COMPARING NEURAL NETWORKS FOR NHL PERFORMANCE FORECASTING

GROUP ID: 44

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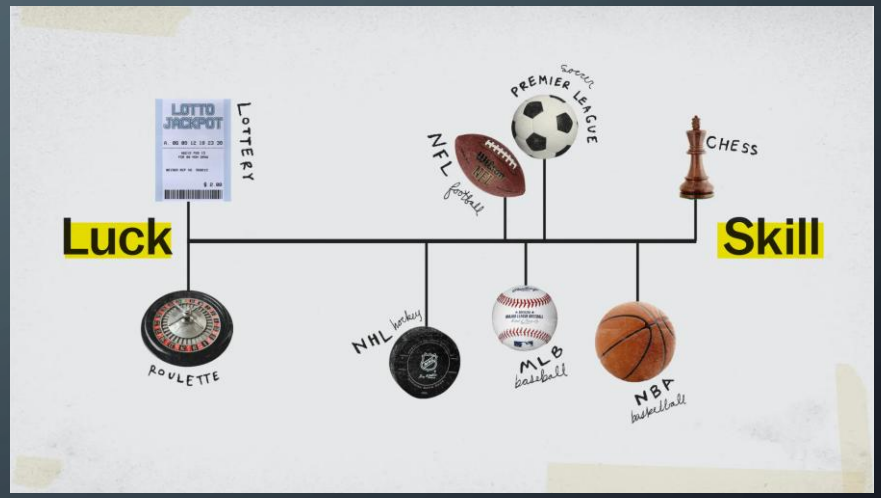
THE PROBLEM

- Objective: predict next-season NHL player performance based on their prior 3 seasons
  - Stats in sports can be volatile, especially hockey
  - Want to see if we can make a viable solution
- Method: use MLP, RNN, LSTM, and a LSTM-MLP hybrid



Michael Mauboussin's skill-luck continuum
https://www.vox.com/videos/2017/6/5/15740632/luck-skill-sports

DATASET

SOURCE: KAGGLE – NHL PLAYER STATISTICS BY BENZIK

- Spans roughly 1979-80 to 2019-20
- Contains rows of box score stats, player details, and more per player-season
- Processed:
  - Removed goalies
  - Trimmed columns
  - Merge season stats when player was on multiple teams
  - Flattened 3-year stat lines

TRAINING FEATURES

- Inputs (x):
  - Per game rates of goals, assists, shots on goal (SOG), as well as the shooting percentage for the current season and previous 2 seasons
  - Player info (position, age, experience, height, weight, BMI)
- Targets (y):
  - Per game rates of goals, assists, shots on goal (SOG) for the next season

```
inputs = [
    'G_per_gp_prev2',
    'A_per_gp_prev2',
    'SOG_per_gp_prev2',
    'Games_played_prev2',
    'Shooting_Percentage_prev2',
    'G_per_gp_prev',
    'A_per_gp_prev',
    'SOG_per_gp_prev',
    'Games_played_prev',
    'Shooting_Percentage_prev',
    'G_per_gp',
    'A_per_gp',
    'SOG_per_gp',
    'Shooting_Percentage',
    'Games_Played',
    'Position',
    'Age',
    'Experience',
    'Height',
    'Weight',
    'Body_mass_index',
]
targets = [
    'G_per_gp_next',
    'A_per_gp_next',
    'SOG_per_gp_next',
    'Games_Played_next',
]
```

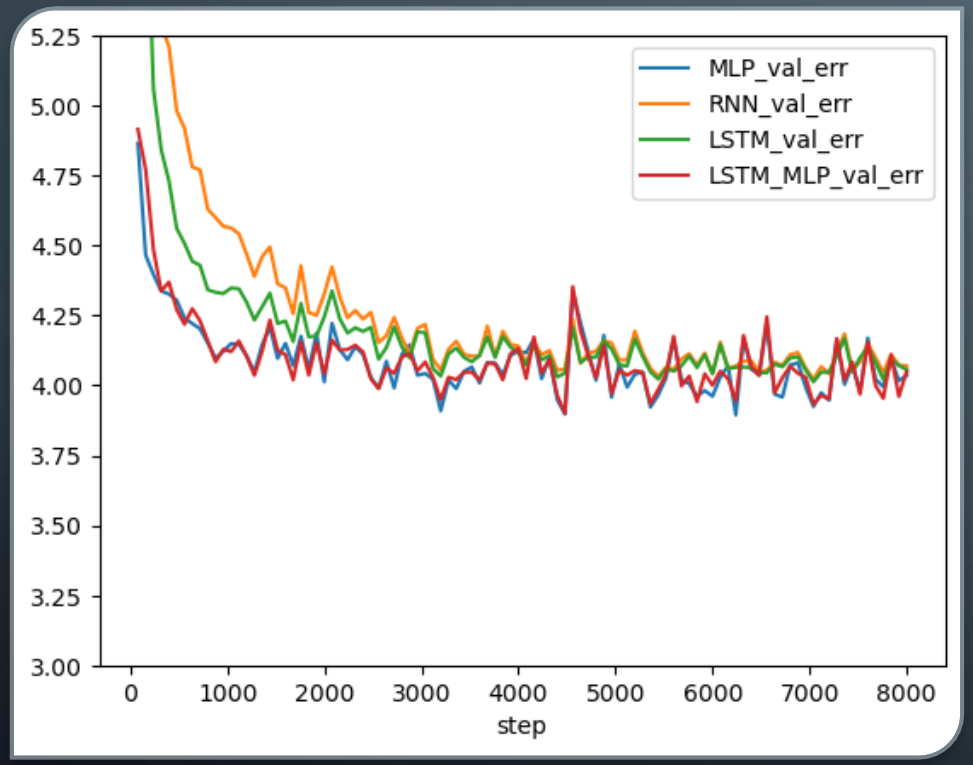
TRAINING

- Nearly identical functions to assignment 3
  - Modified to record error instead of accuracy
  - Learning rate of 1e-3
  - 100 epochs

MODELS

- MLP
  - Connected layers on a flattened input
- RNN
  - 3 season sequence
- LSTM
  - Same as RNN but with LSTM instead
- LSTM + MLP
  - LSTM but passed through an MLP head instead of a single Linear Layer

COMPARISON



- MLP models converge faster
- MLP models spike more

APPLICATION – DUNCAN KEITH

- Aging case – age 35
- Inaccurate goal rates – small denominator
- LSTM + MLP preformed best

	Actual	MLP	RNN	LSTM	LSTM_MLP	MLP_err%	RNN_err%	LSTM_err%	LSTM_MLP_err%
G_per_gp_next	0.073	0.054	0.137	0.127	0.068	26.756	86.654	73.934	6.703
A_per_gp_next	0.415	0.326	0.373	0.485	0.363	21.259	10.110	16.977	12.516
SOG_per_gp_next	1.720	2.007	1.794	2.038	2.025	16.711	4.325	18.498	17.792
Games_Played_next	82.000	64.729	68.532	68.526	65.347	21.063	16.424	16.432	20.308
G	6.000	3.000	9.000	9.000	4.000	50.000	50.000	50.000	33.333
A	34.000	21.000	26.000	33.000	24.000	38.235	23.529	2.941	29.412
SOG	141.000	130.000	123.000	140.000	132.000	7.801	12.766	0.709	6.383

APPLICATION – EVGENI MALKIN

- Injury history case – consistently fewer than 70 GP
- Poor goal rate prediction
- Good GP predictions
- No clear winner

	Actual	MLP	RNN	LSTM	LSTM_MLP	MLP_err%	RNN_err%	LSTM_err%	LSTM_MLP_err%
G_per_gp_next	0.532	0.321	0.373	0.340	0.293	39.705	29.929	36.140	44.919
A_per_gp_next	0.629	0.556	0.552	0.563	0.592	11.555	12.250	10.445	5.809
SOG_per_gp_next	3.081	2.713	2.527	2.587	2.656	11.919	17.967	16.019	13.793
Games_Played_next	62.000	62.387	64.175	63.359	66.001	0.624	3.508	2.192	6.454
G	33.000	20.000	24.000	22.000	19.000	39.394	27.273	33.333	42.424
A	39.000	35.000	35.000	36.000	39.000	10.256	10.256	7.692	0.000
SOG	191.000	169.000	162.000	164.000	175.000	11.518	15.183	14.136	8.377

APPLICATION – LARS ELLER

- Depth player example
- Poor goal predictions again
- Poor GP prediction
- MLP wins

	Actual	MLP	RNN	LSTM	LSTM_MLP	MLP_err%	RNN_err%	LSTM_err%	LSTM_MLP_err%
G_per_gp_next	0.160	0.190	0.273	0.201	0.130	18.541	69.861	25.029	19.048
A_per_gp_next	0.284	0.282	0.340	0.343	0.311	0.649	19.603	20.787	9.597
SOG_per_gp_next	2.012	1.901	1.815	1.788	1.878	5.549	9.787	11.152	6.695
Games_Played_next	81.000	68.761	70.322	70.487	68.719	15.110	13.182	12.980	15.161
G	13.000	13.000	19.000	14.000	9.000	0.000	46.154	7.692	30.769
A	23.000	19.000	24.000	24.000	21.000	17.391	4.348	4.348	8.696
SOG	163.000	131.000	128.000	126.000	129.000	19.632	21.472	22.699	20.859

APPLICATION – JACK HUGHES

- Emerging star
- Injury history
- More accurate – larger denominators
- MLP models performed best

	Actual	MLP	RNN	LSTM	LSTM_MLP	MLP_err%	RNN_err%	LSTM_err%	LSTM_MLP_err%
G_per_gp_next	0.435	0.405	0.469	0.476	0.456	7.008	7.684	9.372	4.734
A_per_gp_next	0.758	0.752	0.659	0.725	0.743	0.827	13.079	4.324	2.023
SOG_per_gp_next	4.419	3.892	3.767	3.789	3.990	11.934	14.755	14.272	9.725
Games_Played_next	62.000	67.784	71.375	73.062	70.383	9.330	15.122	17.842	13.521
G	27.000	27.000	33.000	35.000	32.000	0.000	22.222	29.630	18.519
A	47.000	51.000	47.000	53.000	52.000	8.511	0.000	12.766	10.638
SOG	274.000	264.000	269.000	277.000	281.000	3.650	1.825	1.095	2.555

APPLICATION – JARED MCCANN

- Outlier shooting percentage
- Goals look off – look back at shooting percentage
- GP not good
- MLP clear best

MLP	14.050375
RNN	16.788029
LSTM	14.582742
LSTM_MLP	12.440687

	Actual	MLP	RNN	LSTM	LSTM_MLP	MLP_err%	RNN_err%	LSTM_err%	LSTM_MLP_err%
G_per_gp_next	0.268	0.356	0.417	0.376	0.328	32.762	55.544	40.100	22.111
A_per_gp_next	0.476	0.493	0.517	0.602	0.562	3.707	8.713	26.499	18.104
SOG_per_gp_next	2.463	2.535	2.486	2.578	2.633	2.910	0.908	4.633	6.901
Games_Played_next	82.000	68.652	71.201	71.747	68.609	16.278	13.169	12.503	16.331
G	22.000	24.000	30.000	27.000	22.000	9.091	36.364	22.727	0.000
A	39.000	34.000	37.000	43.000	39.000	12.821	5.128	10.256	0.000
SOG	202.000	174.000	177.000	185.000	181.000	13.861	12.376	8.416	10.396

APPLICATION – RASMUS DAHLIN

- Prime-aged star defender
- Very accurate
- No clear winner

	Actual	MLP	RNN	LSTM	LSTM_MLP	MLP_err%	RNN_err%	LSTM_err%	LSTM_MLP_err%
G_per_gp_next	0.233	0.276	0.276	0.263	0.280	18.318	18.516	12.888	20.395
A_per_gp_next	0.699	0.572	0.599	0.637	0.611	18.081	14.251	8.751	12.576
SOG_per_gp_next	2.740	2.768	2.730	2.779	3.005	1.047	0.353	1.427	9.684
Games_Played_next	73.000	72.585	76.331	76.405	72.555	0.568	4.563	4.664	0.609
G	17.000	20.000	21.000	20.000	20.000	17.647	23.529	17.647	17.647
A	51.000	42.000	46.000	49.000	44.000	17.647	9.804	3.922	13.725
SOG	200.000	201.000	208.000	212.000	218.000	0.500	4.000	6.000	9.000

ANALYSIS

- MLP performed best on half the players
- LSTM + MLP most consistent
- MLP performed best in test
  - LSTM + MLP close behind

	MLP_err%	RNN_err%	LSTM_err%	LSTM_MLP_err%
Duncan Keith	21.447	29.378	31.460	14.330
Evgeni Malkin	15.951	15.913	16.199	17.744
Lars Eller	9.962	28.108	17.487	12.625
Jack Hughes	7.275	12.660	11.452	7.501
Jared McCann	13.914	19.584	20.934	15.862
Rasmus Dahlin	9.504	9.421	6.932	10.816

	MLP_err%	RNN_err%	LSTM_err%	LSTM_MLP_err%
avg_err_%	13.009	19.177	17.411	13.146

DISCUSSION

- RNN and LSTM didn't have enough data to shine
  - Only 3 seasons
  - Conditioned data
  - Small dataset
- Improvements
  - Context
  - Flags
  - Details
  - More data