1 Constraints of Participant Behaviors

1.1 The constraints for ”park”

(1) $\forall i \in (0, e], w_0^B.pos \in D, w_i^B.pos = w_{i-1}^B.pos$
(2) $\forall i \in [0, e], spd_i = 0$

1.2 The constraints for ”retrograde”

(1) $w_e^B.pos \in D, w_0^B.pos \notin D, w_0^B.pos \in l_m$
(2) $fd(w_e^B.pos, w_o^B.pos, l_m) = 1$
(3) $e < p$
(4) $(w_e^B.x - w_0^B.x) = DX(0, e), (w_e^B.y - w_0^B.y) = DY(0, e)$
(5) $\forall i \in (0, e), |\frac{spd_i - spd_{i-1}}{\Delta t}| \leq ac^{max}, spd_i \leq spd^{max}$

1.3 The constraints for ”follow vehicle”

(1) $w_e^B.pos \in D \wedge w_0^B.pos \notin D$
(2) $w_0^B.pos \in l_m \wedge l_m \in R_i, w_e^B.pos \in l_n \wedge l_n \in R_j, i = j, m = n$
(3) $fd(w_0^B.pos, w_e^B.pos, l_m) = 1$
(4) $\forall i \in (0, e], w_i^O.pos \in l_m, \sqrt{(w_i^B.x - w_i^O.x)^2 + (w_i^B.y - w_i^O.y)^2} \geq H$
(5) $e < p$
(6) $(w_0^B.x - w_e^B.x) = DX(0, e), (w_0^B.y - w_e^B.y) = DY(0, e)$
(7) $\forall i \in (0, e), |\frac{spd_i - spd_{i-1}}{\Delta t}| \leq ac^{max}, spd_i \leq spd^{max}$

1.4 The constraints for ”follow lane”

(1) $w_e^B.pos \in D \wedge w_0^B.pos \notin D$
(2) $w_0^B.pos \in l_m \wedge l_m \in R_i, w_e^B.pos \in l_n \wedge l_n \in R_j, i = j, m = n$
(3) $fd(w_0^B.pos, w_e^B.pos, l_m) = 1$
(4) $\nexists i \in (0, e], (w_i^O.pos \in l_m) \wedge (\sqrt{(w_i^B.x - w_i^O.x)^2 + (w_i^B.y - w_i^O.y)^2} \geq H)$
(5) $e < p$
(6) $(w_0^B.x - w_e^B.x) = DX(0, e), (w_0^B.y - w_e^B.y) = DY(0, e)$
(7) $\forall i \in (0, e), |\frac{spd_i - spd_{i-1}}{\Delta t}| \leq ac^{max}, spd_i \leq spd^{max}$

1.5 The constraints for ”cut in”

(1) $w_e^B.pos \in D \wedge w_0^B.pos \notin D$
(2) $w_0^B.pos \in l_m \wedge l_m \in R_i, w_e^B.pos \in l_n \wedge l_n \in R_j, i = j, m \neq n$
(3) $fd(w_0^B.pos, w_e^B.pos, l_m) = 1$
(4) $w_s^B.pos \in l_m, w_f^B.pos \in l_n, fd(w_0^B.pos, w_s^B.pos, l_m) = 1, fd(w_s^B.pos, w_f^B.pos, l_m) = 1, fd(w_f^B.pos, w_e^B.pos, l_n)$
1
(5) $w_s^O.pos \in l_n, fd(w_s^O.pos, w_s^B.pos, l_n) = 1, \sqrt{(w_s^B.x - w_s^O.x)^2 + (w_s^B.y - w_s^O.y)^2} \geq H$
(6) $s = m;$
(7) $m < f < n$, $f < e < p$
(8) $(w_0^B.x - w_s^B.x) = DX(0, s), (w_0^B.y - w_s^B.y) = DY(0, s)$
(9) $(w_s^B.x - w_f^B.x) = DX(s, f), (w_s^B.y - w_f^B.y) = DY(s, f)$

(10) $(w_f^B.x - w_e^B.x) = DX(f,e), (w_s^B.y - w_f^B.y) = DY(s,f)$
(11)$\forall i \in (0,e), |\frac{spd_i - spd_{i-1}}{\Delta t}| \leq ac^{max}, spd_i \leq spd^{max}$

1.6 The constraints for "change lane"

(1) $w_e^B.pos \in D \wedge w_0^B.pos \notin D$
(2) $w_0^B.pos \in l_m \wedge l_m \in R_i, w_e^B.pos \in l_n \wedge l_n \in R_j, i = j, m \neq n$
(3) $fd(w_0^B.pos, w_e^B.pos, l_m) = 1$
(4) $w_s^B.pos \in l_m, w_f^B.pos \in l_n, fd(w_0^B.pos, w_s^B.pos, l_m) = 1, fd(w_s^B.pos, w_f^B.pos, l_m) = 1, fd(w_f^B.pos, w_e^B.pos, l_n)$
1
(5) $\nexists i \in [s,f], (w_i^O.pos \in l_n) \wedge fd(w_i^O.pos, w_i^B.pos, l_n) = 1 \wedge (\sqrt{(w_i^B.x - w_i^O.x)^2 + (w_i^B.y - w_i^O.y)^2} \geq H)$
(6) $s = m$
(7) $m < f < n$, $f < e < p$
(8) $(w_0^B.x - w_s^B.x) = DX(0,s), (w_0^B.y - w_s^B.y) = DY(0,s)$
(9) $(w_s^B.x - w_f^B.x) = DX(s,f), (w_s^B.y - w_f^B.y) = DY(s,f)$
(10) $(w_f^B.x - w_e^B.x) = DX(f,e), (w_s^B.y - w_f^B.y) = DY(s,f)$
(11)$\forall i \in (0,e), |\frac{spd_i - spd_{i-1}}{\Delta t}| \leq ac^{max}, spd_i \leq spd^{max}$

1.7 The constraints for "vehicle cross"

(1) $w_e^B.pos \in D \wedge w_0^B.pos \notin D$
(2) $w_0^B.pos \in l_m \wedge l_m \in R_i, w_e^B.pos \in l_n \wedge l_n \in R_j, i \neq j$
(3) $fd(w_0^B, w_e^B, l_m) = 1$
(3) $\exists l_{ex}^m, l_{en}^m \in l_m, \exists l^n ex, l_{en}^n \in l_n, arctan|(k_1 - k_2)/(1 + k_1 k_2)| < \frac{\pi}{2}, k_1 = (l_{ex}^m.y - l_{en}^m.y)/(l_{ex}^m.x - l_{en}^m.x), k_2 = (l_{ex}^n.y - l_{en}^n.y)/(l_{ex}^n.x - l_{en}^n.x)$
(4) $\sqrt{(l_{en}^n.x - l_{ex}^m.x)^2 + (l_{en}^n.y - l_{ex}^m.y)^2} < \sqrt{(l_{ex}^n.x - l_{en}^n.x)^2 + (l_{ex}^n.y - l_{ex}^n.y)^2}$
(5) $e < p$
(6) $(w_0^B.x - w_e^B.x) = DX(0,e), (w_0^B.y - w_e^B.y) = DY(0,e)$
(7)$\forall i \in (0,e), |\frac{spd_i - spd_{i-1}}{\Delta t}| \leq ac^{max}, spd_i \leq spd^{max}$

1.8 The constraints for "turn around"

(1) $w_e^B.pos \in D \wedge w_0^B.pos \notin D$
(2) $w_0^B.pos \in l_m \wedge l_m \in R_i, w_e^B.pos \in l_n \wedge l_n \in R_j, i \neq j$
(3) $fd(w_0^B, w_e^B, l_m) = 1$
(3) $\exists l_{ex}^m, l_{en}^m \in l_m, \exists l^n ex, l_{en}^n \in l_n, arctan|(k_1 - k_2)/(1 + k_1 k_2)| \geq \frac{\pi}{2}, k_1 = (l_{ex}^m.y - l_{en}^m.y)/(l_{ex}^m.x - l_{en}^m.x), k_2 = (l_{ex}^n.y - l_{en}^n.y)/(l_{ex}^n.x - l_{en}^n.x)$
(4) $\sqrt{(l_{en}^n.x - l_{ex}^m.x)^2 + (l_{en}^n.y - l_{ex}^m.y)^2} < \sqrt{(l_{ex}^n.x - l_{en}^n.x)^2 + (l_{ex}^n.y - l_{ex}^n.y)^2}$
(5) $s < f < e, e < p$
(6) $(w_0^B.x - l_{ex}^m.x) = DX(0,s), (w_0^B.y - l_{ex}^m.y) = DY(0,s)$
(7) $(l^m.ex.x - l^n.en.x) = DX(s,f), (l^m.ex.y - l^n.en.y) = DY(s,f)$
(8) $(l^n.ex.x - l^n.en.x) = DX(s,f), (l^n.ex.y - l^n.en.y) = DY(f,e)$
(9)$\forall i \in (0,e), |\frac{spd_i - spd_{i-1}}{\Delta t}| \leq ac^{max}, spd_i \leq spd^{max}$

1.9 The constraints for "pedestrian walk"

(1) $w_e^B.pos \in D$
(2) $\forall i \in [0, e], w_i^B.pos \notin R$
(3) $(w_0^B.x - w_e^B.x) = DX(0, e), (w_0^B.y - w_e^B.y) = DY(0, e)$
(4)$\forall i \in (0, e), spd_i \leq 5$

1.10 The constraints for "pedestrian cross"

(1) $w_e^B.pos \in D$
(2) $\exists i \in [0, e], w_i^B.pos \in R$
(3) $(w_0^B.x - w_e^B.x) = DX(0, e), (w_0^B.y - w_e^B.y) = DY(0, e)$
(4)$\forall i \in (0, e), spd_i \leq 5$