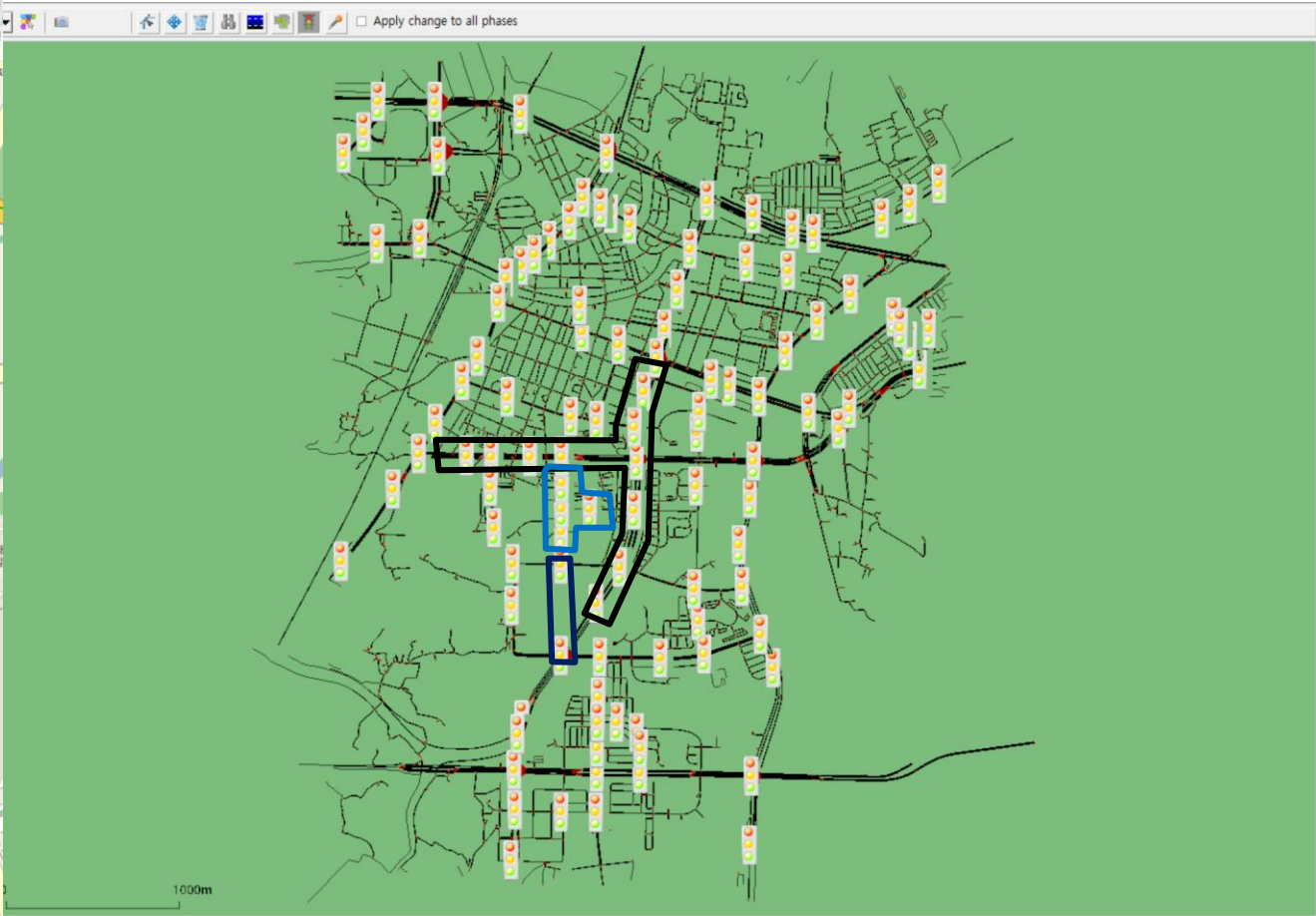
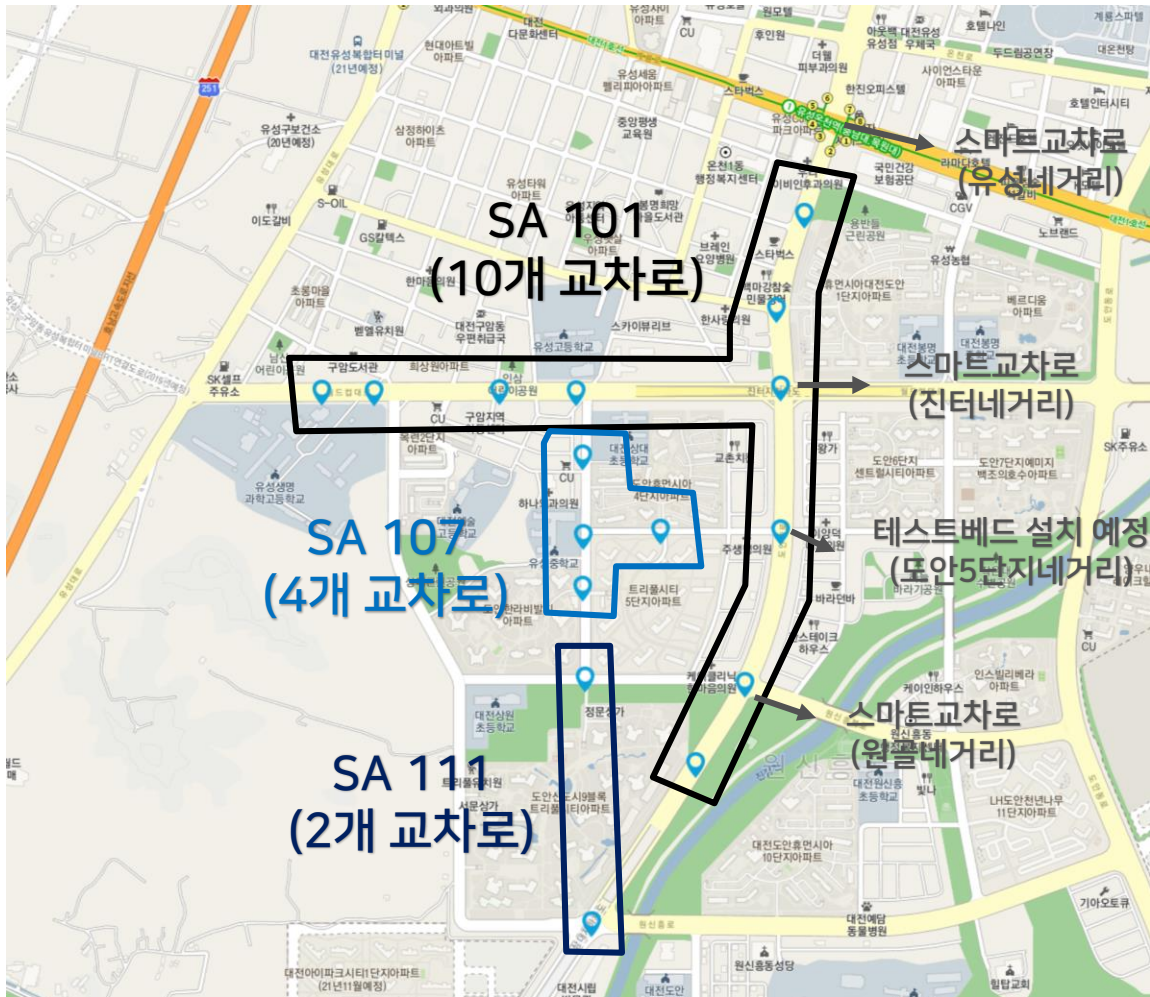


# DQN 기반 다중 교차로 신호 최적화

2021/06/24

피민규



filename	crossName	signalGroup	cycle	offset	minGreen	maxGreen	yellow	nodeID
1-1, 1-2번(단).xls	도안1단지(단)	SA 101	180/180/180/180/180/180/180	115/103/103/103/115/115/115	51,60	51,180	0,3	cluster_563100866_563103911_563103912
11-1번(단).xls	원골(단)	SA 101	180/180/180/180/180/180/180	161/139/139/139/151/151/151	40,53,45	90,53,180	3,0,0	cluster_563103888_563103891
5-1번(단).xls	유성고후문(단)(5-1번)	SA 101	180/180/180/180/180/180/180	165/130/155/169/155/165/2	48,80	48,190	0,3	cluster_563100016_563103847_563109512_563109513
5-2번3.xls	상대초교(단)	SA 101	180/180/180/180/180/180/180	165/130/155/169/155/165/2	51,80	51,190	0,3	cluster_563102154_563103845_563109514_563109515
8번4.xls	도안5단지네거리	SA 101	180/180/180/180/180/180/180	157/146/144/144/157/157/157	26,25,25,26,23,23	45,60,60,45,40,40	3,0,3,3,3	cluster_563103437_563103890_563103913_563103914
구암119안전센터3.xls	구암119안전센터삼거리	SA 101	180/180/180/180/180/180/180	0/0/0/0/0/0/0	30,50	75,195	0,4	cluster_563109510_563109511
원골네거리.xls	원골네거리	SA 101	180/180/180/180/180/180/180	157/144/144/144/157/157/157	15,37,15,51	45,130,30,85	4,3,3,4	cluster_563103641_563103889_563103894_563103895
인삼골네거리.xls	인삼골네거리	SA 101	180/180/180/180/180/180/180	2/140/169/169/165/2/2	43,27,27,17	70,160,45,30	3,4,3,3	cluster_563103433_563103849_563103871_563103872_563103873_563103874_563103875_563104618
도안5단지(단).xls	도안5단지(단)	SA 107	120	0	29,50	29,140	0,3	563106861
유성중삼거리.xls	유성중삼거리	SA 107	120	0	26,27,26	55,65,65	3,0,3	563103625
휴먼시아4단지(단).xls	휴먼시아4단지(단)	SA 107	120	70	28,50	28,140	0,3	NA
10번4.xls	도안9단지4(10번)	SA 111	150/150/150/150/150/150/150	5/5/5/5/5/5/5	32,29,27,33	55,60,60,55	3,3,3,3	563103639
상대네거리.xls	상대네거리	SA 111	150/150/150/150/150/150/150	0/0/0/0/0/0/0	31,49,20,31	55,80,45,55	3,4,4,3	cluster_563103476_563103477_563103812_563103813_563103814_563103815_563103816_563103817_563103820_563103821



# 제어 가능한 교차로 목록

- (단), 제어 불가능 신호(구암119안전센터) 제외, 총 8개



SA101



SA107



SA111

# 구암119안전센터삼거리

교차로명 : 구암119안전센터삼거리		교차로번호 : 68		교차로군 : SA 101		작성년월 :															
4	<div>구암119안전센터</div> <div>유성생명고교</div> <div>인삼골4</div>		Φ1	Φ2	Φ3	Φ4	Φ5	Φ6													
			← →	← →	↙ ↘																
						소방우선신호 작동시 3현시 50초 진행															
교차로 구분		RING A	A1	A2	A3	A4	A5	A6													
			←	←	↙																
교차로 운영		RING B	→	→																	
			B1	B2	B3	B4	B5	B6													
SIGNAL TABLE																					
OPTION			10	20																	
			10	20																	
MIN. GREEN			30	50																	
			30	50																	
MAX. II			75	195																	
			75	195																	
YELLOW(RED)				4																	
				4																	
BEF. PED.																					
WALK																					
WALK CLEAR																					
PLAN TABLE																					
TIME PLAN 1								구분	TOD PLAN 1			TOD PLAN 2			TOD PLAN 3			예약정보(월~일 : 0, 토:7, 일:1, 월~금:8)			
수준	주기(초)	ID	연동	시간분할(초)	감응제어				시각	수준	ID	시각	수준	ID	시각	수준	ID	시각	종료	요일/점별	
1	180	1	0	50.130	RING A. B	압버튼(x)	검지기(O)	검지기(x)	1	00:00	1	1	00:00	1	1	00:00	1	1			
				50.130						2	07:00	2	2	07:00	2	2	09:30	2	3		
				50.130						3	09:30	2	3	09:30	2	3	21:00	3	6		
8" crossName="구암119안전센터삼거리" date="2019-01-28" signalGroup="SA 101">																					

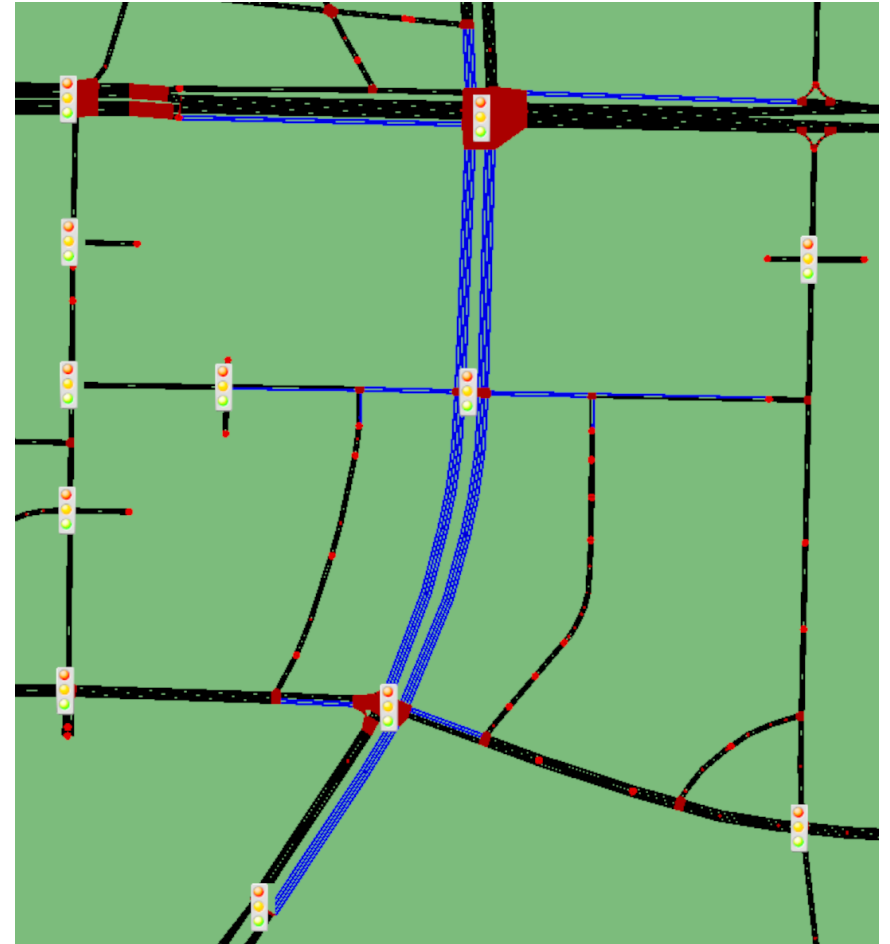
# Problem I

- 똑같은 상황에선, 똑같은 action을 줬을 때, 똑같은 보상을 받을 수 있어야 하지만, 주변 교차로 때문에 그게 안됨
- 그럼 주변 교차로를 state에 포함하자
- 그 주변 교차로의 주변 교차로 때문에 안되려나? (1-hop, 2-hop .. )
- 가중치를 뒤편서 교차로가 멀어질수록 주변 교차로의 state에는 가중치를 곱하자
  - Ex. 1-hop 교차로 가중치 0.7, 2-hop 교차로 가중치 0.5 ...
    - 이 가중치를 학습할 수 있는 방법도 있을지?

# ex) 도안5단지네거리



getConnectedLink(tsID)



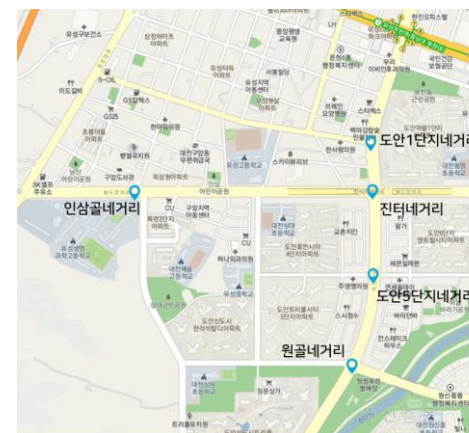
Inflow link의 1-hop link 까지 state  
2-hop(?)

- Actor critic 계열 수렴 잘 안 되고, DQN이 훨씬 잘 됨
- DQN 적용을 위한 Discrete Action 설계
  - TOD 변경이나 민원으로 인한 현시값 조정이 있는 경우, 많이 안 바뀌고 현시 2개 가지고 조정함
  - 현시를 주고 빼기 유리한 신호는 신호 길이가 가장 긴 주 도로 방향 현시인 것으로 보임
  - 주 도로 현시와 나머지 현시 중 하나를 선택해서 조정하자

교차로명 : 진터네거리				교차로번호 : 1506		교차로군 : SA 101		작성년월 : 2011. 4. 7.	
<div><div>4</div><div><div>도안1단지4</div><div>상대초교(단)</div><div>도안5단지4</div></div><div><div>44.0</div><div>43.0</div><div>38.0</div><div>43.0</div><div>계룡대교4</div></div></div>				<div><div>Φ1</div><div>Φ2</div><div>Φ3</div><div>Φ4</div><div>Φ5</div><div>Φ6</div></div> <div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div></div> <div><div>버스 RED</div><div>버스 GREEN</div><div>버스 RED</div><div>버스 RED</div><div>버스 RED</div><div></div></div>		<div><div>퇴근시간 현시간 조정 (만원)</div></div>			
교차로명 : 원골네거리				교차로번호 : 1510		교차로군 : 101		작성년월 : 2011. 4. 7.	
<div><div>4</div><div><div>도안5단지4</div><div>도안9단지4</div><div>원골(단)</div></div><div><div>45.4</div><div>18.1</div><div>41.5</div><div>27.5</div><div>원신흥주민센터</div></div></div>				<div><div>Φ1</div><div>Φ2</div><div>Φ3</div><div>Φ4</div><div>Φ5</div><div>Φ6</div></div> <div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div><div><div><div></div><div></div></div></div></div> <div><div>버스전용</div></div>					
교차로 구분				교차로 운영		SIGNAL TABLE		OPTIO	
MIN. GR				MAX.		YELLOW		BEF. P	
WALK				WALK CL		TIME PLAN		PLAN TABLE	
수준				주기 (초)		ID		연동	
1				180		1		157	
2				180		2		144	
3				180		3		144	
4				180		4		144	
5				180		5		157	
6				180		6		157	
7				180		7		157	
시간분할(초)				RING A, B		압버튼(×)		감응제어	
22.76,22.32,28				20.85,20.55		30.75,20.55		감지기(O)	
22.76,22.32,28				20.85,20.55		30.75,20.55		감지기(×)	
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			
22.76,22.32,28				20.85,20.55		30.75,20.55			

# SA 101 그룹 현시 정보

1	180	1	1.46	18.56, 30.19, 38.15 18.56, 30.19, 38.15
2	180	2	1.33	18.56, 30.19, 38.15 18.56, 30.19, 38.15
		3	1.33	18.56, 30.19, 38.15 18.56, 30.19, 38.15
		4	1.33	18.56, 30.19, 38.15 18.56, 30.19, 38.15
		5	1.46	18.56, 30.19, 38.15 18.56, 30.19, 38.15
3	180	6	1.46	18.56, 30.19, 38.15 18.56, 30.19, 38.15
		7	1.46	18.56, 30.19, 38.15 18.56, 30.19, 38.15



SA101

수준	주기 (초)	ID	연 동	시간분할(초) PING A, B
1	180	1	157	22.76, 22.32, 28.28 22.76, 22.32, 28.28
		2	144	22.76, 22.32, 28.28 22.76, 22.32, 28.28
2	180	3	144	22.76, 22.32, 28.28 22.76, 22.32, 28.28
		4	144	22.76, 22.32, 28.28 22.76, 22.32, 28.28
		5	157	25.73, 22.32, 28.28 25.73, 22.32, 28.28
3	180	6	157	22.76, 22.32, 28.28 22.76, 22.32, 28.28
		7	157	22.76, 22.32, 28.28 22.76, 22.32, 28.28

교차로명 : 인삼골네거리		교차로번호 : 1504		교차로군 : SA 101		작성년월 :	
		Φ1	Φ2	Φ3	Φ4	Φ5	Φ6
4	<p>유성생명 고교</p> <p>36.6</p> <p>18.3</p> <p>유성고교후문</p> <p>도안목련4</p>					PPC 보드설치	


구분	주기 (초)	ID	연동 영동	시간분할(초) RING A, B
1	180	1	2	46, 84, 30, 20
				46, 84, 30, 20
2	180	2	140	46, 84, 30, 20
				46, 84, 30, 20
		3	169	46, 84, 30, 20
				46, 84, 30, 20
		4	169	46, 84, 30, 20
				46, 84, 30, 20
3	180	5	165	46, 84, 30, 20
				46, 84, 30, 20
		6	2	46, 84, 30, 20
				46, 84, 30, 20
7	2	46, 84, 30, 20		
		46, 84, 30, 20		

교차로명 : 도안1단지네거리		교차로번호 : 1502		교차로군 : SA 101		작성년월 :	
4		Φ1	Φ2	Φ3	Φ4	Φ5	Φ6
		 버스 RED	 버스 GREEN	 버스 GREEN	 버스 RED	 버스 RED	 버스 RED

교차로명 : 진터네거리		교차로번호 :	1506	교차로군 : SA 101	작성년월 :		
		Φ1	Φ2	Φ3	Φ4	Φ5	Φ6
4	<p>도안1단지4</p> <p>상대초교(단)</p> <p>43.0</p> <p>44.0</p> <p>38.0</p> <p>도안5단지4</p> <p>계룡대교4</p>						<div>퇴근시간 현시간 조정 (만원)</div>
		버스 RED	버스 GREEN	버스 RED	버스 RED	버스 RED	

수 량	주 기 (초)	ID	연 동	시간분할(초) RING A, B	압
1	180	1	157	20.85,20.55 20.85,20.55	
		2	144	30.75,20.55 30.75,20.55	
2	180	3	144	20.85,20.55 20.85,20.55	
		4	144	20.85,20.55 20.85,20.55	
		5	157	20.85,20.55 20.85,20.55	
3	180	6	157	20.85,20.55 20.85,20.55	
		7	157	20.85,20.55 20.85,20.55	

교차로명 : 도안5단지내거리		교차로번호 : 1509		교차로군 : SA 101		작성년월 :		
4		Φ1	Φ2	Φ3	Φ4	작성년월 :	Φ6	
							<div>아침시간 D 열시각 조정 (민원)</div>	
		버스 RED	버스 GREEN	버스 GREEN	버스 RED	버스 RED		버스 RED

교차로명 : 원골네거리		교차로번호 : 1510	교차로군 : 101	작성년월 : 2011. 4. 7.			
4	<div><div>도안5단지4</div><div>45.4</div><div>도안9단지4</div><div>18.1</div><div>27.5 원신흥주민센터</div><div>41.5</div><div>원골(단)</div></div>	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6
			 버스전용				

수험	주기 (초)	ID	연 동	시간분할(초) RING A, B
1	180	1	157	29.35.35.29.26.26 29.35.35.29.26.26
			146	29.33.33.29.26.30 29.33.33.29.26.30
2	180	2	144	29.35.35.29.26.26 29.35.35.29.26.26
			144	29.35.35.29.26.26 29.35.35.29.26.26
		5	157	29.35.35.29.26.26 29.35.35.29.26.26
			157	29.35.35.29.26.26 29.35.35.29.26.26
3	180	6	157	29.35.35.29.26.26 29.35.35.29.26.26
			157	29.35.35.29.26.26 29.35.35.29.26.26



# DQN Agent

- 각 교차로마다 총 8개의 agent를 독립적으로 생성(상호작용 x, 다른 agent가 무슨 action을 하는지 모름)

- State

- 1-hop 까지 lane별 density
- State space : 1-hop 까지 연결된 lane 수
- 아직 가중치는 도입 안 함 - done

- Action

- 주 도로 방향 현시와 나머지 현시 중 하나 선택해서 증감
- Action space : (현시 수 - 주 도로 방향 현시)\*2
- 변경 안하는 것도 추가 해야 함 - done

- Reward

- + (1-hop 까지 lane별 차량 통과 수의 합)
- -100 (증감 하다가 최소 녹색이나 최대 녹색을 넘어가면)

주 현시  
주 도로 신호 주는 현시, 녹색 시간이 가장 긴 현시

교차로명 : 인삼골네거리	교차로번호 : 1504	교차로군 : SA 101	작성년월 :
4	유성생명고교	유성고교후문(	도안목록4
Φ1	Φ2	Φ3	Φ4
Φ5	Φ6	PPC 보드설치	

주 현시 : 2  
나머지 현시 : 1, 3, 4 (3개)  
Action space : 6

Action : [0, 1, 2, 3, 4, 5]

나머지 신호에서 주 현시에 3초만큼 줌    주 현시에서 나머지 신호에 3초만큼 줌



변경 안함

Action : [0, 1, 2, 3, 4, 5, 6]

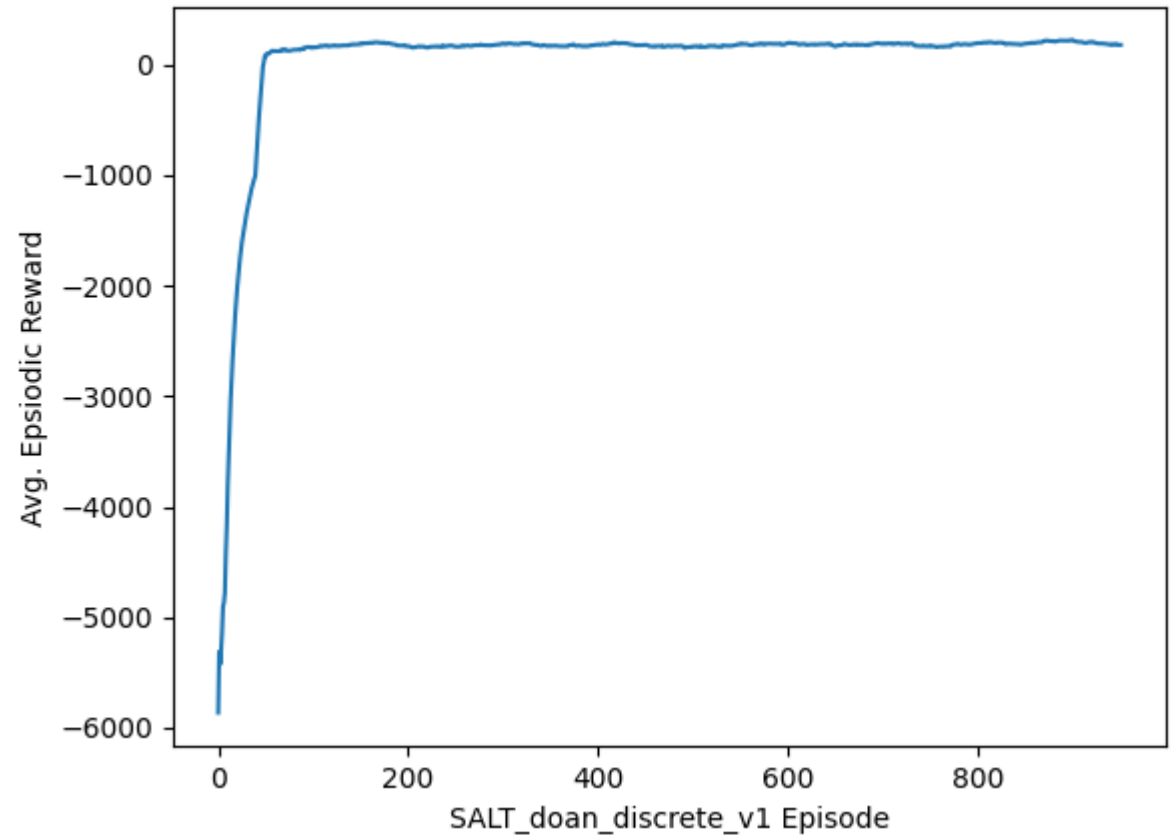
주 현시 : 2  
나머지 현시 : 1, 3, 4 (3개)  
Action space : 7

나머지 신호에서 주 현시에 3초만큼 줌    주 현시에서 나머지 신호에 3초만큼 줌

# 학습 결과

- 1 epoch당 약 23초
- Penalty에 대해서는 50 epoch만에 학습 함
- Y 축 스케일 때문에 제대로 확인 불가..

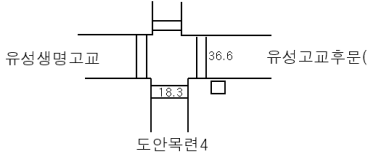
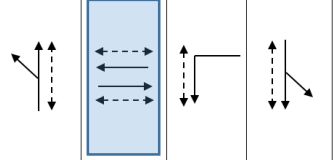
```
<trafficSignal nodeID="cluster_563103433_563103849_563103871_563103872_563103873_563103874_563103875_563104618" version="2" crossNo="1504" crossName="인삼골네거리">
  <schedule offset="140" id="2">
    <phase state="rrrrrGgGgGrrrrrr" duration="43" minDur="43" maxDur="70"/>
    <phase state="rrrrrygyvyrrrrrr" duration="3"/>
    <phase state="rGgGrrrrrrrGgGrrr" duration="80" minDur="27" maxDur="160"/>
    <phase state="ryyyrrrrrrryyyrrr" duration="4"/>
    <phase state="grrrGgGrrrrrrrrrrr" duration="27" minDur="27" maxDur="45"/>
    <phase state="grrryyGrrrrrrrrrrr" duration="3"/>
    <phase state="grrrrrGrrrrrrrrrrGg" duration="17" minDur="17" maxDur="30"/>
    <phase state="yrrrrrGrrrrrrrrrry" duration="3"/>
  </schedule>
  <TOOPlan offset="140" defaultPlan="2"/>
</trafficSignal>
```



# Action 파라미터 조정 실험

- 교차로마다 신호 조정 효과가 다를 수 있음
- 3초, 5초, 7초에 대해서 실험

주 현시(?)  
주 도로 신호 주는 현시, 녹색 시간이 가장 긴 현시

교차로명 : 인삼골네거리	교차로번호 : 1504	교차로군 : SA 101	작성년월 :
4			PPC 보드설치

주 현시 : 2

나머지 현시 : 1, 3, 4 (3개)

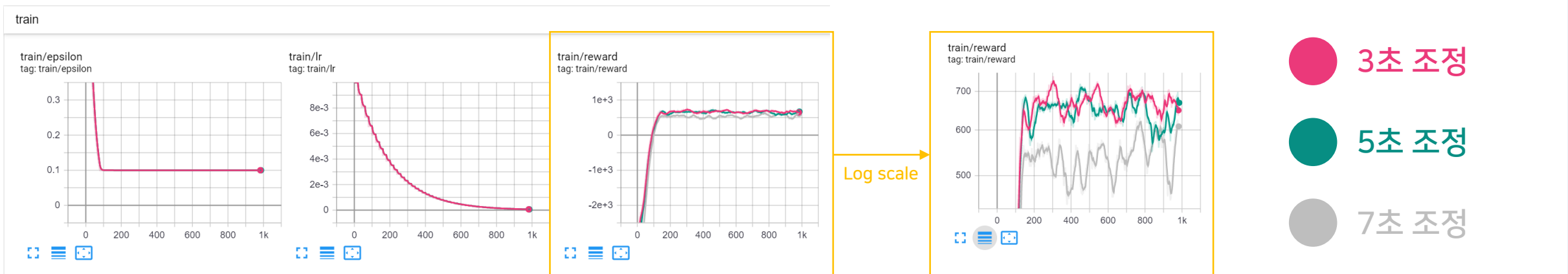
Action space : 7

변경 안함

Action : [0, 1, 2, 3, 4, 5, 6]

나머지 신호에서 주 현시에 3초만큼 줄 주 현시에서 나머지 신호에 3초만큼 줄

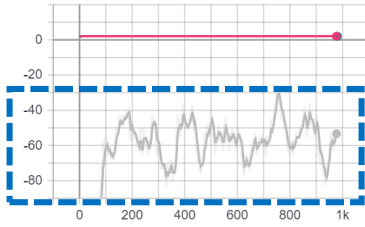
## 학습 결과



# 학습 결과 - 각 교차로별 reward

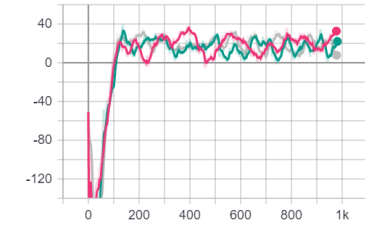
train\_agent\_reward

train\_agent\_reward/agent\_0\_유성중삼거리  
tag: train\_agent\_reward/agent\_0\_유성중삼거리



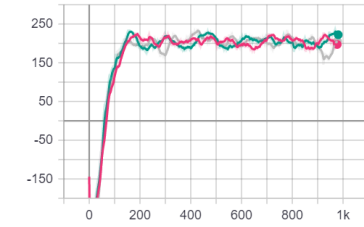
🔍 ☰ 🖨

train\_agent\_reward/agent\_1\_도안9단지4(10번)  
tag: train\_agent\_reward/agent\_1\_도안9단지4(10번)



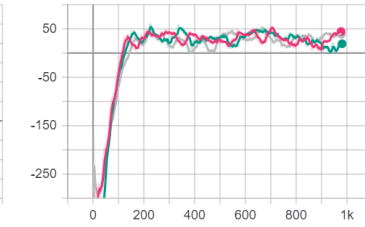
🔍 ☰ 🖨

train\_agent\_reward/agent\_2\_진터네거리  
tag: train\_agent\_reward/agent\_2\_진터네거리



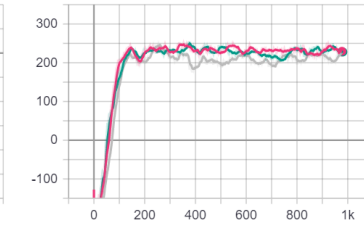
🔍 ☰ 🖨

train\_agent\_reward/agent\_3\_인삼골네거리  
tag: train\_agent\_reward/agent\_3\_인삼골네거리



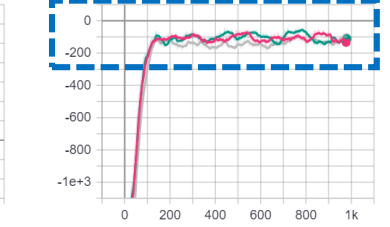
🔍 ☰ 🖨

train\_agent\_reward/agent\_4\_도안5단지네거리  
tag: train\_agent\_reward/agent\_4\_도안5단지네거리



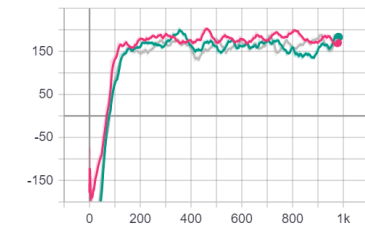
🔍 ☰ 🖨

train\_agent\_reward/agent\_5\_상대네거리  
tag: train\_agent\_reward/agent\_5\_상대네거리



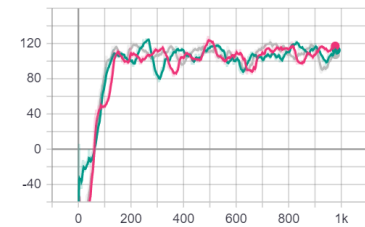
🔍 ☰ 🖨

train\_agent\_reward/agent\_6\_도안1단지네거리  
tag: train\_agent\_reward/agent\_6\_도안1단지네거리



🔍 ☰ 🖨

train\_agent\_reward/agent\_7\_원골네거리  
tag: train\_agent\_reward/agent\_7\_원골네거리

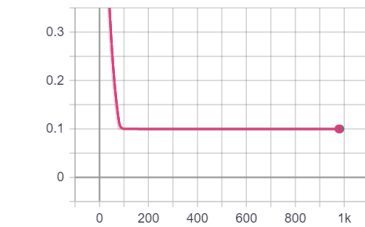


🔍 ☰ 🖨

대부분의 action이 마이너스 보상(페널티)을 받는 경우 학습이 안 되는 것처럼 보임  
→ Epsilon\_min 값이 0.1이라 학습할 땐 계속 탐험하는게 원인  
→ Test 할 땐 마이너스 보상 없이 잘 동작함

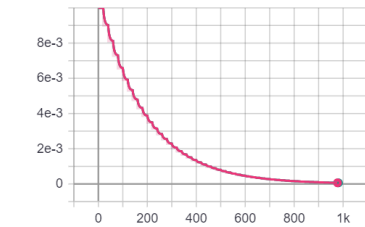
train

train/epsilon  
tag: train/epsilon



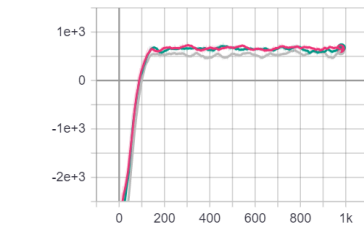
🔍 ☰ 🖨

train/lr  
tag: train/lr



🔍 ☰ 🖨

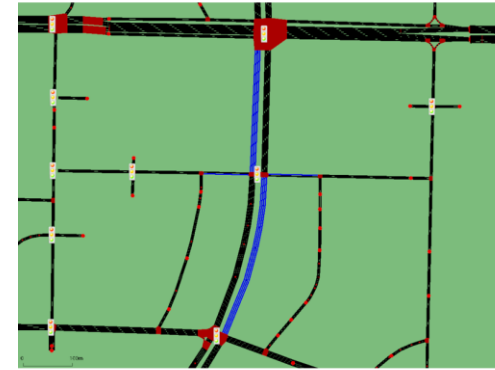
train/reward  
tag: train/reward



🔍 ☰ 🖨

# State weight 조정 실험

- 1-hop lane까지
- State 가중치 1, 0.7, 0.5, 0.3, 0.0 에 대해서 실험
- Reward는 가중치 1로 고정, 1-hop lane까지 차량 통과량 합/100



getConnectedLink(tslID)



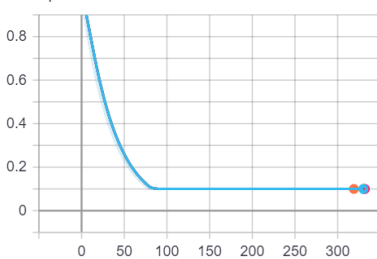
Inflow link의 1-hop link 까지 state  
2-hop(?)



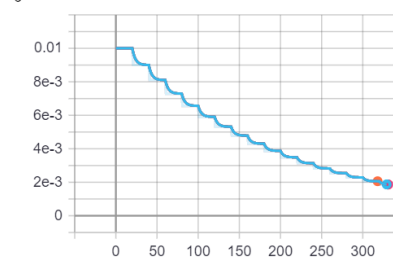
## 학습 결과

train

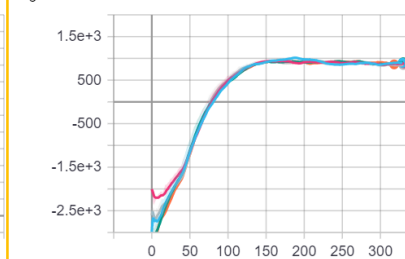
train/epsilon  
tag: train/epsilon



train/lr  
tag: train/lr

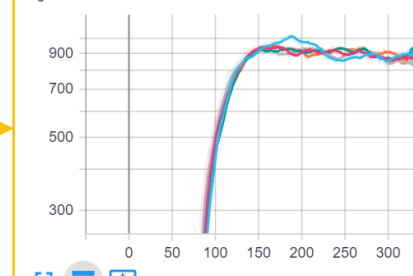


train/reward  
tag: train/reward



Log scale

train/reward  
tag: train/reward



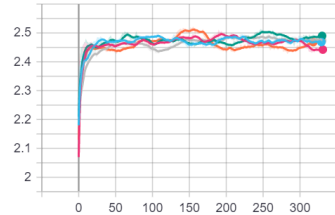
- State weight 0.0
- State weight 0.3
- State weight 0.5
- State weight 0.7
- State weight 1.0



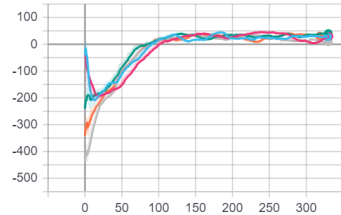
# 학습 결과 - 각 교차로별 reward

train\_agent\_reward

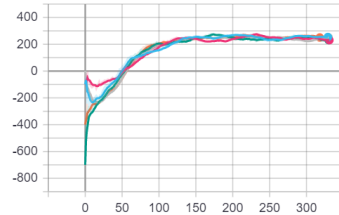
train\_agent\_reward/agent\_0\_유성중삼거리  
tag: train\_agent\_reward/agent\_0\_유성중삼거리



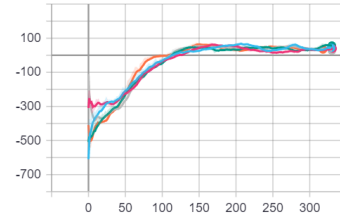
train\_agent\_reward/agent\_1\_도안9단지4(10번)  
tag: train\_agent\_reward/agent\_1\_도안9단지4(10번)



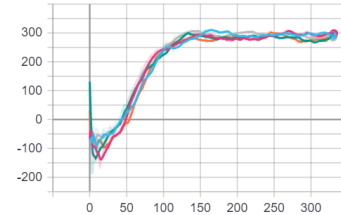
train\_agent\_reward/agent\_2\_진터네거리  
tag: train\_agent\_reward/agent\_2\_진터네거리



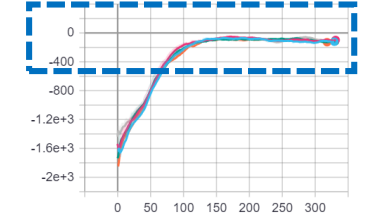
train\_agent\_reward/agent\_3\_인삼골네거리  
tag: train\_agent\_reward/agent\_3\_인삼골네거리



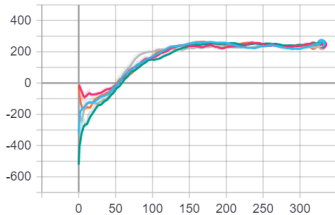
train\_agent\_reward/agent\_4\_도안5단지네거리  
tag: train\_agent\_reward/agent\_4\_도안5단지네거리



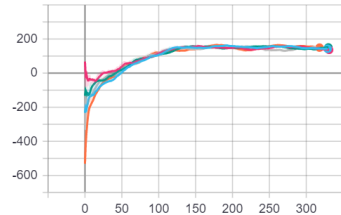
train\_agent\_reward/agent\_5\_상대네거리  
tag: train\_agent\_reward/agent\_5\_상대네거리



train\_agent\_reward/agent\_6\_도안1단지네거리  
tag: train\_agent\_reward/agent\_6\_도안1단지네거리

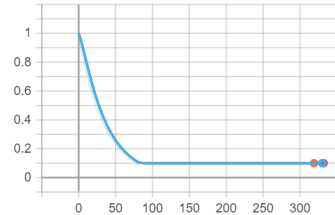


train\_agent\_reward/agent\_7\_원골네거리  
tag: train\_agent\_reward/agent\_7\_원골네거리

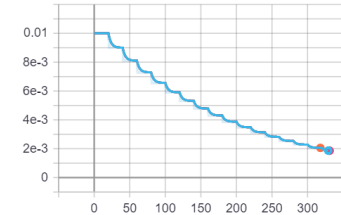


train

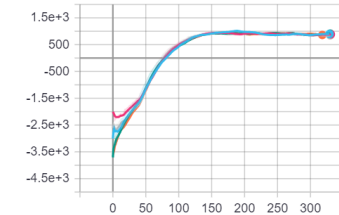
train/epsilon  
tag: train/epsilon



train/lr  
tag: train/lr



train/reward  
tag: train/reward

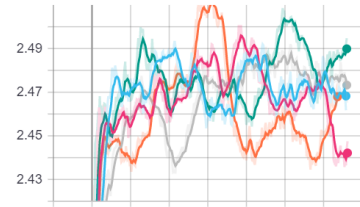


# 학습 결과 - 각 교차로별 reward

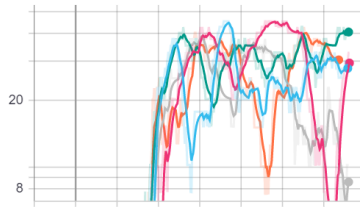
Ignore outliers in chart scaling, log scale

train\_agent\_reward

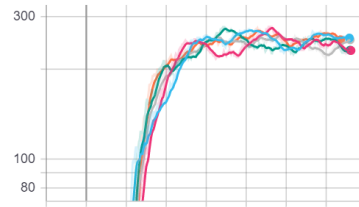
train\_agent\_reward/agent\_0\_유성중삼거리  
tag: train\_agent\_reward/agent\_0\_유성중삼거리



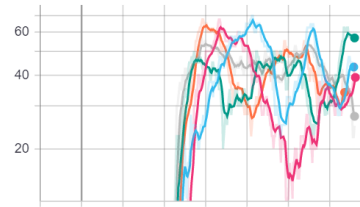
train\_agent\_reward/agent\_1\_도안9단지4(10번)  
tag: train\_agent\_reward/agent\_1\_도안9단지4(10번)



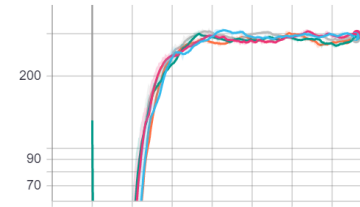
train\_agent\_reward/agent\_2\_진터네거리  
tag: train\_agent\_reward/agent\_2\_진터네거리



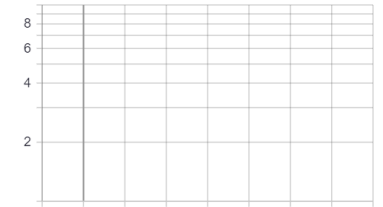
train\_agent\_reward/agent\_3\_인삼골네거리  
tag: train\_agent\_reward/agent\_3\_인삼골네거리



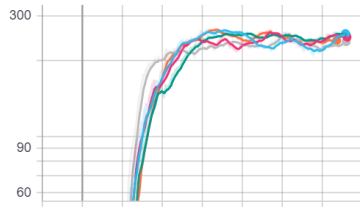
train\_agent\_reward/agent\_4\_도안5단지네거리  
tag: train\_agent\_reward/agent\_4\_도안5단지네거리



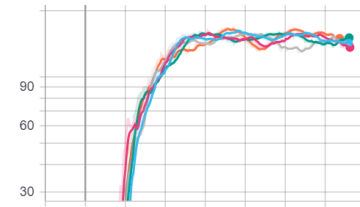
train\_agent\_reward/agent\_5\_상대네거리  
tag: train\_agent\_reward/agent\_5\_상대네거리



train\_agent\_reward/agent\_6\_도안1단지네거리  
tag: train\_agent\_reward/agent\_6\_도안1단지네거리

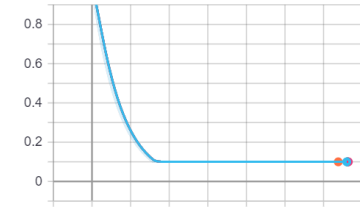


train\_agent\_reward/agent\_7\_원골네거리  
tag: train\_agent\_reward/agent\_7\_원골네거리

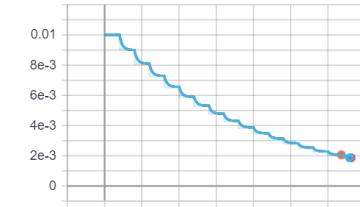


train

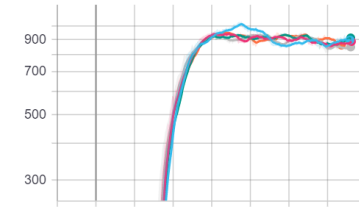
train/epsilon  
tag: train/epsilon



train/lr  
tag: train/lr



train/reward  
tag: train/reward



# 결과 비교

200번 model 기준

State weight	Total Reward	Action							
		유성중3	도안9단지4	진터4	인삼골4	도안5단지4	상대4	도안1단지4	원골4
0.0	1292.5	0	0	0	6	0	0	0	0
0.3	1294.5	0	0	0	6	0	0	10	0
0.5	1292.3	0	0	6	3	0	2	0	4
0.7	1295.2	1	0	0	0	0	0	0	0
1.0	1294.5	0	0	0	0	0	0	0	0
기존 신호	1309.8								

# Action 수정

- 2현시 - 3
- 3현시 - 7
- 4현시 - 15
- 5현시 - 31
- 6현시 - 53

```
action_list_phase_num2 = getActionList(phase_num = 2, max_phase = 0)
print("action space: {} #naction list: {}".format(len(action_list_phase_num2), action_list_phase_num2))
```

```
action space: 3
action list: [[-1, 1], [1, -1], [0, 0]]
```

```
action_list_phase_num3 = getActionList(phase_num = 3, max_phase = 0)
print("action space: {} #naction list: {}".format(len(action_list_phase_num3), action_list_phase_num3))
```

```
action space: 7
action list: [[-1, 0, 1], [1, -1, 0], [-1, 1, 0], [1, 0, -1], [-2, 1, 1], [2, -1, -1], [0, 0, 0]]
```

```
action_list_phase_num4 = getActionList(phase_num = 4, max_phase = 0)
print("action space: {} #naction list: {}".format(len(action_list_phase_num4), action_list_phase_num4))
```

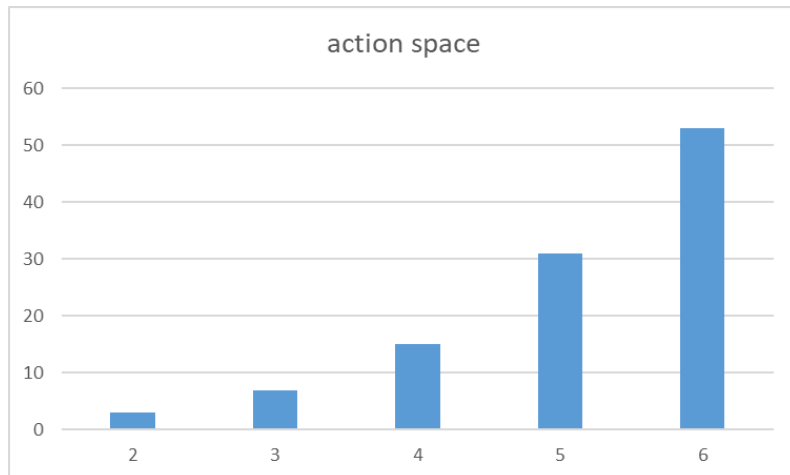
```
action space: 15
action list: [[-2, 0, 1, 1], [-1, 0, 0, 1], [-2, 1, 0, 1], [-1, 0, 1, 0], [-2, 1, 1, 0], [1, -1, 0, 0], [-1, 1, 0, 0], [2, -1, -1, 0], [1, 0, -1, 0], [2, -1, 0, -1], [1, 0, 0, -1], [2, 0, -1, -1], [-3, 1, 1, 1], [3, -1, -1, -1], [0, 0, 0, 0]]
```

```
action_list_phase_num5 = getActionList(phase_num = 5, max_phase = 0)
print("action space: {} #naction list: {}".format(len(action_list_phase_num5), action_list_phase_num5))
```

```
action space: 31
action list: [[-3, 0, 1, 1, 1], [-2, 0, 0, 1, 1], [-3, 1, 0, 1, 1], [-2, 0, 1, 0, 1], [-3, 1, 1, 0, 1], [-1, 0, 0, 0, 1], [-2, 1, 0, 0, 1], [-2, 0, 1, 1, 0], [-3, 1, 1, 1, 0], [-1, 0, 0, 1, 0], [-2, 1, 0, 1, 0], [-1, 0, 1, 0, 0], [-2, 1, 1, 0, 0], [1, -1, 0, 0, 0], [-1, 1, 0, 0, 0], [2, -1, -1, 0, 0], [1, 0, -1, 0, 0], [2, -1, 0, -1, 0], [1, 0, 0, -1, 0], [3, -1, -1, -1, 0], [2, 0, -1, -1, 0], [2, -1, 0, 0, -1], [1, 0, 0, 0, -1], [3, -1, -1, 0, -1], [2, 0, -1, 0, -1], [3, -1, 0, -1, -1], [2, 0, 0, -1, -1], [3, 0, -1, -1, -1], [-4, 1, 1, 1, 1], [4, -1, -1, -1, -1], [0, 0, 0, 0, 0]]
```

```
action_list_phase_num6 = getActionList(phase_num = 6, max_phase = 0)
print("action space: {} #naction list: {}".format(len(action_list_phase_num6), action_list_phase_num6))
```

```
action space: 53
action list: [[-4, 0, 1, 1, 1, 1], [-3, 0, 0, 1, 1, 1], [-4, 1, 0, 1, 1, 1], [-3, 0, 1, 0, 1, 1], [-4, 1, 1, 0, 1, 1], [-2, 0, 0, 0, 1, 1], [-3, 1, 0, 0, 1, 1], [-3, 0, 1, 1, 0, 1], [-4, 1, 1, 1, 0, 1], [-2, 0, 0, 1, 0, 1], [-3, 1, 0, 1, 0, 1], [-2, 0, 1, 0, 0, 1], [-3, 1, 1, 0, 0, 1], [-2, 1, 0, 0, 0, 1], [-3, 0, 1, 1, 1, 0], [-4, 1, 1, 1, 1, 0], [-2, 0, 0, 1, 1, 0], [-3, 1, 0, 1, 1, 0], [-2, 0, 1, 0, 1, 0], [-3, 1, 1, 0, 1, 0], [-2, 1, 0, 0, 1, 0], [-2, 0, 1, 1, 0, 0], [-2, 1, 1, 0, 0, 0], [2, -1, -1, 0, 0, 0], [2, -1, 0, -1, 0, 0], [3, -1, -1, -1, 0, 0], [2, 0, -1, -1, 0, 0], [2, -1, 0, 0, -1, 0], [2, 0, -1, 0, -1, 0], [3, -1, 0, -1, -1, 0], [2, 0, 0, -1, -1, 0], [4, -1, -1, -1, -1, 0], [3, 0, -1, -1, -1, 0], [2, -1, 0, 0, 0, -1], [3, -1, -1, 0, 0, -1], [2, 0, -1, 0, 0, -1], [3, -1, 0, -1, 0, -1], [2, 0, 0, -1, 0, -1], [4, -1, -1, -1, 0, -1], [3, 0, -1, -1, 0, -1], [3, -1, 0, 0, -1, -1], [2, 0, 0, 0, -1, -1], [4, -1, -1, 0, -1, -1], [3, 0, -1, 0, -1, -1], [4, -1, 0, -1, -1, -1], [3, 0, 0, -1, -1, -1], [4, 0, -1, -1, -1, -1], [-5, 1, 1, 1, 1, 1], [5, -1, -1, -1, -1, -1], [0, 0, 0, 0, 0, 0]]
```



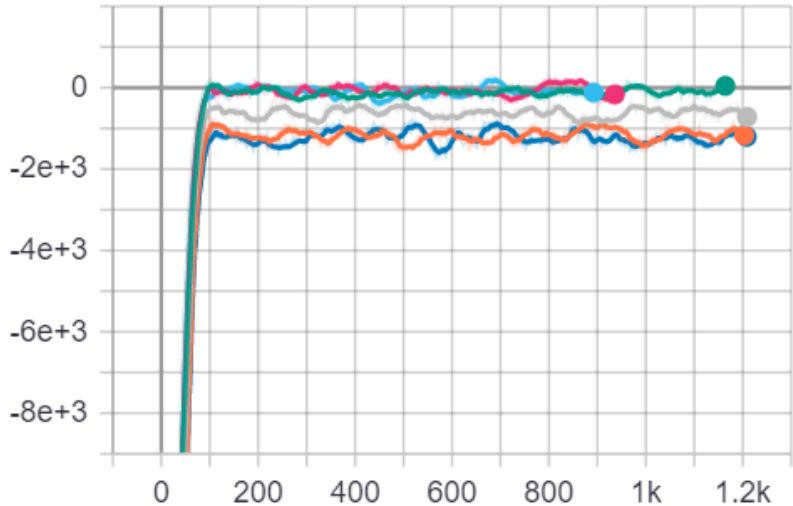
- 학습 잘 안되면 2,3현시 합쳐서 5현시로 변경 후 실험

[illegible]



# 6개 실험 결과(state weight와 add time 변경)

train/reward\_40ep\_mean  
tag: train/reward\_40ep\_mean



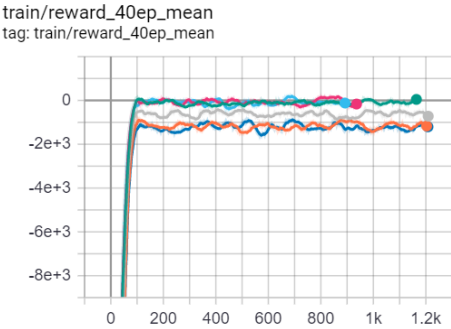
State Weight	Add Time
0.0	3
0.0	5
0.0	7
0.5	3
0.5	7
1.0	3

Name	Smoothed	Value	Step	Time	Relative
SALT_doan_discrete_v2/sw0.0_at3_07-08_18-46-37	45.61	79.55	1.164k	Fri Jul 9, 09:27:35	14h 40m 32s
SALT_doan_discrete_v2/sw0.0_at5_07-08_19-15-51	-721	-765.3	1.209k	Fri Jul 9, 10:23:57	15h 7m 40s
SALT_doan_discrete_v2/sw0.0_at7_07-08_19-15-59	-1169	-1228	1.203k	Fri Jul 9, 10:23:34	15h 7m 8s
SALT_doan_discrete_v2/sw0.5_at3_07-08_18-38-51	-166.3	-150.7	936	Fri Jul 9, 06:35:14	11h 55m 59s
SALT_doan_discrete_v2/sw0.5_at7_07-08_19-16-06	-1206	-1308	1.208k	Fri Jul 9, 10:23:51	15h 7m 17s
SALT_doan_discrete_v2/sw1.0_at3_07-08_17-04-23	-119.4	-131.3	892	Fri Jul 9, 04:19:10	11h 14m 23s

# State Weight 0.0 Add Time 3

```
state_weight 0.0 addtime 3 model_num 1160
0-hop lanes Fixed Time Passed Sum 23470.0 RL Passed Sum 23285.0 Imp -0.79
1-hop lanes Fixed Time Passed Sum 40341.0 RL Passed Sum 40110.0 Imp -0.57
0-hop lanes Fixed Time AverageSpeed mean 19.4 RL AverageSpeed mean 19.06 Imp -1.75
1-hop lanes Fixed Time AverageSpeed mean 27.76 RL AverageSpeed mean 27.71 Imp -0.18
0-hop lanes Fixed Time WaitingTime Sum 57474.3 RL WaitingTime Sum 57305.8 Imp 0.29
1-hop lanes Fixed Time WaitingTime Sum 66382.5 RL WaitingTime Sum 66186.1 Imp 0.3
0-hop lanes Fixed Time AverageDensity mean 0.11 RL AverageDensity mean 0.11 Imp -0.0
1-hop lanes Fixed Time AverageDensity mean 0.045 RL AverageDensity mean 0.045 Imp -0.0
0-hop lanes Fixed Time SumTravelTime sum 1085114.0 RL SumTravelTime sum 1163920.0 Imp -7.26
1-hop lanes Fixed Time SumTravelTime sum 1328766.0 RL SumTravelTime sum 1417314.0 Imp -6.66
0-hop lanes Fixed Time WaitingQLength mean 1.207 RL WaitingQLength mean 1.196 Imp 0.91
1-hop lanes Fixed Time WaitingQLength mean 0.446 RL WaitingQLength mean 0.443 Imp 0.67
```

State Weight	Add Time
0.0	3
0.0	5
0.0	7
0.5	3
0.5	7
1.0	3

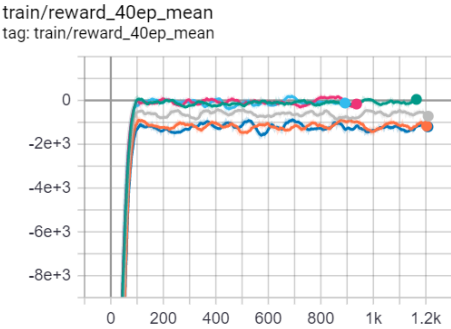


Name	Smoothed	Value	Step	Time	Relative
SALT_doan_discrete_v2/sw0.0_at3_07-08_18-46-37	45.61	79.55	1.164k	Fri Jul 9, 09:27:35	14h 40m 32s
SALT_doan_discrete_v2/sw0.0_at5_07-08_19-15-51	-721	-765.3	1.209k	Fri Jul 9, 10:23:57	15h 7m 40s
SALT_doan_discrete_v2/sw0.0_at7_07-08_19-15-59	-1169	-1228	1.203k	Fri Jul 9, 10:23:34	15h 7m 8s
SALT_doan_discrete_v2/sw0.5_at3_07-08_18-38-51	-166.3	-150.7	936	Fri Jul 9, 06:35:14	11h 55m 59s
SALT_doan_discrete_v2/sw0.5_at7_07-08_19-16-06	-1206	-1308	1.208k	Fri Jul 9, 10:23:51	15h 7m 17s
SALT_doan_discrete_v2/sw1.0_at3_07-08_17-04-23	-119.4	-131.3	892	Fri Jul 9, 04:19:10	11h 14m 23s

# State Weight 0.0 Add Time 5

```
state_weight 0.0 addtime 5 model_num 1200
0-hop lanes Fixed Time Passed Sum 23442.0 RL Passed Sum 23305.0 Imp -0.58
1-hop lanes Fixed Time Passed Sum 40281.0 RL Passed Sum 40145.0 Imp -0.34
0-hop lanes Fixed Time AverageSpeed mean 19.33 RL AverageSpeed mean 19.03 Imp -1.55
1-hop lanes Fixed Time AverageSpeed mean 27.74 RL AverageSpeed mean 27.7 Imp -0.14
0-hop lanes Fixed Time WaitingTime Sum 56955.6 RL WaitingTime Sum 57135.6 Imp -0.32
1-hop lanes Fixed Time WaitingTime Sum 65884.0 RL WaitingTime Sum 66070.2 Imp -0.28
0-hop lanes Fixed Time AverageDensity mean 0.11 RL AverageDensity mean 0.108 Imp 1.82
1-hop lanes Fixed Time AverageDensity mean 0.045 RL AverageDensity mean 0.044 Imp 2.22
0-hop lanes Fixed Time SumTravelTime sum 1086715.0 RL SumTravelTime sum 1111648.0 Imp -2.29
1-hop lanes Fixed Time SumTravelTime sum 1328535.0 RL SumTravelTime sum 1358979.0 Imp -2.29
0-hop lanes Fixed Time WaitingQLength mean 1.213 RL WaitingQLength mean 1.163 Imp 4.12
1-hop lanes Fixed Time WaitingQLength mean 0.447 RL WaitingQLength mean 0.431 Imp 3.58
```

State Weight	Add Time
0.0	3
0.0	5
0.0	7
0.5	3
0.5	7
1.0	3

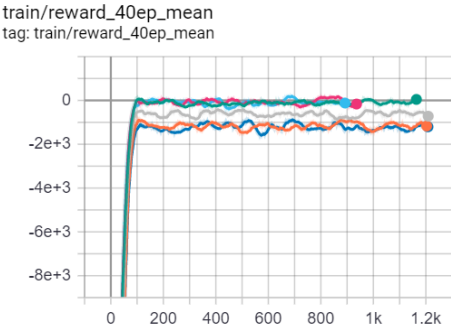


Name	Smoothed	Value	Step	Time	Relative
SALT_doan_discrete_v2/sw0.0_at3_07-08_18-46-37	45.61	79.55	1.164k	Fri Jul 9, 09:27:35	14h 40m 32
SALT_doan_discrete_v2/sw0.0_at5_07-08_19-15-51	-721	-765.3	1.209k	Fri Jul 9, 10:23:57	15h 7m 40s
SALT_doan_discrete_v2/sw0.0_at7_07-08_19-15-59	-1169	-1228	1.203k	Fri Jul 9, 10:23:34	15h 7m 8s
SALT_doan_discrete_v2/sw0.5_at3_07-08_18-38-51	-166.3	-150.7	936	Fri Jul 9, 06:35:14	11h 55m 59
SALT_doan_discrete_v2/sw0.5_at7_07-08_19-16-06	-1206	-1308	1.208k	Fri Jul 9, 10:23:51	15h 7m 17s
SALT_doan_discrete_v2/sw1.0_at3_07-08_17-04-23	-119.4	-131.3	892	Fri Jul 9, 04:19:10	11h 14m 23

# State Weight 0.0 Add Time 7

```
state_weight 0.0 addtime 7 model_num 1200
0-hop lanes Fixed Time Passed Sum 23492.0 RL Passed Sum 23321.0 Imp -0.73
1-hop lanes Fixed Time Passed Sum 40382.0 RL Passed Sum 40168.0 Imp -0.53
0-hop lanes Fixed Time AverageSpeed mean 19.57 RL AverageSpeed mean 19.13 Imp -2.25
1-hop lanes Fixed Time AverageSpeed mean 27.96 RL AverageSpeed mean 27.73 Imp -0.82
0-hop lanes Fixed Time WaitingTime Sum 56066.5 RL WaitingTime Sum 57014.1 Imp -1.69
1-hop lanes Fixed Time WaitingTime Sum 64354.3 RL WaitingTime Sum 66060.0 Imp -2.65
0-hop lanes Fixed Time AverageDensity mean 0.109 RL AverageDensity mean 0.109 Imp -0.0
1-hop lanes Fixed Time AverageDensity mean 0.044 RL AverageDensity mean 0.045 Imp -2.27
0-hop lanes Fixed Time SumTravelTime sum 1083783.0 RL SumTravelTime sum 1149243.0 Imp -6.04
1-hop lanes Fixed Time SumTravelTime sum 1323546.0 RL SumTravelTime sum 1402532.0 Imp -5.97
0-hop lanes Fixed Time WaitingQLength mean 1.203 RL WaitingQLength mean 1.181 Imp 1.83
1-hop lanes Fixed Time WaitingQLength mean 0.443 RL WaitingQLength mean 0.439 Imp 0.9
```

State Weight	Add Time
0.0	3
0.0	5
0.0	7
0.5	3
0.5	7
1.0	3

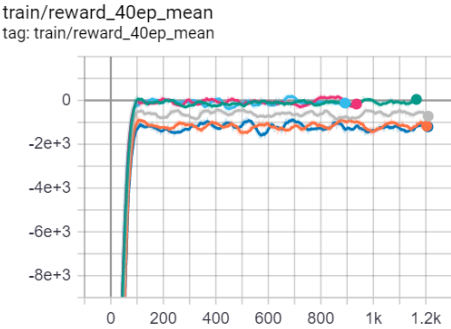


Name	Smoothed	Value	Step	Time	Relative
SALT_doan_discrete_v2/sw0.0_at3_07-08_18-46-37	45.61	79.55	1.164k	Fri Jul 9, 09:27:35	14h 40m 32s
SALT_doan_discrete_v2/sw0.0_at5_07-08_19-15-51	-721	-765.3	1.209k	Fri Jul 9, 10:23:57	15h 7m 40s
SALT_doan_discrete_v2/sw0.0_at7_07-08_19-15-59	-1169	-1228	1.203k	Fri Jul 9, 10:23:34	15h 7m 8s
SALT_doan_discrete_v2/sw0.5_at3_07-08_18-38-51	-166.3	-150.7	936	Fri Jul 9, 06:35:14	11h 55m 59s
SALT_doan_discrete_v2/sw0.5_at7_07-08_19-16-06	-1206	-1308	1.208k	Fri Jul 9, 10:23:51	15h 7m 17s
SALT_doan_discrete_v2/sw1.0_at3_07-08_17-04-23	-119.4	-131.3	892	Fri Jul 9, 04:19:10	11h 14m 23s

# State Weight 0.5 Add Time 3

```
state_weight 0.5 addtime 3 model_num 930
0-hop lanes Fixed Time Passed Sum 23456.0 RL Passed Sum 23384.0 Imp -0.31
1-hop lanes Fixed Time Passed Sum 40342.0 RL Passed Sum 40272.0 Imp -0.17
0-hop lanes Fixed Time AverageSpeed mean 19.46 RL AverageSpeed mean 18.84 Imp -3.19
1-hop lanes Fixed Time AverageSpeed mean 27.85 RL AverageSpeed mean 27.62 Imp -0.83
0-hop lanes Fixed Time WaitingTime Sum 56837.5 RL WaitingTime Sum 58378.3 Imp -2.71
1-hop lanes Fixed Time WaitingTime Sum 65571.4 RL WaitingTime Sum 67380.4 Imp -2.76
0-hop lanes Fixed Time AverageDensity mean 0.11 RL AverageDensity mean 0.11 Imp -0.0
1-hop lanes Fixed Time AverageDensity mean 0.045 RL AverageDensity mean 0.045 Imp -0.0
0-hop lanes Fixed Time SumTravelTime sum 1084396.0 RL SumTravelTime sum 1157365.0 Imp -6.73
1-hop lanes Fixed Time SumTravelTime sum 1325445.0 RL SumTravelTime sum 1407277.0 Imp -6.17
0-hop lanes Fixed Time WaitingQLength mean 1.213 RL WaitingQLength mean 1.196 Imp 1.4
1-hop lanes Fixed Time WaitingQLength mean 0.447 RL WaitingQLength mean 0.442 Imp 1.12
```

State Weight	Add Time
0.0	3
0.0	5
0.0	7
0.5	3
0.5	7
1.0	3



Name	Smoothed	Value	Step	Time	Relative
SALT_doan_discrete_v2/sw0.0_at3_07-08_18-46-37	45.61	79.55	1.164k	Fri Jul 9, 09:27:35	14h 40m 32
SALT_doan_discrete_v2/sw0.0_at5_07-08_19-15-51	-721	-765.3	1.209k	Fri Jul 9, 10:23:57	15h 7m 40s
SALT_doan_discrete_v2/sw0.0_at7_07-08_19-15-59	-1169	-1228	1.203k	Fri Jul 9, 10:23:34	15h 7m 8s
SALT_doan_discrete_v2/sw0.5_at3_07-08_18-38-51	-166.3	-150.7	936	Fri Jul 9, 06:35:14	11h 55m 59
SALT_doan_discrete_v2/sw0.5_at7_07-08_19-16-06	-1206	-1308	1.208k	Fri Jul 9, 10:23:51	15h 7m 17s
SALT_doan_discrete_v2/sw1.0_at3_07-08_17-04-23	-119.4	-131.3	892	Fri Jul 9, 04:19:10	11h 14m 23

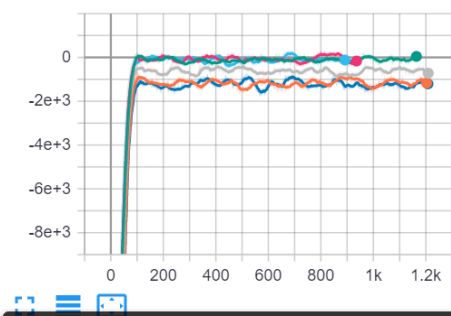


# State Weight 0.5 Add Time 7

```
state_weight 0.5 addtime 7 model_num 1200
0-hop lanes Fixed Time Passed Sum 23501.0 RL Passed Sum 23351.0 Imp -0.64
1-hop lanes Fixed Time Passed Sum 40363.0 RL Passed Sum 40207.0 Imp -0.39
0-hop lanes Fixed Time AverageSpeed mean 19.72 RL AverageSpeed mean 19.22 Imp -2.54
1-hop lanes Fixed Time AverageSpeed mean 27.95 RL AverageSpeed mean 27.75 Imp -0.72
0-hop lanes Fixed Time WaitingTime Sum 56002.3 RL WaitingTime Sum 56692.7 Imp -1.23
1-hop lanes Fixed Time WaitingTime Sum 64981.8 RL WaitingTime Sum 65542.5 Imp -0.86
0-hop lanes Fixed Time AverageDensity mean 0.11 RL AverageDensity mean 0.108 Imp 1.82
1-hop lanes Fixed Time AverageDensity mean 0.045 RL AverageDensity mean 0.044 Imp 2.22
0-hop lanes Fixed Time SumTravelTime sum 1091096.0 RL SumTravelTime sum 1109893.0 Imp -1.72
1-hop lanes Fixed Time SumTravelTime sum 1332110.0 RL SumTravelTime sum 1357099.0 Imp -1.88
0-hop lanes Fixed Time WaitingQLength mean 1.206 RL WaitingQLength mean 1.162 Imp 3.65
1-hop lanes Fixed Time WaitingQLength mean 0.445 RL WaitingQLength mean 0.43 Imp 3.37
```

State Weight	Add Time
0.0	3
0.0	5
0.0	7
0.5	3
0.5	7
1.0	3

train/reward\_40ep\_mean  
tag: train/reward\_40ep\_mean

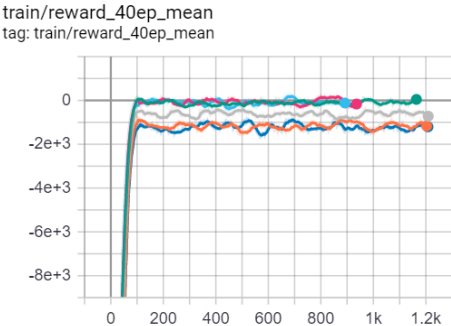


Name	Smoothed	Value	Step	Time	Relative
SALT_doan_discrete_v2/sw0.0_at3_07-08_18-46-37	45.61	79.55	1.164k	Fri Jul 9, 09:27:35	14h 40m 32s
SALT_doan_discrete_v2/sw0.0_at5_07-08_19-15-51	-721	-765.3	1.209k	Fri Jul 9, 10:23:57	15h 7m 40s
SALT_doan_discrete_v2/sw0.0_at7_07-08_19-15-59	-1169	-1228	1.203k	Fri Jul 9, 10:23:34	15h 7m 8s
SALT_doan_discrete_v2/sw0.5_at3_07-08_18-38-51	-166.3	-150.7	936	Fri Jul 9, 06:35:14	11h 55m 59s
SALT_doan_discrete_v2/sw0.5_at7_07-08_19-16-06	-1206	-1308	1.208k	Fri Jul 9, 10:23:51	15h 7m 17s
SALT_doan_discrete_v2/sw1.0_at3_07-08_17-04-23	-119.4	-131.3	892	Fri Jul 9, 04:19:10	11h 14m 23s

# State Weight 1.0 Add Time 3

```
state_weight 1.0 addtime 3 model_num 890
0-hop lanes Fixed Time Passed Sum 23518.0 RL Passed Sum 23260.0 Imp -1.1
1-hop lanes Fixed Time Passed Sum 40348.0 RL Passed Sum 40128.0 Imp -0.55
0-hop lanes Fixed Time AverageSpeed mean 19.63 RL AverageSpeed mean 19.25 Imp -1.94
1-hop lanes Fixed Time AverageSpeed mean 27.92 RL AverageSpeed mean 27.82 Imp -0.36
0-hop lanes Fixed Time WaitingTime Sum 56186.2 RL WaitingTime Sum 56370.6 Imp -0.33
1-hop lanes Fixed Time WaitingTime Sum 64940.4 RL WaitingTime Sum 64710.8 Imp 0.35
0-hop lanes Fixed Time AverageDensity mean 0.11 RL AverageDensity mean 0.106 Imp 3.64
1-hop lanes Fixed Time AverageDensity mean 0.045 RL AverageDensity mean 0.043 Imp 4.44
0-hop lanes Fixed Time SumTravelTime sum 1080619.0 RL SumTravelTime sum 1098473.0 Imp -1.65
1-hop lanes Fixed Time SumTravelTime sum 1321483.0 RL SumTravelTime sum 1342992.0 Imp -1.63
0-hop lanes Fixed Time WaitingQLength mean 1.201 RL WaitingQLength mean 1.145 Imp 4.66
1-hop lanes Fixed Time WaitingQLength mean 0.443 RL WaitingQLength mean 0.423 Imp 4.51
```

State Weight	Add Time
0.0	3
0.0	5
0.0	7
0.5	3
0.5	7
1.0	3



Name	Smoothed	Value	Step	Time	Relative
SALT_doan_discrete_v2/sw0.0_at3_07-08_18-46-37	45.61	79.55	1.164k	Fri Jul 9, 09:27:35	14h 40m 32s
SALT_doan_discrete_v2/sw0.0_at5_07-08_19-15-51	-721	-765.3	1.209k	Fri Jul 9, 10:23:57	15h 7m 40s
SALT_doan_discrete_v2/sw0.0_at7_07-08_19-15-59	-1169	-1228	1.203k	Fri Jul 9, 10:23:34	15h 7m 8s
SALT_doan_discrete_v2/sw0.5_at3_07-08_18-38-51	-166.3	-150.7	936	Fri Jul 9, 06:35:14	11h 55m 59s
SALT_doan_discrete_v2/sw0.5_at7_07-08_19-16-06	-1206	-1308	1.208k	Fri Jul 9, 10:23:51	15h 7m 17s
SALT_doan_discrete_v2/sw1.0_at3_07-08_17-04-23	-119.4	-131.3	892	Fri Jul 9, 04:19:10	11h 14m 23s

# 실험 결과 요약

- State weight는 1이 가장 좋음

```
state_weight 1.0 addtime 3 model_num 890
0-hop lanes Fixed Time Passed Sum 23518.0 RL Passed Sum 23260.0 Imp -1.1
1-hop lanes Fixed Time Passed Sum 40348.0 RL Passed Sum 40128.0 Imp -0.55
0-hop lanes Fixed Time AverageSpeed mean 19.63 RL AverageSpeed mean 19.25 Imp -1.94
1-hop lanes Fixed Time AverageSpeed mean 27.92 RL AverageSpeed mean 27.82 Imp -0.36
0-hop lanes Fixed Time WaitingTime Sum 56186.2 RL WaitingTime Sum 56370.6 Imp -0.33
1-hop lanes Fixed Time WaitingTime Sum 64940.4 RL WaitingTime Sum 64710.8 Imp 0.35
0-hop lanes Fixed Time AverageDensity mean 0.11 RL AverageDensity mean 0.106 Imp 3.64
1-hop lanes Fixed Time AverageDensity mean 0.045 RL AverageDensity mean 0.043 Imp 4.44
0-hop lanes Fixed Time SumTravelTime sum 1080619.0 RL SumTravelTime sum 1098473.0 Imp -1.65
1-hop lanes Fixed Time SumTravelTime sum 1321483.0 RL SumTravelTime sum 1342992.0 Imp -1.63
0-hop lanes Fixed Time WaitingQLength mean 1.201 RL WaitingQLength mean 1.145 Imp 4.66
1-hop lanes Fixed Time WaitingQLength mean 0.443 RL WaitingQLength mean 0.423 Imp 4.51
```

State Weight	Add Time
0.0	3
0.0	5
0.0	7
0.5	3
0.5	7
1.0	3



getConnectedLink()가 불안정해서 그럴 가능성이 있음