

# CS 490/590 – DEEP LEARNING: HW4

Spring 2023

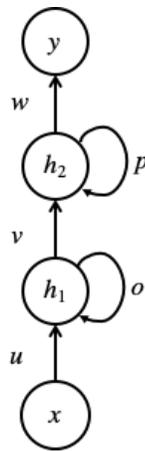
Dr. Eren Gultepe

Southern Illinois University Edwardsville

**DUE DATE: Wednesday, April 19, 2023 at 11:59 pm**

You may work on this question as a group or with a partner, but you must **submit your answer individually**. You submit a document in any type of format. Whomever you work with, include their name in your submission.

1. [10pts] For the following stacked RNN,



with the forward pass equations,

$$z_1^{(t)} = ux^{(t)} + oh_1^{(t-1)}$$

$$h_1^{(t)} = \phi(z_1^{(t)})$$

$$z_2^{(t)} = vh_1^{(t)} + ph_2^{(t-1)}$$

$$h_2^{(t)} = \phi(z_2^{(t)})$$

$$r^{(t)} = wh_2^{(t)}$$

$$y^{(t)} = \phi(r^{(t)})$$

derive all the backpropagation rules that will allow you to determine  $\bar{o}$ ,  $\bar{p}$ ,  $\bar{u}$ ,  $\bar{v}$ , and  $\bar{w}$ . In the above formulas, the subscripts represent the hidden layer number and the superscripts represent the timestep. Assume that  $\mathcal{L}$  is not defined, just like  $\phi$ , which is also kept in its general form. *Hint: You may need to draw out an unrolled computation graph to help in your derivation.*