ASEN 5519 - Algorithmic Motion Planning
Fall 2021

Homework 2

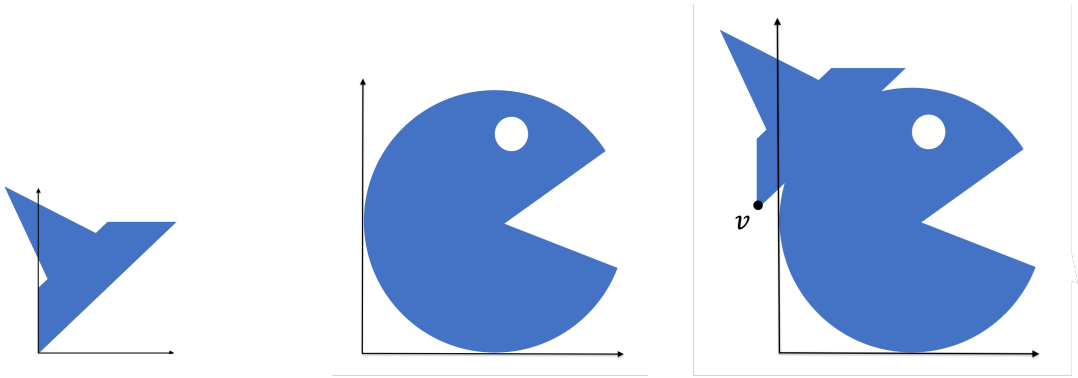
Assigned September 3; Due September 10

Exercise 1. Define appropriate sets that describe the following shapes:

(a) Hat in Figure 1a,

(b) Pacman in Figure 1b,

(c) Birthday Pacman in Figure 1c, where point $v = (x_v, y_v)$. (hint: use the results in parts (a) and (b))



(a) Hat (b) Pacman (c) Birthday Pacman

Figure 1: Exercise 1

Exercise 2. Implement BUG 1 and BUG 2 algorithms for a left-turning robot in your favorite programming language (Matlab is acceptable but not preferred) and consider two workspaces W_1 and W_2 as specified below.

- $W_1 = [-1, 14] \times [-1, 14]$, $q_{\text{start}} = (0, 0)$, $q_{\text{goal}} = (10, 10)$, and obstacles WO_1 and WO_2, where WO_1 is a rectangle and WO_2 is the union of four rectangles, i.e., $WO_2 = \bigcup_{i=2}^{5} \overline{WO}_i$. The vertices of the rectangles are:

$$
\begin{array}{llllll}
WO_1: & v_1^1 = (1,1), & v_1^2 = (2,1), & v_1^3 = (2,5), & v_1^4 = (1,5) \\
\overline{WO}_2: & v_2^1 = (3,3), & v_2^2 = (4,3), & v_2^3 = (4,12), & v_2^4 = (3,12) \\
\overline{WO}_3: & v_3^1 = (3,12), & v_3^2 = (12,12), & v_3^3 = (12,13), & v_3^4 = (3,13) \\
\overline{WO}_4: & v_4^1 = (12,5), & v_4^2 = (13,5), & v_4^3 = (13,13), & v_4^4 = (12,13) \\
\overline{WO}_5: & v_5^1 = (6,5), & v_5^2 = (12,5), & v_5^3 = (12,6), & v_5^4 = (6,6)
\end{array}
$$

- $W_2 = [-7, 36] \times [-7, 7]$, $q_{\text{start}} = (0, 0)$, $q_{\text{goal}} = (35, 0)$, and obstacle $WO = \bigcup_{i=1}^{9} \overline{WO}_i$, where each $\overline{WO}_i$ is a rectangle with vertices:

$$
\begin{array}{llllll}
\overline{WO}_1: & v_1^1 = (-6,-6), & v_1^2 = (25,-6), & v_1^3 = (25,-5), & v_1^4 = (-6,-5) \\
\overline{WO}_2: & v_2^1 = (-6,5), & v_2^2 = (30,5), & v_2^3 = (30,6), & v_2^4 = (-6,6) \\
\overline{WO}_3: & v_3^1 = (-6,-5), & v_3^2 = (-5,-5), & v_3^3 = (-5,5), & v_3^4 = (-6,5) \\
\overline{WO}_4: & v_4^1 = (4,-5), & v_4^2 = (5,-5), & v_4^3 = (5,1), & v_4^4 = (4,1) \\
\overline{WO}_5: & v_5^1 = (9,0), & v_5^2 = (10,0), & v_5^3 = (10,5), & v_5^4 = (9,5) \\
\overline{WO}_6: & v_6^1 = (14,-5), & v_6^2 = (15,-5), & v_6^3 = (15,1), & v_6^4 = (14,1) \\
\overline{WO}_7: & v_7^1 = (19,0), & v_7^2 = (20,0), & v_7^3 = (20,5), & v_7^4 = (19,5) \\
\overline{WO}_8: & v_8^1 = (24,-5), & v_8^2 = (25,-5), & v_8^3 = (25,1), & v_8^4 = (24,1) \\
\overline{WO}_9: & v_9^1 = (29,0), & v_9^2 = (30,0), & v_9^3 = (30,5), & v_9^4 = (29,5)
\end{array}
$$

(a) Plot the paths generated by Bug 1 and Bug 2 algorithms.

(b) What are the lengths of the paths generated by Bug 1 and Bug 2 algorithms?

(c) Would you expect the same path lengths if the robot were right turning?