TU München
Fakultät für Informatik
PD Dr. Rudolph Triebel
John Chiotellis, Maximilian Denninger

Machine Learning for Computer Vision

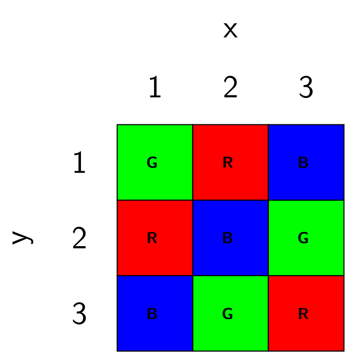
June 8, 2018
Topic: Hidden Markov Models

Exercise 1: Viterbi algorithm

We play again with our robot from the first homework assignment. As we mentioned back then the robot has a camera with an observation model that looks as follows:

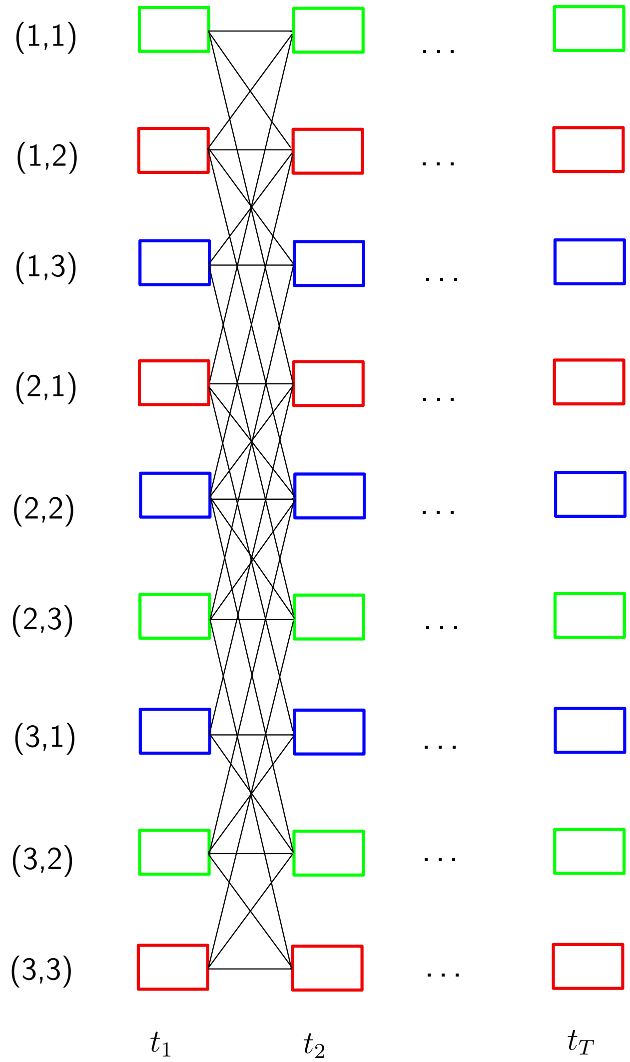
Sensed color \ Actual color	R	G	B
R	0.8	0.1	0.1
G	0.1	0.6	0.2
B	0.1	0.3	0.7

This time we put the robot in a room where the floor looks like this:



a) *What is the state space? What is the observation space? Draw the trellis diagram.*

The state is the position of the robot. We have a discrete state space of 9 squares. Each state is a pair (x,y), so $x_i \in \{(1,1),(1,2)\dots,(3,3)\}$.
The observation space is also discrete and it consists of the 3 colors the robot may observe, so $z_i \in \{R, G, B\}$. The trellis diagram would look as follows:



b) *Assume the robot can only move vertically and horizontally. We let the robot move randomly. If the attempted move leads outside of the bounds of the room the robot stays at its current position. Compute the state transition matrix.*

The robot can only move vertically or horizontally, so there are four possible moves (up, down, left, right). Since the robot moves randomly, each of these has probability $p_{move} = 0.25$. For all states except the one in the central square, there are moves that lead out of the bounds of the room. Then the robot stays at its current position, so the probability for that move is added to the probability of transition to the self-state.

c) *After 3 time steps, what is most likely the path that the robot followed if the camera reads* $\{z_1 =$ *R,* $z_2 =$*G,* $z_3 =$ *G* $\}$ *? Assume the robot's initial position is unknown.*

We want to use the Viterbi algorithm to estimate the most likely sequence of squares the robot followed. To do that we need to compute the transition matrix A (previous question), the initial state probabilities π_i and the observation model $p(z_i|x_i)$. The robot's initial position is unknown, therefore we have $\pi_i = \frac{1}{9} \quad \forall i \in \{1, \ldots, 9\}$.
For the rest, see the code.