

*Prof. Ryan Cotterell*

# Course Assignment

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**Collaborators:**

Other student 1

Other student 2

By submitting this work, I verify that it is my own. That is, I have written my own solutions to each problem for which I am submitting an answer. I have listed above all others with whom I have discussed these answers.

## Part I

# Course Assignment Episode 1

## Question 1

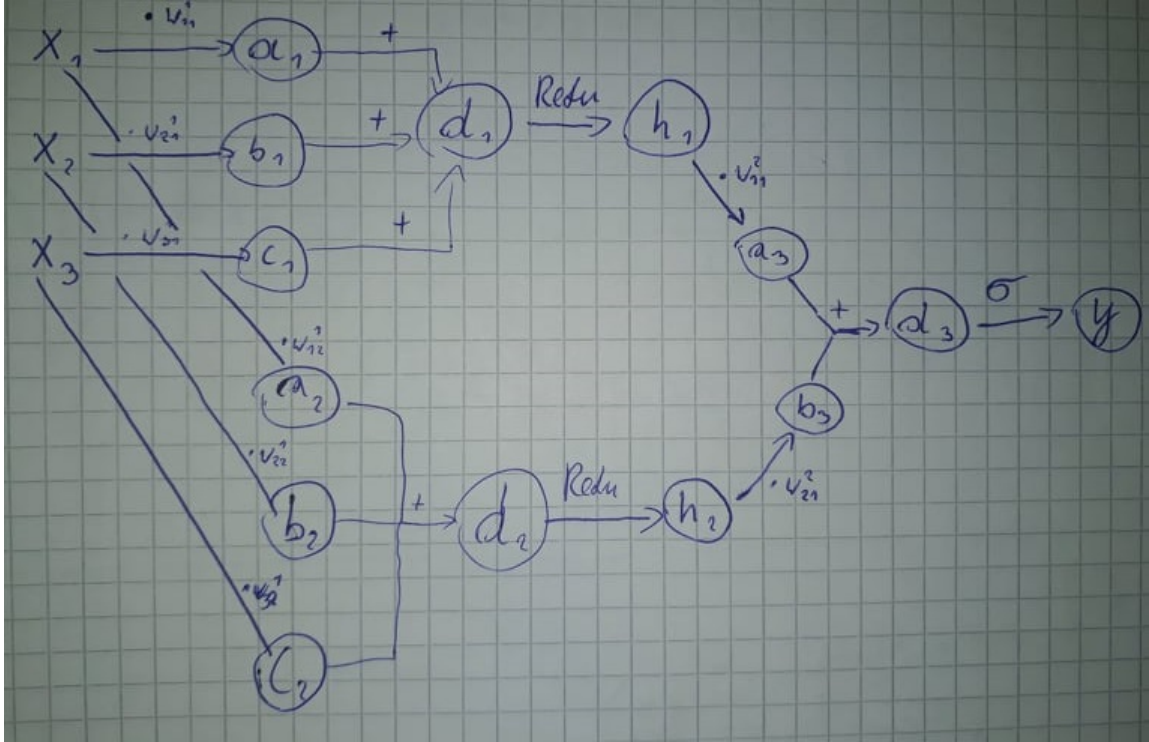


Figure 1: The computation graph of  $f$ .

- (a)  $a_1 = x_1 \cdot w_{11}^1$   $b_1 = x_2 \cdot w_{21}^1$   $c_1 = x_3 \cdot w_{31}^1$   
 $d_1 = a_1 + b_1 + c_1$   
 $h_1 = \text{ReLU}(d_1)$   
 $a_2 = x_1 \cdot w_{12}^1$   $b_2 = x_2 \cdot w_{22}^1$   $c_2 = x_3 \cdot w_{32}^1$   
 $d_2 = a_2 + b_2 + c_2$   
 $h_2 = \text{ReLU}(d_2)$   
 $a_3 = h_1 \cdot w_{11}^2$   $b_3 = h_2 \cdot w_{21}^2$   
 $d_3 = a_3 + b_3$   
 $y = \sigma(d_3)$
- (b) (i)  
(ii)

- (iii)
- (iv)

| number | sample strings                            | accepted | weight |
|--------|---|----------|--------|
| 1      | educational is this not                   |          |        |
| 2      | is this assignment educational            |          |        |
| 3      | not educational is not educational        |          |        |
| 4      | this assignment is not educational        |          |        |
| 5      | is this assignment educational            |          |        |
| 6      | this assignment course is educational     |          |        |
| 7      | is this assignment not educational        |          |        |
| 8      | this assignment not                       |          |        |
| 9      | this course assignment is not educational |          |        |
| 10     | this course is not not educational        |          |        |
| 11     | not educational is this                   |          |        |
| 12     | course assignment is not educational      |          |        |
| 13     | not this assignment is educational        |          |        |
| 14     | not not not educational                   |          |        |
| 14     | is this course assignment not educational |          |        |
| 15     | course assignment is this                 |          |        |
| 16     | this course is interesting                |          |        |
| 17     | this course assignment not educational    |          |        |

Table 1: Some strings from  $\mathcal{V}_{\geq 2, \leq 6}$

iteration: n = 0, weight matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 1, weight matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 2, weight matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 3, weight matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 0, backtracking matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 1, backtracking matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 2, backtracking matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 3, backtracking matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

Figure 2: Floyd-Warshall algorithm, iteration 0 to 3; left column matrix should contain weights after iteration n; right column matrix should be iteratively filled for backtracking each path

iteration: n = 4, weight matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 5, weight matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 6, weight matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 7, weight matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 4, backtracking matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 5, backtracking matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 6, backtracking matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

iteration: n = 7, backtracking matrix

|                  | a<br>this | b<br>assign-<br>ment | c<br>course | d<br>is | e<br>not | f<br>edu-<br>cational |
|------------------|-----------|----------------------|-------------|---------|----------|-----------------------|
| a<br>this        |           |                      |             |         |          |                       |
| b<br>assignment  |           |                      |             |         |          |                       |
| c<br>course      |           |                      |             |         |          |                       |
| d<br>is          |           |                      |             |         |          |                       |
| e<br>not         |           |                      |             |         |          |                       |
| f<br>educational |           |                      |             |         |          |                       |

Figure 3: Floyd-Warshall algorithm, iteration 4 to 7; left column matrix should contain weights after iteration n; right column matrix should be iteratively filled for backtracking each path