Name:

**Question 1**: Write out the joint probability for the following sentence using the chain rule:

*p(There, is, only, one, person, who, is, not, ordinary)*

Write out the probability above using the second-order Markov assumption.

p(There, is, only, one, person, who, is, not, ordinary)

= p(There) ∙ p(is | There) ∙ p(only | There, is) ∙ p(one | is, only) ∙ p(person | only, one) ∙ p(who | one, person) ∙ p(is | person, who) ∙ p(not | who, is) ∙ p(ordinary | is, not)

**Question 2**: Consider the following training corpus **T** of sentences:

* *START Karlsson is round STOP*
* *START He lives on the roof STOP*
* *START He is happy STOP*
* *START On the roof STOP*
* *START Karlsson lives happily STOP*
  1. Compute the following maximum likelihood parameters: p(Karlsson|START) =c(Karlsson, START)/c(START) = 2/5

p(Karlsson|lives,happily)= c(Karlsson, lives, happily)/c(lives, happily) = 0/1

p(STOP|happy) = c(STOP, happy)/c(happy) = 1/1

* 1. Compute the probability of the following sentences under the trigram model trained on **T**:

*START Karlsson is happy STOP*

p(START, Karlsson, is, happy, STOP)

= p(START) ∙ p(Karlsson | START) ∙ p(is | START, Karlsson) ∙ p(happy | Karlsson, is) ∙ p(STOP | is, happy)

= 5/27 \* 2/5 \* 1/2 \* 0/1 \* 1/1 = 0

*START Karlsson lives on the roof STOP*

p(START, Karlsson, lives, on, the, roof, STOP)

= p(START) ∙ p(Karlsson | START) ∙ p(lives | START, Karlsson) ∙ p(on | Karlsson, lives) ∙ p(the | lives, on) ∙ p(roof | on, the) ∙ p(STOP | the, roof)

= 5/27 \* 2/5 \* 1/2 \* 0/1 \* 1/1 \* 2/2 \* 2/2 = 0

**Question 3**: We have the following training corpus:

the green book STOP my blue book STOP his green house STOP book STOP

Assume we have a language model based on this corpus using linear interpolation with *i*  1/ 3 for all i. Compute the value of the parameter p(book|the green) under this model. Assume STOP as part of your unigram model.

p(book|the green) = ∙p(book | the green) + ∙p(book | green) + ∙p(book)

= 1/3\*1/1 + 1/3\*1/2 + 1/3\*3/14 = 1/3 + 1/6 + 1/14 = 8/14