence to support this claim? Why or why not?

Additional notes: This type of experimentation (known as A/B testing) might be more common than you think. The following article is an excellent read: http://www.wired.com/2012/04/ff_abtesting/

CSC 320 - Fall 2020
Instructor: Dr. Tu

MIPS Assembly Programming Project #1

(100 points)

Requirements:

- Name your source program **project1**.
- Please email your code (text only) to tuh@easternct.edu . The subject of your email must be "MIPS Project #1".
- For each project, make sure the project #, your name, course, date, and description are displayed at the beginning of your program as shown below:

```
# Programmer: your name
# Project #1
# Course: CSC320, fall 2020
# Date: 10/06/2020
# Description: This program converts cents into quarters, dimes,
#              nickels, and pennies.
```

- Make sure you use **comments** to describe what actions you are taking in your code.

Problem Statement:

Write a MIPS assembly program that prompts the user for some number of cents (integer) and read the user input. Then translate that number of into a number of quarters, dimes, nickels and pennies (all integers) equal to that amount and outputs the result. The output should adequately tell the user what is being output (not just the numeric results).

Sample Execution 1:

Enter some number of cents: 118
118 cents is equivalent to 4 quarter(s), 1 dime(s), 1 nickel(s), and 3 penny(s).

Sample Execution 2:

Enter some number of cents: -8
Error! You must enter a positive number. Please try again.

CSC 320 - Fall 2020
Instructor: Dr. Tu

MIPS Assembly Programming Project #1

(100 points)

Requirements:

- Name your source program **project1**.
- Please email your code (text only) to tuh@easternct.edu . The subject of your email must be "MIPS Project #1".
- For each project, make sure the project #, your name, course, date, and description are displayed at the beginning of your program as shown below:

```
# Programmer: your name
# Project #1
# Course: CSC320, fall 2020
# Date: 10/06/2020
# Description: This program converts cents into quarters, dimes,
#              nickels, and pennies.
```

- Make sure you use **comments** to describe what actions you are taking in your code.

Problem Statement:

Write a MIPS assembly program that prompts the user for some number of cents (integer) and read the user input. Then translate that number of into a number of quarters, dimes, nickels and pennies (all integers) equal to that amount and outputs the result. The output should adequately tell the user what is being output (not just the numeric results).

Sample Execution 1:

Enter some number of cents: 118
118 cents is equivalent to 4 quarter(s), 1 dime(s), 1 nickel(s), and 3 penny(s).

Sample Execution 2:

Enter some number of cents: -8
Error! You must enter a positive number. Please try again.

CSC320 – Computer Organization and Architecture

Assignment #1 (200 points total) - *NEW* Due date: Monday, 10/5/2020 at 11:59pm

Please Read:

1. Please write your answers on lined or blank paper - no need to copy the questions again.
2. Use your phone to take photos of your answers (or scan). Please reduce the resolution/size of the images if possible.
3. Email your files (acceptable formats: pdf, jpg, jpeg, gif, doc, or docx) with email subject "CSC320 Assignment #1" to tuh@easternct.edu
4. Please email your MIPS Assembly Programming Project #1 as a separate text file (with subject "MIPS project #1") before the due date/time.

Chapter 1:

Exercise 1.5 on page 55 (a, b, and c - 15 points)
Exercise 1.7 on page 56 (a, b, and c - 15 points)

Chapter 2:

1. Translate the following C/Java code to MIPS assembly code. Assume that the variables *i* and *j* are assigned to registers $s3, and $s4, respectively. Assume that the base address of the arrays A and B are in registers $s1 and $s2, respectively (add comments to your MIPS code). (15 points)

```
B[8] = A[i − j];
```

2. Translate the following C/Java code to MIPS assembly code. Assume that the values of *a*, *i*, and *j* are in registers $s0, $t0, and $t1, respectively. Assume that register $s2 holds the base address of the array A (add comments to your MIPS code). (20 points)

```
j = 0;
for(i=0 ; i<a ; i++)
        A[i] = i + j++;
```

3. Using the MIPS program below (with bugs intact), determine the instruction format for each instruction and write the **decimal** values of each instruction field. (20 points)

```
      addi $v0, $zero, 0
loop: lw $v1, 0($a0)
      sw $v1, 0($a1)
      sll $a0, $a0, 2
      add $a1, $a1, $a0
      beq $v1, $zero, loop
```


4. Convert **7fff fffa** (Hexadecimal) into **Decimal -** assuming unsigned numbers (5 points)
5. Convert the **Decimal** number 52 to **Binary** notation. (5 points)
6. Express the **Decimal** number -52 (negative 52) in **16-bit 2's Complement** Binary (signed). (5 points)

7. Complete MIPS Assembly Programming Project #1 (100 points)