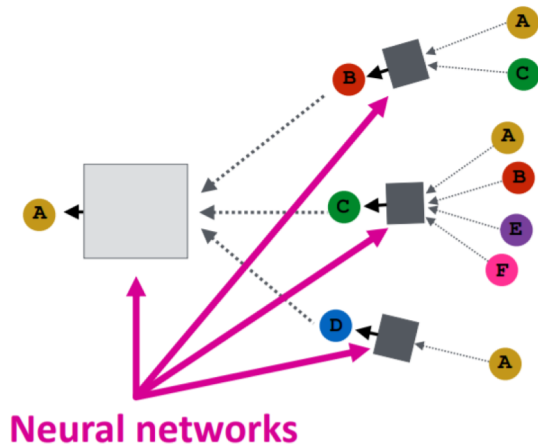
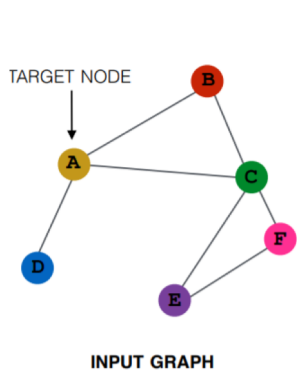


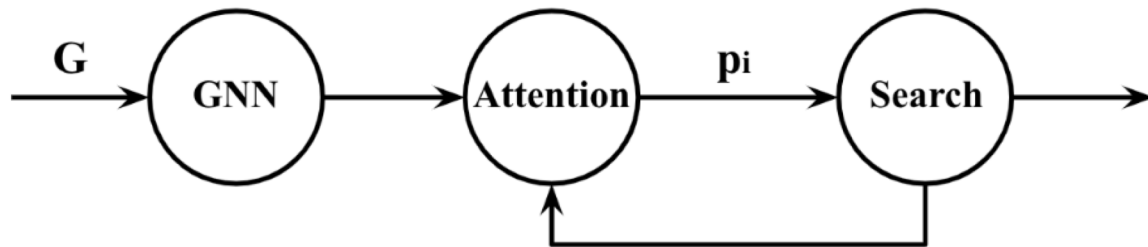
Learning to Solve Combinatorial Optimization Problems on Real- World Graphs in Linear Time

Section IV and V

Overview

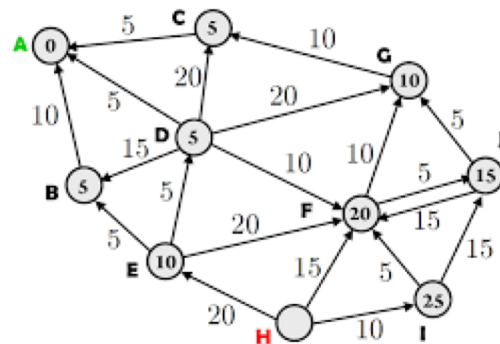
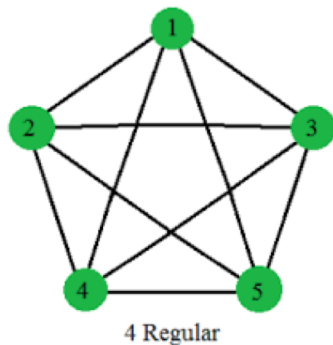


- Get rid of the heuristics.
- Optimize Execution time.

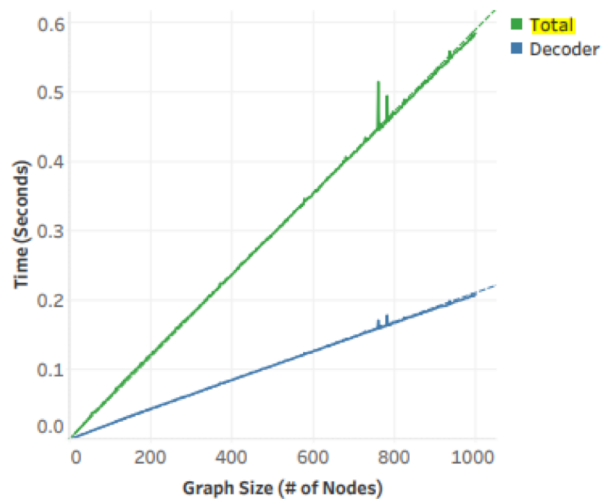


Simulations

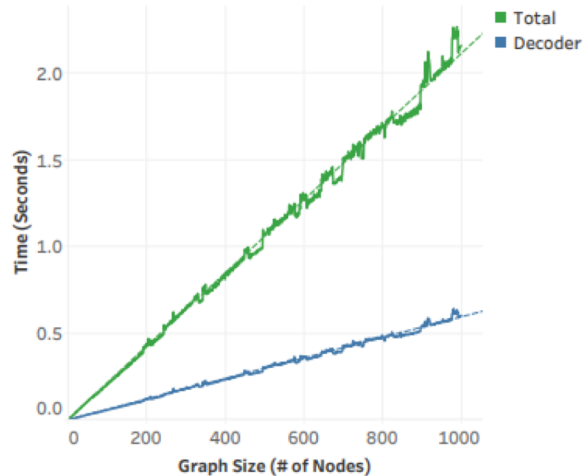
- All simulations done on [Google Cloud](#) with an NVIDIA TESLA P100 GPU .
- Used TSPLIB <https://tsplib95.readthedocs.io/en/stable/pages/usage.html#loading-problems>
- Millions of runs for multiple instances of graphs such as Random Regular, Euclidean.
- Training time for MST: 90mins(12.9K graphs). Training time for TSP: 48hours(2M Graphs).



Results



(a) MST



(b) TSP

1000 graphs with 1-1000 nodes, each instance run for 1000 times.
Running time of Encoder is under *2ms*.

Results

TSPLIB Instance	Exact Concorde	RL			Approx.		
		Ours	GPN	S2V-DQN	Farthest	2-opt	Nearest
eil51	426	439	485	439	448	452	514
berlin52	7,542	7,681	8,795	7,734	8,121	7,778	8,981
st70	675	684	701	685	729	701	806
eil76	538	555	591	558	583	597	712
pr76	108,159	112,699	118,032	111,141	119,649	125,276	153,462
rat99	1,211	1,268	1,472	1,250	1,319	1,351	1,565
kroA100	21,282	21,452	24,806	22,335	23,374	23,306	26,856
kroB100	22,141	22,488	24,369	22,548	24,035	23,129	29,155
kroC100	20,749	21,427	24,780	21,468	21,818	22,313	26,327
kroD100	21,294	21,555	23,494	21,886	22,361	22,754	26,950
kroE100	22,068	22,267	23,467	22,820	23,604	25,325	27,587
rd100	7,910	8,243	8,844	8,305	8,652	8,832	9,941
eil101	629	650	704	667	687	694	825
lin105	14,379	14,571	15,795	14,895	15,196	16,184	20,363
pr107	44,303	44,854	55,087	44,780	45,573	46,505	48,522
pr124	59,030	59,729	67,901	61,101	61,645	61,595	69,299
bier127	118,282	120,672	134,089	123,371	127,795	136,058	129,346
ch130	6,110	6,208	6,457	6,361	6,655	6,667	7,575
pr136	96,772	98,957	110,790	100,185	104,687	103,731	120,778
pr144	58,537	60,492	67,211	59,836	62,059	62,385	61,651
ch150	6,528	6,729	7,074	6,913	6,866	7,439	8,195
kroA150	26,524	27,419	30,260	28,076	28,789	28,313	33,610
kroB150	26,130	27,165	29,141	26,963	28,156	28,603	32,825
pr152	73,682	79,326	85,331	75,125	75,209	77,387	85,703
u159	42,080	43,687	52,642	45,620	46,842	42,976	53,637
rat195	2,323	2,384	2,686	2,567	2,620	2,569	2,762
d198	15,780	17,754	19,249	16,855	16,161	16,705	18,830
kroA200	29,368	30,553	34,315	30,732	31,450	32,378	35,798
kroB200	29,437	30,381	33,854	31,910	31,656	32,853	36,982
ts225	126,643	130,493	147,092	140,088	140,625	143,197	152,494
tsp225	3,916	4,091	4,988	4,219	4,233	4,046	4,748
Mean Opt. Gap	1	1.032	1.144	1.045	1.074	1.087	1.238

Conclusion and Future Work

- Unified framework is provided using RL with GNN representation.
- Solves multiple problems over graphs such as TSP, MST, VRP, etc.
- Uses Line Graph to represent nodes and edges.
- Demonstrate linear running time.
- No heuristics needed.
- *Decompose and solve.*
- *Use Meta Learning* <https://machinelearningmastery.com/meta-learning-in-machine-learning/>