ESE532 Project P1 Report

Ritika Gupta, Taylor Nelms, and Nishanth Shyamkumar

October 30, 2019

1. Our group makeup is Ritika Gupta, Taylor Nelms, and Nishanth Shyamkumar.

2. (a) We end up with $64ns$ to process each $64b$ word of input, which comes out to 76.8 (so, 76) cycles for a 1.2GHz processor.

   (b) By similar logic as the last question, with a 200MHz clock, we end up with 12.8 (so, 12) cycles to process all of the input.

3. (a) (i) **Content-Defined Chunking**:

```
skip input to minChunkSize − windowSize
buffer = input[minChunkSize − windowSize : minChunkSize]
curHash = 0
for byte in buffer:
    curHash += hash(byte)
if curHash == 0:
    markChunkBreak()
else:
    while (curHash != 0 and (notAtMaxChunkSize())):
        curHash −= hash(buffer[0])
        moveBufferWindow()
        readNextByte()
        curHash += hash(buffer[windowSize − 1])
    markChunkBreak()
```

   (ii) **SHA-256**:

```
h[0:7] = initializeHashValues()
k[0:63] = initializeRoundConstants()
padInitialMessage()#pads to a 512−bit boundary
for chunk512bitSection in chunk:
    w[0:15] = chunk512bitSection

    #Extend the first 16 words into the remaining 48 words w[16..63] of the message s
    for i from 16 to 63
        s0 := (w[i−15] rightrotate  7) xor (w[i−15] rightrotate 18) xor (w[i−15] righ
3)
        s1 := (w[i− 2] rightrotate 17) xor (w[i− 2] rightrotate 19) xor (w[i− 2] righ
        w[i] := w[i−16] + s0 + w[i−7] + s1

    a:h = h[0:7]
    #Compression function main loop:
    for i from 0 to 63
        S1 := (e rightrotate 6) xor (e rightrotate 11) xor (e rightrotate 25)
        ch := (e and f) xor ((not e) and g)
        temp1 := h + S1 + ch + k[i] + w[i]
        S0 := (a rightrotate 2) xor (a rightrotate 13) xor (a rightrotate 22)
        maj := (a and b) xor (a and c) xor (b and c)
        temp2 := S0 + maj

        h := g
        g := f
```

```
           f  :=  e
           e  :=  d + temp1
           d  :=  c
           c  :=  b
           b  :=  a
           a  :=  temp1 + temp2

       h[0:7]  +=  [a:h]
```

digest = h0 append h1 append h2 append h3 append h4 append h5 append h6 append h7

Credit: Wikipedia

(iii) **Chunk Matching**:

```
if shaResult in chunkDictionary:
    send(shaResult)
else:
    send(LZW(rawChunk))
```

(iv) **LZW Encoding**:

```
table = {}
for i in range(256):
    table[i] = i
curPos = 256
STRING = Input.read()
while(True):
    CHAR = Input.read()
    if STRING + CHAR in table.values():
        STRING += CHAR
    else:
        Output.write(table[STRING])
        table[STRING + CHAR] = curPos
        curPos += 1
        STRING = CHAR
    if Input.isDone():
        break
```

Credit: https://www.dspguide.com/ch27/5.htm

(b) (i) **Content-Defined Chunking**:
We'll need a rolling hash window's worth of working memory, spanning 16ish bytes.

(ii) **SHA-256**:
We'll want a table of constant values for the hash algorithm (roughly 72 bytes), plus a 64-byte SHA-block span of memory to work on.

(iii) **Chunk Matching**:
We'll want a table to store hash values for index purposes, which would require at least 8 bytes times the maximum number of chunks to be processed.

(iv) **LZW Encoding**:
This is a somewhat tricky question given the associative memory involved, but it will be on the scale of roughly MAX_CHUNK_SIZE entries times 12 bits.

(c)

(d)

(e)

4. (a)

(b)

(c)

(d)

(e)

5. (a)

   (b)

   (c)

   (d)

   (e)

   (f)