SGN-4106 Speech Recognition
Exam 22.5.2013
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Students may use their own calculators (a standard scientific calculator). The answers should be in English. The questions do not need to be returned.

Problem 1
Explain the meaning of the following terms (1 point each):
(Write maximum two sentences for each.)
      a) triphone
      b) coarticulation
      c) Gaussian mixture model
      d) mel scale
      e) forward algorithm
      f) Viterbi algorithm

Problem 2
Explain in general terms the steps required for building an isolated word recognition system based on HMM. Specifically, what are the components of such a system and how it is used for recognition? *(Write maximum one page.)* (6 points)

Problem 3
Describe the processing steps needed for calculating mel-frequency cepstral coefficients (MFCCs) in a standard front end of a speech recognition system. Explain shortly the purpose of each operation. No formulas needed! *(Write maximum one page.)* (6 points)

Problem 4
a) Explain shortly the reestimation of HMM parameters using the forward-backward algorithm. No formulas needed! *(Write maximum half a page.)* (3 points)

b) Explain shortly the construction of a bigram language model and how it is used in a speech recognition system. No formulas needed! *(Write maximum half a page.)* (3 points)

Problem 5
A two-state discrete-output HMM has the following parameters λ:

    $P(q_1|q_1) = 0.7, P(q_2|q_1) = 0.3,$

    $P(q_1|q_2) = 0.4, P(q_2|q_2) = 0.6,$

    $b_1(R) = 0.5, b_1(G) = 0.4, b_1(B) = 0.1,$

    $b_2(R) = 0.3, b_2(G) = 0.5, b_2(B) = 0.2.$

At time $t = 1$ the HMM is in state 1.

a) Calculate the total probability $P(O|\lambda)$ of observation sequence $O = o_1o_2o_3o_4 = $ GGRB. (3 points)

b) What is the most likely state sequence given the above observation sequence O? (3 points)