SENTIMENT ANALYSIS

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1. Introduction:

Sentiment Analysis is defined as a subset of text analysis, which uses Natural Language Processing Machine Learning Algorithm, that comes under the domain of Artificial Intelligence, to systematically identify, extract, quantify, and study affective states and subjective information.

The basic task is to classify the polarity of the expressed opinion, whether it is positive, negative, or neutral. Beyond polarity, the sentiment analysis looks at the emotional states. [1]

The three levels of Sentiment Analysis are: Document-Level Analysis that identifies emotion, Topical Analysis that matches the keyword of the topic being discussed and Aspect-Based Analysis that provides a quantitative summary of the sentiment expressed. [2]

According to a Harvard Professor, 95% of purchasing decisions are made using emotions instead of logic. [3] Hence, Sentiment Analysis plays a vital role in the age of ecommerce where online shopping is greater than the transactions carried out in a physical store. [4] The emphasis on Sentiment Analysis is directly linked with understanding of the importance of customer-centric culture that incorporates customer-reviews.

In the age of information overload, companies having big data of customer feedback and lack of automation in its analysis has led to insights vacuum resulting in economic losses due to human biases, errors and unproductive usage of time. [5]

There are multiple benefits of delegating sentiment analysis to a machine. Firstly, the artificial intelligence algorithm designed by diverse engineers, scrutinized by various strategists and approved by experienced top-level managers is less prone to vulnerabilities in decision making performed by a single analyst. Secondly, the algorithm can link vast amounts of historical records to identify any patterns in society's sentiments of a product and its trajectory in various domains in order to predict its future profitability. Moreover, the analysis provides upselling opportunities to customers identified to be satisfied. Furthermore, it can also be used to train other Artificial Intelligence softwares such as chatbot that responds according to the customer's mood. In addition, it can identify key emotional triggers that drive customer decisions. Lastly, it can reduce customer churn by identifying dissatisfied customers to appease for retention.

2. Literature Review:

The origin of sentiment analysis can be traced to the 1950s, when sentiment analysis was primarily used on physical documents. The rise of social media has fueled interest in sentiment analysis, owing to the proliferation of multiple forms of digital expression, online opinion can be thought of as virtual currency for businesses in customer-centric culture, just like every other data is said to be new oil. [6]

Sentiment Analysis softwares' popularity is evident from its promotion as an excellent program to be coded by beginners in Data Science and Artificial Intelligence, as well as, proof of concept capstone project for those interested in pursuing Artificial Intelligence. Most Sentiment Analysis softwares coded by beginners are in Python, the mainstream language for Data Preprocessing and Machine Learning, while expert linguists have also uploaded tutorials on concepts behind coding the algorithm in more difficult languages such as Javascript, R, Java and C++, most which use existing APIs that contain datasets and dictionaries to train the model.

The top five enterprise-level Sentiment Analysis softwares are Awario, Brandwatch, Talkwalker, Lexalytics and Hootsuite Insights. [7] On the other hand, there are no public Sentiment Analysis softwares available that are coded in Assembly Language. Thus, we decided to program one using MASM with the intention of developing an open-source software that can run on low-end personal computers used in the majority of workplaces and the laptops used by remote-working.

3. Problem Definition:

The aim of this project is to create a low-level version of the popular Natural Language Processing algorithm, Sentiment Analysis, with lower system requirements than its Machine-Learning counterpart, so that it can work on computers affordable to small-scale organizations, who want to use this robust contextual text-mining software that enables product-managers to understand customer emotions in the product reviews by automatic extraction and quantification of subjective information.

4. Methodology:

The software is programmed using Assembly Language which runs using Microsoft Macro Assembler (MASM). The dependencies used are Irvine32 library for its built-in procedures and Macros. Visual Studio Community 2019 and later are utilized for working with the dependencies. The project requires the .asm file and text files to be in the same folder, for the .asm file to access the text files.

The methodology utilized has special emphasis on keeping the console user-friendly, starting from a minimal title screen and royal color scheme (white text on red background) to quickly displaying a visually appealing emoticon at the end of every analysis. After being greeted, the user is asked to enter a customer-review on the console, in which the assembly program converts any uppercase characters to lowercase in order to reduce processing time, by avoiding comparison of both uppercase and lowercase characters, and stores the line into an input file, so that it can process a sentence word by word through the file, which is more efficient than if it tried to process the whole line by directly storing it into the a variable. Next, the program stores the file content into a variable and checks the file's format. Then, it searches through each text file, one by one, and checks if any of the word matches with any word stored in the text file, if detected then that word is the emotion and the name of the file is the category where the emotion belongs. Lastly, the sentiment of the customer-review input, is output under the basic sentiments category along with displaying a relevant emoticon for faster judgements by user, which is productive under heavy workload.

5. Detailed Design and Architecture:

The design begins with inclusion of a dependency that is Irvine32 library. Then the function prototypes are declared before beginning the data and code segments. The first portion of the code segment contains the settings of command prompt display and welcome screen.

The next portion prompts the user for an input sentence, that is, the review whose sentiment is to be analysed. Then the code for converting any upper-case characters into lower-case is mentioned, in order to compare it with the lower-case words in the emotions text files.

After which comes the code for storing the inputted sentence to the input.txt file and then the code for reading the stored sentence from input.txt into a variable. After the code for checking the file's format comes the code for displaying prompts regarding input, and then the code for detecting emotions in order to display the relevant emoticon. The purpose of writing them at the end is so that the program can branch to them when the certain conditions for displaying a prompt and emoticon are met.

The architecture utilized by the program is x86 architecture based on Intel 8086 Microprocessor. The program utilizes Data, Code and Stack Segments, as well as, General Purpose Registers.

6. Implementation and Testing Programming Coding:

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TITLE SENTIMENT ANALYSIS
INCLUDE Irvine32.inc

NoFile PROTO, fileName:PTR BYTE   ;File not found error
Emotionless  PROTO,  noEmotionWord:PTR  BYTE,  noEmotionWordSize:DWORD     ;If  no emotion detected then none file
Counter PROTO,NoOfEmotions:DWORD    ;Count emotion type
Search PROTO, src: ptr byte, key: ptr byte, strSize: dword, keySize: dword
Display PROTO, EmotionWord:PTR BYTE, EmotionWordSize:DWORD   ;Print Emotion Word
Display_Word PROTO, foundWord:PTR BYTE  ;Display
clear PROTO, textString:PTR BYTE, StringLength:DWORD  ;Remove
extracted_Word PROTO   ;Word extracted from file

.data

EmotionStringSize DWORD 10000
EmotionString BYTE 10000 dup(0)
EmotionCount BYTE 6 DUP(?)
EC BYTE ?
largest SBYTE -1
position DWORD ?

FileNames byte  "Happy.txt",0,0,0,0,0,0,0,0,0,0,0
                byte  "Sad.txt",0,0,0,0,0,0,0,0,0,0,0,0,0
                byte  "Anger.txt",0,0,0,0,0,0,0,0,0,0,0
                byte  "Disgust.txt",0,0,0,0,0,0,0,0,0
                byte  "Fear.txt",0,0,0,0,0,0,0,0,0,0,0,0
                byte  "None.txt",0,0,0,0,0,0,0,0,0,0,0

EmotionNum DWORD 6
EmotionLength DWORD 400
TempFileNames DWORD  ?

EmotionfileHandler DWORD 0

inputFile BYTE "Input.txt",0
inputString BYTE 20000 dup(0)
inputFileHandler DWORD 0
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currentInputIndex DWORD  inputString
extractedWord BYTE 400 dup(0)
extractedWordSize DWORD 0

Detec_Emot_No BYTE  20000 dup(0)
IndexNoEmotionWords DWORD offset Detec_Emot_No

lineOutBYTE 40 dup(?)
uword byte 40 dup(?)


;//loop counters
mainLoopCounter DWORD 20000
world_len byte ?


;//flags
inputFileEnded DWORD 0
fileEmotionWritten DWORD 0
lastWord DWORD 0


;//Strings to be used
semiColon BYTE ":",0
dot BYTE "."
bigSpace BYTE "       ",0
new_line byte 0Dh,0Ah


;//prompts
promptEnter byte "ENTER A SENTENCE",0
promptDisplay byte "ENTERED SENTENCE",0
promptFile1 BYTE "File '",0
promptFile2 BYTE "' does not exist or cannot be opened.",0
promptNoDot BYTE "PROGRAM EXITED!!!!!!",0
promptHappy BYTE "HAPPY EMOTION DETECTED :)",0
promptSad BYTE "SAD EMOTION DETECTED :(",0
promptAnger BYTE "ANGER EMOTION DETECTED :(",0
promptDisgust BYTE "DISGUST EMOTION DETECTED:)(",0
promptFear BYTE "FEAR EMOTION DETECTED :|",0
promptMixed BYTE "MIXED EMOTION DETECTED :)",0
promptLove BYTE "LOVE EMOTION DETECTED :)",0
promptSurprise BYTE "SURPRISE EMOTION DETECTED!!",0
promptNone BYTE "YOU ENTERED AN EMOTIONLESS SENTENCE!!!{-",0
BlueTextOnMagenta = white + (red * 16)
DefaultColor = magenta + (Green * 16)


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                BYTE "@,.,.,.,.,.,,,,.,.,.,.,.,.,.,.,.,.,.,.,.,.,,.,,.,.,,,.,.,.,.,./", 13, 10
                BYTE "@*,,,,,,.,,,,,,.,.,.,.,.,.,.,.,.,.,.,.,.,.,,.,.,...,,,,,,,,.,,#", 13, 10
                BYTE "@@,,.,,,,.,,,,,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,,.,.,.,.,,,,.,,,,.,,@", 13, 10
                BYTE "@@,,,.,.,.,.,.,.,.,,,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,,,,,,,,.,,@", 13, 10
                BYTE "@@@................,.,.,.,.,.,.,.,.,.,.,.,.,.,.,,.,,,......@@", 13, 10
                BYTE "@@@@,,,,.,,,,,,,.,.,,.,.,.,.,.,.,.,.,.,.,.,.,.,,,.,,,,,,,.@@@", 13, 10
                BYTE "@@@@@/,,.,,,,.,.,..,.,,,,,%%/////////%%,,,,,.,,.,,.,,,,.,,@@@@@", 13, 10
```

```
                    BYTE
"@@@@@@@,.,,,,,,,.,.,.,,,,,.%%%#%%%%%%,,.,,..,.,.,..,,,,,@@@@@@", 13, 10
                    BYTE   "@@@@@@@@@,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,@@@@@@@@",   13,
10
                    BYTE
"@@@@@@@@@@@@,.,.,.,.,,,,.,,,,,,,.,,,,,,,,.,.,.,,.@@@@@@@@@@@", 13, 10
                    BYTE
"@@@@@@@@@@@@@@@@@@@@&,,,.,,,,,,,.,,,,,,,%@@@@@@@@@@@@@@
@@@@@", 13, 10
                    BYTE
"@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@@@@@@@@@@@@@@@@@@@@", 13, 10, 13, 10, 13, 10,0

femoji BYTE "0000000000000,.-------.,0000000000000000",13,10
      BYTE "000000000,:'            ':,000000000000",13,10
            BYTE "0000000,:                    :,00000000",13,10
            BYTE "000000:                        :0000000",13,10
            BYTE "00000,'                        ',000000",13,10
            BYTE "0000,:                         :,00000",13,10
            BYTE "0000: :      .          .      : :00000",13,10
            BYTE "00000000| :   __       __   : |000000000",13,10
            BYTE "000000|  `/'     ~' . '     '~\'  |00000",13,10
            BYTE "0000000|  ~  ,-~^, | ,^~-,  ~  |00000000",13,10
            BYTE "000000|   |       }:{       |   |00000",13,10
            BYTE "000000|   l       / | \       !   |00000",13,10
            BYTE "000000        .~  (_,.--' .^. '--.,_)  ~.000000",13,10
            BYTE "000000|     ---:' / | \ `:---     |00000",13,10
            BYTE "00000000\_.       \/^\/       ._/0000000",13,10
            BYTE "00000000V| \                  / |V0000000",13,10
            BYTE "000000000| |T~\__!_!__/~T| |000000000000",13,10
            BYTE "000000000| |`IIII_I_I_I_IIII'| |00000000",13,10
            BYTE "000000000|  \,III I I I III,/ |000000000",13,10
            BYTE "000000000000\    `~~~~'     /000000000000",13,10
            BYTE "00000000000\   .       .   /000000000000",13,10
            BYTE "0000000000000\.    ^    ./00000000000000",13,10
            BYTE " 000000000000000^~  ^ ~^0000000000000000", 13, 10, 13, 10, 13, 10,0
```

```
.code

main PROC

;********************************Console Output
call clrscr
mov eax, BlueTextOnMagenta
call SetTextColor
call clrscr
LEA edx, welcome
call writeString
call crlf



;********************************User Input
call crlf
LEA edx, promptEnter
call writestring
call crlf
mov edx,0
LEA edx, inputString
mov ecx,lengthof inputString
call readstring
call crlf



;********************************Uppercase to Lowercase
LEA esi,inputString
mov ecx,lengthof inputString
lop:
	mov al,[esi]
	cmp al,65
	jb nx
	cmp al,0
	je comp
	cmp al,90
	ja nx
	add al,32
	mov [esi],al
	nx:
		inc esi
		loop lop


;*****************************************************
mov edx,0
LEA edx, promptDisplay
call writestring
call crlf
comp:
LEA edx, inputString
call writestring
call crlf
call crlf


;*****************************************************Writing Input to file
mov edx,0
mov eax,0
LEA edx, inputFile
call CreateOutputFile
mov lineout, al
LEA esi,inputString
mov ecx,lengthof inputString
LEA edi, uword
call crlf
l1:
	lodsb
	cmp al,0
	je q
	cmp al," "
	je done
	stosb
	loop l1

done:
	mov world_len,0
```

```
    LEA edx, uword
    call writestring

    mov bl,cl
    mov ecx,lengthof uword
    LEA edi, uword

    x:
        mov bh,[edi]
        cmp bh,0
        je d
        inc world_len
        inc edi
        loop x
    d:
        movzx eax,lineout
        LEA edx,  uword
        movzx ecx,world_len
        call WriteToFile
        lea edx,new_line
        movzx eax,lineout
        mov ecx, 2
        call WriteToFile
        movzx ecx,world_len
        LEA edi, uword
    y:
        mov bh,0
        mov [edi],bh
        inc edi
        loop y
    mov cl,bl
    mov edi,offset uword
    call crlf
    jmp l1
q:
    mov world_len,0
    mov edx,offset uword
    call writestring
    call crlf
    mov bl,cl
```

```
        mov ecx,lengthof uword
        mov edi,offset uword
        a:
                mov bh,[edi]
                cmp bh,0
                je b
                inc world_len
                inc edi
                loop a
        b:
                movzx eax,lineout
                movzx ecx,world_len
                mov edx, OFFSET uword
                call WriteToFile
                lea edx,new_line
                movzx eax,lineout
                mov ecx, 2
                call WriteToFile
                movzx eax,lineout
                mov edx, OFFSET dot
                mov ecx,1
                call WriteToFile
                mov edi,offset uword
                movzx ecx,world_len
        z:
                mov bh,0
                mov [edi],bh
                inc edi
                loop z
movzx eax, lineout
call CloseFile


;*****************************************File Reading
mov eax, offset Detec_Emot_No
mov IndexNoEmotionWords, eax

mov edx, offset inputFile

call openInputFile
```

```
mov inputFilehandler, eax

cmp eax, INVALID_HANDLE_VALUE
je InputFileNotExist


mov ecx, lengthOf inputString
mov edx, offset inputString
mov eax, inputfilehandler
call readFromFile




;********************************File Format

INVOKE Search, addr inputString, addr dot, lengthof inputString, lengthof dot


cmp ebx,-1
je noInputFormat
mov ebx,0


mov TempFileNames, offset FileNames
mov ecx,EmotionNum
OuterLoop:

                    mov EmotionNum, ecx

                    ;Setting flags to zero
                    mov eax, 0
                    mov fileEmotionWritten, eax
                    mov lastWord, eax
                    mov inputFileEnded, eax

                    ;Resetting currentInputIndex
                    mov esi, offset inputString
                    mov currentInputIndex, esi
```

```
        INVOKE clear, offset EmotionString, EmotionStringSize

        mov edx, TempFileNames
        call openInputFile
        mov EmotionfileHandler, eax

        cmp eax, INVALID_HANDLE_VALUE
        je FileNotExist


        mov ecx, lengthOf EmotionString
        mov edx, offset EmotionString
        mov eax, EmotionfileHandler
        call readFromFile
        ;reading completed, text moved to categoryString



        mov ecx, mainLoopCounter
        innerLoop:
                mov mainLoopCounter, ecx
                mov eax, inputFileEnded
                cmp eax, 0
                jne breakLoopCateg2

                call extracted_Word

                INVOKE Search, addr EmotionString, addr extractedWord, EmotionStringSize, extractedWordSize

                cmp ebx, -1
                je loopEnd

                mov eax, fileEmotionWritten
                cmp eax, 0
                jne alreadyPrintedCateg2
                INVOKE Display, TempFileNames, EmotionLength

        alreadyPrintedCateg2:
```

```
                                        INVOKE Display_Word, offset extractedWord
                                        mov EC,cl
                                        INVOKE Counter,EmotionNum

                        jmp loopEnd

loopEnd:                ;restoring ecx after a function call
                        mov ecx, mainLoopCounter
                        loop Innerloop

                        breakLoopCateg2:
                        call crlf

                        jmp skipThis
FileNotExist:
                        INVOKE NoFile, tempFileNames
skipThis:

                        add TempFileNames,20
                        mov ecx,EmotionNum
                        dec ecx
                        cmp ecx, 0
jnz outerLoop




;*******************************Input Prompts
jmp skipDownStatement
noInputFormat:
        call crlf
        mov edx, offset promptNoDot
        call writeString
        call crlf

jmp skipDownStatement

InputFileNotExist:
        INVOKE NoFile, addr inputFile
```

```
skipDownStatement:

mov al, Detec_Emot_No[0]
cmp al, 0
;je exitTheProgram



mov ecx,lengthOf EmotionCount
mov esi,0
LEC:
        mov al,EmotionCount[esi]
        cmp al,largest
        jg storeLargest
        jmp next

        storeLargest:
                                mov largest,al
                                mov position,esi
                                jmp next

        next:
                inc esi
Loop LEC

mov eax,0


mov eax,position
;   Comparing emotion type


cmp eax,5
je pHappy
cmp eax,4
je pSad
cmp eax,3
je pAnger
cmp eax,2
je pDisgust
```

```
cmp eax,1
je pFear
cmp eax,0
je pNone

pHappy:
                  mov edx,OFFSET promptHappy
                  call writeString
                  call crlf
            call crlf
      lea edx,hemoji
            call WriteString
            call crlf
                  jmp conclude

pSad:
    mov edx,OFFSET promptSad
          call writeString
          call crlf

     call crlf
     lea edx,semoji
           call WriteString
           call crlf

          jmp conclude

pAnger:
      mov edx,OFFSET promptAnger
            call writeString
            call crlf

                  call crlf
      lea edx,aemoji
            call WriteString
            call crlf

            jmp conclude

pDisgust:
       mov edx,OFFSET promptDisgust
             call writeString
             call crlf

                   call crlf
                   lea edx,demoji
             call WriteString
             call crlf

             jmp conclude

pFear:
           mov edx,OFFSET promptFear
           call writeString
           call crlf

           call crlf
           lea edx,femoji
           call WriteString
           call crlf

           jmp conclude

pNone:
           mov edx,OFFSET promptNone
           call writeString
           call crlf
           jmp conclude

conclude:


exit
main ENDP

;********************************main end

NoFile PROC, fileName:PTR BYTE

call crlf
call crlf
mov edx, offset promptFile1
call writeString
mov edx, fileName
call writeString
mov edx, offset promptFile2
call writeString

ret
NoFile ENDP


; ****************************

clear PROC, textString:PTR BYTE, StringLength:DWORD

	mov edi, textString
	mov eax, 0
	mov ecx, stringLength
	rep stosb

ret
clear ENDP

Display_Word PROC, foundWord:PTR BYTE

	inc foundword
	mov edx, foundword
	call writeString

ret
Display_Word ENDP


; **************** Procedure to display emotion Word Extracted from files ************

Display PROC, EmotionWord:PTR BYTE, EmotionWordSize:DWORD

	mov esi, EmotionWord
	mov ecx, EmotionWordSize
```

```
        mov eax,0
        mov fileEmotionWritten, eax

loopPrintCategName:
                                mov al, [esi]
                                cmp al, '.'
                                je breakPrintCategName
                                mov al, [esi]
                                call writeChar

                                inc esi
loop loopPrintCategName

breakPrintCategName:
        mov edx, offset semiColon
        call writeString
        call crlf

        mov eax, 0fh
        mov fileEmotionWritten, eax


        mov edx, offset bigSpace
        call writeString

ret
Display ENDP

; *************** Word Extration from files ************


extracted_Word PROC

INVOKE clear, addr extractedWord, extractedWordSize

        mov ecx, lengthOf inputString
        mov eax, 0
        mov ebx, 0
        mov extractedWordSize, eax
        mov esi, currentInputIndex
        lea edi, extractedWord

        mov al, 0ah
        stosb
        inc extractedWordSize

        cmp al, '.'
        je return

noComma:
copy:
                mov al, [esi]
                cmp al, 0ah
                je addComma

                mov bl, [esi]
                cmp bl, '.'
                je FileEnded

                movsb
                inc extractedWordSize
               loop copy

FileEnded:
        mov eax, 0fh
        mov inputFileEnded, eax

addComma:
        mov al, 0ah
        stosb
        inc esi
        inc extractedWordSize



return:

   ;find size of the word here
        mov currentInputIndex, esi
ret
```

```
extracted_Word ENDP

; *************** Searcing Procedure ************

Search proc uses ecx esi edi eax, src: ptr byte, key: ptr byte, strSize: dword, keySize: dword

	mov ecx, strSize
	mov esi, src
	mov edi, key
	mov eax, 0
	
 ;dec keySize -> no null character

 L2:

   cmp eax, keySize
   jz L5

   cmpsb
   jz L3
   mov edi, key
   cmp eax, 1
   jb L4
   dec esi
   mov eax, 0
   jmp L4

   L3:
   inc eax

 L4:
 loop L2

; *************** If Not Found ************

	mov ebx, -1
 ret

 L5:
```

```
; *************** If Found ************

    mov ebx, esi
    sub ebx, src
    sub ebx, eax
 ret
Search endp

; *************** Emotion Counting ************

Counter PROC,NoOfEmotions:DWORD

        mov eax,NoOfEmotions
        dec eax

        cmp al,5
        je inHappy
        cmp al,4
        je inSad
        cmp al,3
        je inAnger
        cmp al,2
        je inDisgust
        cmp al,1
        je inFear
        cmp al,0
        je inNone



inHappy:
                mov esi,eax
                add EmotionCount[si],1
                jmp last
inSad:
         mov esi,eax
         add EmotionCount[si],1
         jmp last
inAnger:
```

```
            mov esi,eax
            add EmotionCount[si],1
                  jmp last
inDisgust:
             mov esi,eax
             add EmotionCount[si],1
                   jmp last
inFear:
           mov esi,eax
           add EmotionCount[si],1
           jmp last
inNone:
                  mov esi,eax
                  add EmotionCount[si],1
                  jmp last

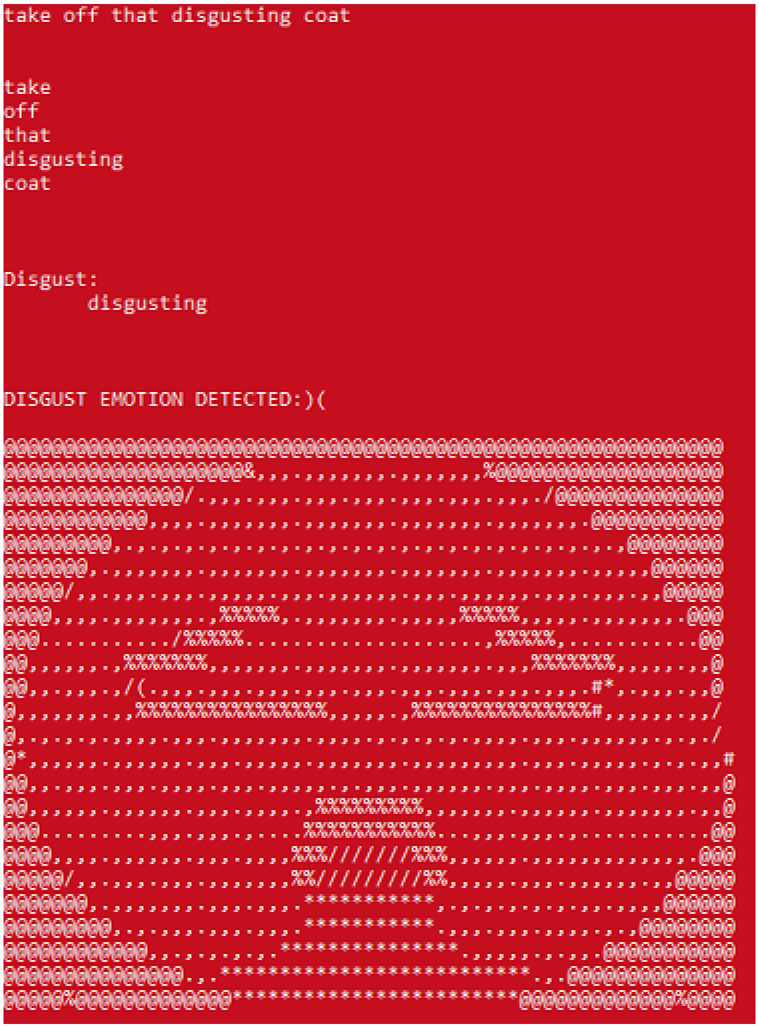
last:
ret
Counter ENDP

END main
```

7. Results Software Simulation and Discussion:

The software simulation results discussed below are limited only to the three of the many emotions it can detect. The output for every emotion is not attached below since the test cases were based on the complexity of the sentence, from a simple sentence to moving on to compound one, since only testing each emotion simply would not reveal the extent of the software's abilities.

The first test case has entered a review containing an emotion pertaining to disgust. The program correctly categorized the emotion and displayed a valid emoticon as an appealing way of displaying the result.



```
take off that disgusting coat


take
off
that
disgusting
coat



Disgust:
       disgusting



DISGUST EMOTION DETECTED:)(

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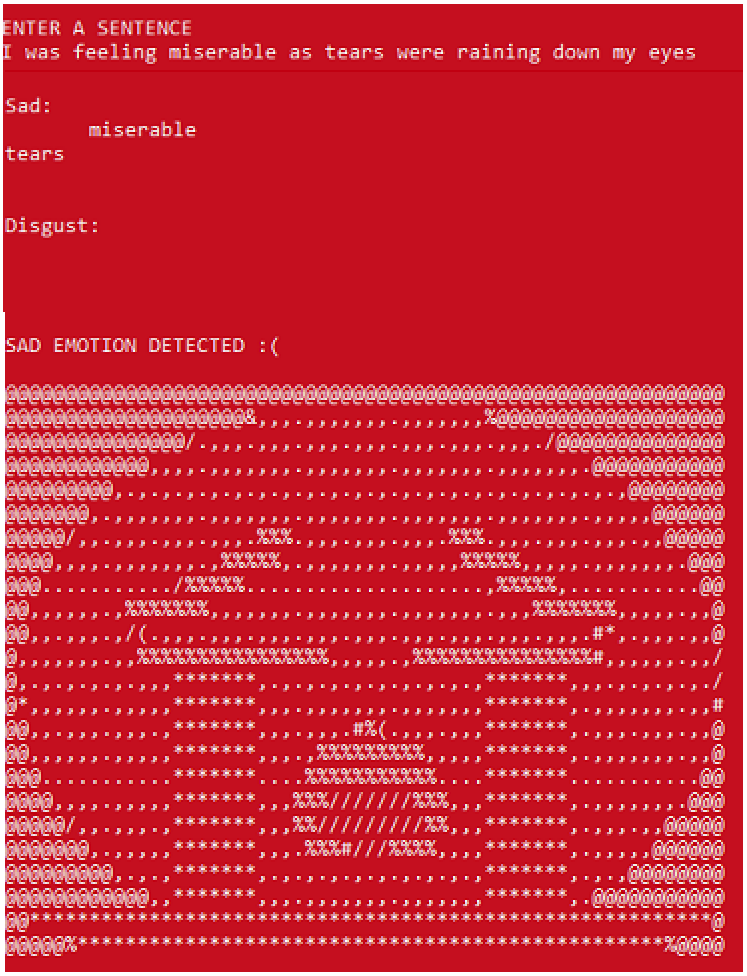
In the next level, a complex synonym of the basic emotion is tested, in this case, miserable which it correctly identified as related to sadness.



```
ENTER A SENTENCE
I was feeling miserable as tears were raining down my eyes

Sad:
        miserable
tears


Disgust:




SAD EMOTION DETECTED :(

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
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@@@@@%**************************************************%@@@@
```
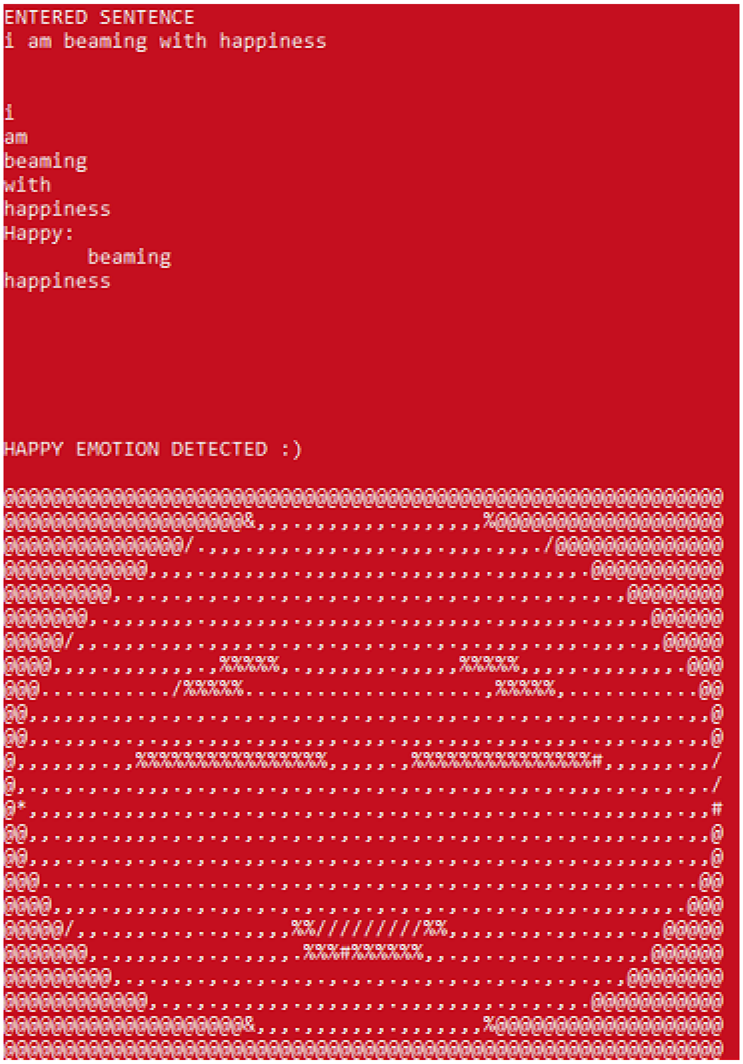

Finally, it was tested for the possibility of multiple words pertaining to the same emotion, for example beaming and happy. It successfully detected and categorized both.



```
ENTERED SENTENCE
i am beaming with happiness


i
am
beaming
with
happiness
Happy:
        beaming
happiness





HAPPY EMOTION DETECTED :)

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
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@@@.,,,..,,,..,,,..,,,..,,,..,,,..,,,..,,,..,,,..,,,..,,,.@@
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```

8. Conclusion, Cost and Future Work:

Sentiment Analysis using Microsoft Macro-Assembler is an efficient solution to the problems occurring by manual analysis of customer reviews, aimed at quantifying emotions in them, using affordable hardware, in order to scale a customer-centric culture.

The cost is limited to hardware only since the time spent in analysis is negligible. The recommended system requirements are 8 GB RAM and the microprocessor requirement mentioned by Visual Studio Community however it does not require any Graphics Processing Unit as compared to program's higher level language counterparts.

The future direction of this software is optimizing the algorithm to make it state of the art sentiment analysis algorithm in Assembly Language that can be embedded into any Internet of Technology or microprocessor device that supports its assembly language, for example, if Microsoft launches its own virtual reality headsets, they can be integrated with algorithm for fast sentiment analysis in the era of Metaverse.

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