DRL Bridge bidding Inventor by using Reinforcement Learning(RL)

An attempt to learn and use bidding systems.
As an example we used 1 Spade(5+,12-21) – 1 NT (0-2 spades, 8-11).

The basic idea is to have a policy to recommend an action (bid) given a situation (state). A Markov Decision Process (MDP).

We have encoded the shape of the hand and hcp together with two inputs for bidding history, -1 if no bid is made as the state:
[s,h,d,c,p,-1,-1]
North having 5-7 s, 12-21 hcp. S have 0-2 s and 8-11 hcp; we only used one neural net but hopefully it can differ between the hands.
Sometimes RL is used in a table with entries but often the table would be very demanding on memory and can't interpolate between the cases.
In our case, assuming 15 bids are possible the size would be:
13*13*13*13*30*15*15 = 192 GB RAM if only one byte is used; *8 if floating point numbers, so we go for a Neural net – 4 layers of 50 neurons each is a much small number but introduces a second learning problem; train/learn the net and learn actions, easy to get unstable.

Learning rates 1e-3, 1e-4, 1e-5, 1e-6, 1e-7 was tried; not much difference but 1e-6 sometimes better.

Experiences;
1. Gamma = 0.95 reduces the future values by this factor and encourages short biddings?
Well, because we compare with par-result and losing imps the results are negative resulting in strange learning.
Solution: Add offset +20 imps to results to keep them positive (+20 corresponds to par-result), subtract 20 when printing/showing to the user.

2. Adding more bids actually got worse performance than just a single rebid (-4 imps/deal); what to do if partner just bid random 3 C or 4D after my rebid ? – better to pass and play in 1 NT.
Solution: Don't allow Pass as rebid..later: create new examples with excluded hands like (semi)bal 5 sp and 11-13 h.c.p assuming to be passed.

3. Couldn't solve DA2C-algorithm on GPU.. but worked good on multi-core CPUs and actually faster. Now a run with 2 million trial bids took 15 mins on a 5 yr old i5-8700K with 12 hyperthreaded cores, using 10 and saving 2 for GUI etc.

Examples (Learning rate = 1e-6, two bids, no pass-rebid)

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1♠-Bidding Contract Score Impdiff (Parscore) N[shape,hcp] S[shape,hpc]  N-cards E-cards S-cards W-cards
1N 2♠ 2N -100 -5 ( 110 ) [6, 2, 3, 2, 15] [1, 3, 3, 6, 9]  n AKJ987.A6.K64.T8  e 642.873.AQJ93.32  s T.KQ5.T82.KJ7654  w Q53.JT942.75.AQ9
1N 3♣ 3♠ 170 -6 ( 420 ) [5, 1, 5, 2, 18] [2, 4, 2, 5, 8]  n AQJ84.A.AKT52.63  e 7.862.Q986.KQT54  s K6.K975.J3.J9872  w T9532.QJT43.74.A
1N 2♣ 2N 180 -6 ( 430 ) [5, 3, 3, 2, 15] [2, 2, 5, 4, 8]  n AQJ74.KJT.JT8.K3  e 52.74.9764.A8764  s T9.65.KQ532.QJ92  w K863.AQ9832.A.T5
1N 2♦ 2N 180 -7 ( 450 ) [6, 1, 1, 5, 13] [2, 4, 3, 4, 11]  n AJ9853.K.4.KQT96  e 764.Q62.KJ972.A5  s T2.A975.AQT.J842  w KQ.JT843.8653.73
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1N 3♣ 4♣ 190 -15 ( 1440 ) [6, 2, 3, 2, 15] [1, 3, 3, 6, 11]  n AQ9632.AQ.K96.T9  e T874.KJT9854.5.K  s 5.732.A32.AQJ864  w KJ.6.QJT874.7532
1N 2♣ 2♦ 130 -8 ( 450 ) [5, 3, 4, 1, 15] [1, 5, 3, 4, 9]  n AT872.A63.K974.A  e KQ43.T98.63.Q953  s 5.KQJ75.T85.KT74  w J96.42.AQJ2.J862
1N 2N 3♣ 170 -13 ( 920 ) [5, 2, 5, 1, 19] [1, 1, 4, 7, 9]  n AQT53.QJ.AKQJ9.T  e KJ874.A852.T6.J6  s 2.9.8743.AKQ8754  w 96.KT7643.52.932
1N 2♠ 2N 150 -7 ( 430 ) [5, 1, 4, 3, 15] [2, 4, 3, 4, 10]  n AKJ86.9.AK95.654  e T972.J853.74.AJ3  s Q3.KQ76.T62.K987  w 54.AT42.QJ83.QT2
1N 2♦ 2♣ 230 -13 ( 990 ) [5, 3, 1, 4, 20] [2, 4, 5, 2, 9]  n AKT32.KT2.Q.AKJ9  e 965.Q85.A762.875  s J4.AJ97.KT983.32  w Q87.643.J54.QT64
1N 2♦ 3♣ -250 -11 ( 300 ) [5, 5, 2, 1, 12] [2, 5, 2, 4, 11]  n AQT96.KQ954.J9.8  e J543.A7.AT7642.K  s K7.JT832.KQ.Q653  w 82.6.853.AJT9742
1N 2♦ 3♣ 110 -7 ( 420 ) [6, 1, 1, 5, 16] [2, 5, 4, 2, 9]  n AKQ984.K.5.KJ852  e J2.T87.QJ84.QT94  s T6.Q9542.AK97.63  w 753.AJ63.T632.A7
1N 2♣ 2N 150 -6 ( 400 ) [5, 3, 3, 2, 15] [1, 3, 4, 5, 11]  n A8432.K83.A54.K2  e T.A752.762.98765  s Q.Q64.KQT8.QT432  w KJ9765.JT9.J93.A
1N 2♥ 2N 150 -7 ( 420 ) [5, 3, 4, 1, 16] [1, 5, 4, 3, 11]  n AKT87.K72.KQJ2.7  e J54.QJT4.3.AQ984  s 2.A8653.A864.KT5  w Q963.9.T975.J632
1N 2N 3♣ -50 -14 ( 920 ) [5, 2, 4, 2, 17] [1, 5, 4, 3, 11]  n KQT76.A6.K432.KQ  e 53.KJ5.QT76.T942  s J.T9743.AJ95.AJ8  w A9842.Q82.8.7653
1N 2N 3♥ -250 -8 ( 100 ) [6, 3, 2, 2, 16] [2, 2, 6, 3, 8]  n AKT984.K3.K.K4  e J652.AJ87.9.AQ93  s 73.65.AQJ765.JT5  w Q.QT94.T842.8762
1N 2♣ 2N -100 -5 ( 110 ) [6, 2, 2, 3, 13] [2, 5, 3, 3, 9]  n K96532.A5.AQ.T42  e J4.KJT8.KJ952.A7  s A7.Q9764.T74.QJ6  w QT8.32.863.K9853
1N 3♣ 3♣ 170 -6 ( 430 ) [5, 3, 1, 4, 17] [2, 4, 4, 3, 9]  n KQT76.K92.8.AKQ5  e AJ2.Q74.AJ732.97  s 53.A865.KQT4.T86  w 984.JT3.965.J432
1N 3♣ 3♥ -100 -5 ( 110 ) [5, 4, 2, 2, 12] [2, 3, 5, 3, 10]  n AQ632.Q873.A2.76  e 84.42.KQT85.J854  s T9.K65.J9743.AQ2  w KJ75.AJ97.9.6.KT93
1N 3♣ 4♣ -100 -6 ( 120 ) [5, 1, 4, 3, 12] [1, 5, 3, 4, 10]  n K9864.Q.AK42.985  e 2.AJ963.QT9.AJ73  s Q.KT754.875.KQT4  w AJT753.82.J63.62
1N 2♣ 2♠ 140 0 ( 140 ) [5, 2, 4, 2, 12] [2, 4, 4, 3, 10]  n KQT82.Q2.KQ84.43  e J6.K763.972.T762  s 94.AJ54.JT53.A95  w A753.T98.A6.KQJ8
1N 3♣ 4♣ -100 -11 ( 420 ) [5, 1, 3, 4, 14] [2, 6, 4, 1, 11]  n AKQT9.7.Q83.QJT6  e J632.A6.65.AK983  s 74.KJT842.AK42.7  w 85.Q953.JT97.542
1N 3♣ 3N -50 -5 ( 140 ) [5, 2, 4, 2, 14] [1, 5, 4, 3, 9]  n A9754.96.AKQ4.J8  e KQJ6.K5.T9.A7653  s 2.A8732.8652.KQ9  w T83.QJT4.J73.T42
1N 2♠ 2N 210 -6 ( 460 ) [6, 2, 1, 4, 14] [2, 2, 5, 4, 11]  n AK8732.AQ.T.JT64  e T.JT86542..K8753  s Q4.97.QJ542.AQ92  w J965.K3.AK98763.
1N 2♣ 2♠ 110 0 ( 110 ) [5, 4, 3, 1, 12] [2, 1, 4, 6, 10]  n AQT54.J863.AJ4.6  e J9.AKT97.T6.J854  s K3.5.Q752.KQ9732  w 8762.Q42.K983.AT
1N 3♣ 3♦ -50 -10 ( 400 ) [5, 1, 3, 4, 17] [2, 5, 3, 3, 10]  n QJT74.J.AT6.AKQT  e 3.Q7653.Q42.J962  s K5.AKT98.975.874  w A9862.42.KJ83.53
1N 2N 3♣ -150 7 ( -450 ) [5, 2, 4, 2, 14] [2, 2, 5, 4, 11]  n AK853.Q9.KQ32.82  e QT7642.A6542.T.9  s J9.KJ.A9754.QT54  w .T873.J86.AKJ763
1N 2N 3♣ -100 -5 ( 90 ) [6, 2, 3, 2, 12] [1, 4, 5, 3, 9]  n AT9843.A5.854.A3  e KQ765.T984.2.JT9  s J.K732.QJ976.Q72  w 2.QJ6.AKT3.K8654
1N 3♣ 3♣ -150 -11 ( 430 ) [6, 5, 0, 2, 14] [2, 3, 5, 3, 10]  n AKT984.AK852..32  e 7.J643.J642.AQ94  s J5.T97.KQ873.KJ6  w Q632.Q.AT95.T875
1N 2♣ 2♣ -200 -7 ( 100 ) [5, 4, 2, 2, 13] [1, 5, 4, 3, 8]  n KJ862.AKQ6.97.64  e A.873.AKJT4.AJ72  s 4.JT954.Q852.KQ5  w QT9753.2.63.T983
1N 2N 2N 120 -7 ( 420 ) [5, 1, 3, 4, 16] [2, 6, 1, 4, 8]  n AKQ74.Q.T83.AJ73  e JT6.T84.KJ9654.K  s 95.A76532.A.T842  w 832.KJ9.Q72.Q965
1N 3♣ 3N -150 0 ( -140 ) [5, 0, 5, 3, 12] [2, 4, 2, 5, 8]  n A6542..AKJ53.754  e T.J84.QT9862.AKJ  s K8.KQT3.74.T9862  w QJ973.A97652..Q3
1N 2♠ 2♣ -200 -7 ( 100 ) [6, 2, 3, 2, 12] [1, 3, 6, 3, 8]  n KT8542.A8.KQ7.52  e QJ763.KT42.J4.QT  s A.753.AT8652.943  w 9.QJ96.93.AKJ876
1N 2♥ 3♣ -50 -5 ( 120 ) [5, 3, 2, 3, 16] [2, 4, 3, 4, 8]  n KJ632.A65.K5.KQ6  e 97.J2.98763.9873  s Q8.9843.AJ2.JT52  w AT54.KQT7.QT4.A4
1N 2♣ 2♣ 140 0 ( 140 ) [6, 2, 2, 3, 12] [2, 3, 6, 2, 10]  n KT7653.A9.J6.A92  e QJ4.KJ643.KQ.JT4  s A8.Q52.A97532.53  w 92.T87.T84.KQ876
1N 2♦ 2♦ -100 0 ( -90 ) [5, 1, 4, 3, 14] [2, 5, 2, 4, 8]  n AQ765.Q.7654.AQ7  e 4.KJ982.QJT2.JT9  s J9.AT764.K8.8642  w KT832.53.A93.K53
1N 2N 3♣ -50 -5 ( 140 ) [5, 3, 3, 2, 14] [0, 4, 5, 4, 8]  n KT843.K95.K93.KQ  e AJ952.32.74.A652  s .JT84.AQT52.JT73  w Q76.AQ76.J86.984
1N 3♣ 3♦ -200 -7 ( 90 ) [6, 2, 2, 3, 13] [1, 4, 4, 4, 9]  n KQJ973.A7.73.K32  e 4.K6542.AKJT.JT7  s A.J983.Q942.Q864  w T8652.QT.865.A95
1N 2♦ 2♥ 260 -15 ( 1520 ) [5, 3, 2, 3, 15] [2, 6, 2, 3, 10]  n AQJ97.T65.A3.A63  e T52.J3.KQJ62.Q87  s K3.AK9742.85.T92  w 864.Q8.T974.KJ54
1N 2♦ 3♣ 170 -13 ( 920 ) [5, 3, 3, 2, 16] [0, 2, 5, 6, 11]  n KQ854.AK6.A83.T2  e A9763.QJ93.54.AJ  s .74.KQJT6.KQ7653  w JT2.T852.972.984
1N 2♦ 2♥ 170 -6 ( 420 ) [5, 1, 2, 5, 19] [1, 6, 4, 2, 8]  n AK965.8.AJ.AK974  e T743.QT93.Q4.Q52  s J.AK7642.T753.83  w Q82.J5.K9862.JT6
1N 3♣ 3♣ -50 -11 ( 450 ) [7, 4, 1, 1, 12] [1, 3, 3, 6, 11]  n AKT7543.KJ82.2.J  e 8.Q94.T7643.AT75  s J.AT6.AQ8.986432  w Q962.753.KJ95.KQ
1N 2♠ 3♣ 170 -13 ( 920 ) [6, 4, 0, 3, 17] [1, 2, 8, 2, 10]  n AJT643.AQ97.AQ8  e 85.J8632.Q5.KT95  s 2.K5.AKT96432.73  w KQ97.T4.J87.J642
1N 3♣ 3♣ 140 -4 ( 300 ) [6, 2, 2, 3, 15] [2, 6, 3, 2, 8]  n AJ9743.K4.42.AQJ  e K865.J2.K.KT8753  s Q2.AT9875.Q73.42  w T.Q63.AJT9865.96
1N 3♣ 3♣ -350 -6 ( -130 ) [7, 2, 2, 2, 12] [1, 3, 6, 3, 8]  n AKQ9854.52.K3.74  e JT62.76.J54.JT92  s 7.KJ3.QT9762.Q83  w 3.AQT984.A8.AK65
1N 2N 2N 120 -7 ( 420 ) [6, 3, 1, 3, 13] [1, 3, 5, 4, 10]  n AQJT9.JT7.T.AJ6  e K765.854.Q74.Q94  s 4.Q96.AKJ52.T875  w 83.AK32.9863.K32
1N 3♣ 3♣ -50 -14 ( 980 ) [5, 6, 1, 1, 15] [2, 2, 5, 4, 8]  n AQT72.AKJT64.5.J  e 986.52.AK8.KQ532  s K3.98.J9642.AT64  w J54.Q73.QT73.987
1N 2♥ 2♣ -100 1 ( -140 ) [5, 2, 5, 1, 12] [2, 3, 3, 5, 10]  n AQJ92.Q4.J9862.Q  e K53.KJ3.AQT74.T4  s 74.T95.K53.AK985  w T86.A8762..J7632
1N 3♣ 3N 430 0 ( 430 ) [5, 2, 2, 4, 13] [2, 2, 7, 2, 11]  n AKJ97.A3.63.J842  e Q54.92.J942.9765  s 62.75.AKQT875.Q3  w T83.KQJT864..AKT
1N 3♣ 3♣ -100 -6 ( 140 ) [5, 3, 3, 2, 13] [2, 4, 2, 5, 11]  n QJ876.KT3.AJ8.Q4  e KT93.872.9652.75  s 54.QJ96.KQ.KT832  w A2.A54.T743.AJ96
1N 2N 2N 210 -6 ( 460 ) [6, 2, 2, 3, 20] [2, 4, 4, 3, 9]  n AKQJ43.K3.KJ.K96  e 65.75.AQ9632.QT8  s 72.A986.T875.AJ3  w T98.QJT42.4.7542
Average imps -6.7
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Not very useful but can be improved by removing weak openers and with more training.

Running with 3 possible bids 2 miljon times;
Ended with opener always bidding 2 C (instead of always pass). Learning rate 1e-6 was used, maybe another run can be better.

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1♠-Bidding Contract Score Impdiff (Parscore) N[shape,hcp] S[shape,hpc]  N-cards E-cards S-cards W-cards
1N 2♣ 2♣ 110 -1 ( 140 ) [5, 3, 1, 4, 15] [2, 2, 6, 3, 10]  n AQ842.T65.A.AJ73  e 965.A73.K54.T852  s 73.Q4.QJT832.KQ4  w KJT.KJ982.976.96
1N 2♣ 2♣ -100 -5 ( 110 ) [6, 1, 3, 3, 12] [1, 5, 4, 3, 10]  n KQJ874.K.QT7.J83  e 3.Q8653.K9865.Q6  s 9.JT942.AJ42.A74  w AT652.A7.3.KT952
1N 2♣ 2♣ 130 -7 ( 400 ) [5, 2, 2, 4, 12] [1, 3, 4, 5, 11]  n KT842.54.AK.Q943  e 53.KJ63.J965.K86  s Q.QT8.Q432.AJ752  w AJ976.A972.T87.T
1N 2♣ 2♣ 110 -7 ( 400 ) [5, 3, 2, 3, 13] [1, 4, 4, 4, 11]  n AJ974.Q97.J6.AJ2  e KQ865.T4.Q82.985  s 3.AJ63.K943.KT76  w T2.K852.AT75.Q43
1N 2♣ 2♣ -200 -12 ( 450 ) [5, 6, 0, 2, 14] [1, 3, 7, 2, 9]  n AKT74.AJT863..Q9  e Q653.K5.QJ82.742  s 2.Q72.KT96543.KJ  w J98.94.A7.AT8653
1N 2♣ 2♣ 170 -13 ( 920 ) [5, 5, 2, 1, 15] [2, 1, 3, 7, 10]  n 86543.AQ543.AK.Q  e T72.T9.T96542.J6  s AJ.8.Q73.KT98542  w KQ9.KJ762.J8.A73
1N 2♣ 2♣ -50 -4 ( 110 ) [6, 1, 3, 3, 12] [1, 6, 3, 3, 9]  n AT9842.3.QJ3.KQ2  e K3.Q62.98742.AJ4  s 6.AJT854.AT5.T73  w QJ75.K97.K6.9865
1N 2♣ 2♣ 170 -13 ( 990 ) [5, 3, 2, 3, 19] [1, 4, 3, 5, 10]  n AKJ84.AJT.A2.Q93  e Q2.Q52.J974.AT64  s 5.K986.K63.KJ872  w T9763.743.QT85.5
1N 2♣ 2♣ -300 -5 ( -100 ) [5, 2, 5, 1, 12] [2, 2, 6, 3, 9]  n AJ975.92.KQ873.Q  e KT8.AT75..J98765  s Q3.K6.AT9542.T42  w 642.QJ843.J6.AK3
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1N 2♣ 2♠ 150 -6 ( 400 ) [5, 2, 2, 4, 14] [2, 4, 2, 5, 10]  n AKT98.J4.K5.QJ75  e QJ75.K96.Q872.K9  s 42.Q852.A3.A8642  w 63.AT73.JT964.T3
1N 2♣ 2♠ 150 -6 ( 400 ) [5, 2, 1, 5, 12] [1, 4, 5, 3, 11]  n AK643.Q7.8.QJT63  e T72.KT5.AK7.9874  s 9.A963.QJ964.A52  w QJ85.J842.T532.K
1N 2♣ 2♠ 90 -2 ( 140 ) [5, 4, 2, 2, 12] [1, 4, 3, 5, 10]  n Q9876.AQ74.J2.QJ  e J42.9632.KQ84.54  s T.KT85.T97.AK862  w AK53.J.A653.T973
1N 2♣ 2♠ 90 -1 ( 120 ) [5, 3, 3, 2, 13] [2, 3, 3, 5, 8]  n AJT95.963.QJ9.KQ  e K4.K842.K7542.J6  s 73.T75.A86.AT842  w Q862.AQJ.T3.9753
1N 2♣ 2♠ 130 0 ( 140 ) [5, 2, 1, 5, 14] [2, 3, 5, 3, 11]  n AKT93.J2.J.KQT65  e Q5.AK85.982.9432  s 86.T94.AQT63.AJ8  w J742.Q763.K754.7
1N 2♣ 2♠ -200 -8 ( 140 ) [5, 3, 2, 3, 12] [1, 6, 4, 2, 10]  n AKQJ7.632.Q4.852  e 653.AT94.73.QJT3  s 9.KQJ875.KJ98.96  w T842..AT652.AK74
1N 2♣ 2♠ 110 0 ( 110 ) [6, 3, 3, 1, 13] [1, 2, 3, 7, 8]  n AK8752.K83.432.K  e J9.AJ942.AKT7.T6  s 4.Q5.QJ5.QJ85432  w QT63.T76.986.A97
1N 2♣ 2♠ 90 -8 ( 420 ) [6, 3, 4, 0, 14] [2, 2, 4, 5, 9]  n AK9865.A98.K985.  e 74.KQ64.T63.K853  s J2.32.QJ72.AJT76  w QT3.JT75.A4.Q942
1N 2♣ 2♠ 90 -8 ( 450 ) [5, 2, 1, 5, 14] [1, 7, 4, 1, 10]  n QJT53.A4.4.AQJT7  e K9.J73.A7532.K52  s A.KQT9652.JT86.8  w 87642.8.KQ9.9643
1N 2♣ 2♠ 150 -7 ( 450 ) [5, 2, 2, 4, 13] [2, 3, 5, 3, 11]  n AQT52.T9.KJ.K943  e 986.A643.QT.QJ52  s 73.K72.A8764.AT6  w KJ4.QJ85.9532.87
1N 2♣ 2♠ 130 -8 ( 460 ) [6, 3, 1, 3, 15] [1, 3, 5, 4, 11]  n AQJT43.A74.3.A75  e 9862.32.KQT62.42  s K.K98.AJ874.T963  w 75.QJT65.95.KQJ8
1N 2♣ 2♠ -100 -6 ( 140 ) [5, 4, 2, 2, 16] [1, 4, 5, 3, 8]  n AJT52.AQJT.86.KJ  e KQ98.2.K752.QT76  s 7.K543.AJT43.842  w 643.9876.Q9.A953
1N 2♣ 2♠ 130 -8 ( 460 ) [6, 3, 2, 2, 20] [1, 4, 4, 4, 11]  n AKT763.AQ7.KT.A5  e Q9542.T52.54.T92  s J.KJ84.J763.KQ83  w 8.963.AQ982.J764
1N 2♣ 2♠ 110 -7 ( 420 ) [6, 0, 3, 4, 12] [1, 4, 4, 4, 11]  n AK9765..972.KQT6  e JT42.AKQ872.A64.  s 8.J643.KQJ8.A854  w Q3.T95.T53.J9732
1N 2♣ 2♠ 130 0 ( 130 ) [5, 1, 2, 5, 12] [2, 3, 4, 4, 9]  n K9873.2.K4.AQ743  e AJ.AKQJT96.T9.J5  s 64.853.AQ85.KT82  w QT52.74.J7632.96
1N 2♣ 2♠ 90 -8 ( 420 ) [6, 4, 2, 1, 15] [0, 3, 5, 5, 8]  n AKQ632.Q832.A8.4  e T87.AK975.Q5.963  s .JT4.97432.AKT72  w J954.6.KJT6.QJ85
1N 2♣ 2♠ 90 0 ( 90 ) [5, 4, 2, 2, 12] [2, 2, 4, 5, 8]  n A9862.KJ53.KJ.84  e KQJ.AT6.T82.A953  s T4.Q2.9643.KQJ62  w 753.9874.AQ75.T7
1N 2♣ 2♠ 150 -7 ( 460 ) [5, 2, 3, 3, 19] [2, 4, 3, 4, 9]  n KQT94.AQ.AT6.A54  e J762.9632.93.J96  s 83.KJ87.K72.QT87  w A5.T54.QJ854.K32
1N 2♣ 2♠ -200 -8 ( 140 ) [7, 2, 1, 3, 16] [2, 5, 4, 2, 8]  n AKQT653.53.A.K96  e 987.762.T53.AT42  s 42.KQT84.QJ64.85  w J.AJ9.K9872.QJ73
1N 2♣ 2♠ -100 -11 ( 400 ) [5, 2, 4, 2, 12] [2, 5, 3, 3, 9]  n A9754.A6.T542.A4  e QJ.K542.QJ763.Q6  s 62.Q9873.A98.KT9  w KT83.JT.K.J87532
1N 2♣ 2♠ 110 -8 ( 450 ) [6, 4, 1, 2, 13] [2, 4, 2, 5, 9]  n AKQT43.KJ52.3.T2  e J87.AT7.AKT92.J7  s 65.Q963.86.AK984  w 92.84.QJ754.Q653
1N 2♣ 2♠ 150 2 ( 100 ) [6, 3, 0, 4, 15] [2, 3, 3, 5, 10]  n AKJ643.KT5..AT64  e 8.A98763.K7642.3  s 75.QJ4.J93.KQJ92  w QT92.2.AQT85.875
1N 2♣ 2♠ -200 -12 ( 420 ) [5, 3, 2, 3, 15] [2, 7, 3, 1, 8]  n AK752.954.A4.KJ7  e JT96.A7.QJ8.AT82  s Q8.KQJT632.T65.6  w 43.8.K9732.Q9543
1N 2♣ 2♠ 90 -8 ( 450 ) [5, 3, 2, 3, 16] [2, 5, 4, 2, 11]  n AKJ83.AT8.KJ.764  e T942.J.A86.Q9832  s Q7.K9632.QT72.KJ  w 65.Q754.9543.AT5
1N 2♣ 2♠ -100 -5 ( 110 ) [6, 3, 3, 1, 12] [1, 3, 4, 5, 9]  n KQ8652.AJ2.Q53.8  e AT4.K94.K4.AJT73  s 7.T53.A762.KQ652  w J93.Q876.JT98.94
1N 2♣ 2♠ -200 -7 ( 100 ) [7, 3, 0, 3, 12] [0, 5, 7, 1, 10]  n KQJT432.QJ9..KT8  e 9865..JT94.A7643  s .K8432.AK87632.5  w A7.AT765.Q5.QJ92
1N 2♣ 2♠ 130 -13 ( 990 ) [5, 3, 2, 3, 17] [2, 4, 3, 4, 11]  n KQT54.A84.64.AKJ  e J3.Q752.872.T653  s A6.KJT6.K53.9872  w 9872.93.AQJT9.Q4
1N 2♣ 2♠ -100 -11 ( 430 ) [6, 4, 3, 0, 13] [2, 2, 4, 5, 9]  n KJ8732.AT54.KQ3.  e 94.Q632.JT854.KJ  s T6.J7.A962.A9852  w AQ5.K98.7.QT7643
1N 2♣ 2♠ 130 -7 ( 430 ) [5, 5, 2, 1, 17] [2, 3, 3, 5, 9]  n AKQ96.QT864.K3.K  e T743.A.AJ42.J643  s J8.972.QT9.AQ985  w 52.KJ53.8765.T72
1N 2♣ 2♠ 130 0 ( 130 ) [5, 1, 4, 3, 15] [2, 3, 3, 5, 9]  n AK765.5.Q975.AQ2  e Q4.AJT863.J64.53  s T3.KQ9.T83.KJ984  w J982.742.AK2.T76
1N 2♣ 2♠ 2♠ -50 -4 ( 90 ) [6, 2, 3, 2, 12] [1, 4, 5, 3, 9]  n AT9843.A5.854.A3  e KQ765.T984.2.JT9  s J.K732.QJ976.Q72  w 2.QJ6.AKT3.K8654
1N 2♣ 2♠ 90 -16 ( 1440 ) [6, 1, 4, 2, 14] [1, 3, 6, 3, 11]  n AK8742.T.KT87.A3  e Q53.K7642.Q.Q642  s T.A85.A96432.KT7  w J96.QJ93.J5.J985
1N 2♣ 2♠ 130 -7 ( 400 ) [5, 3, 2, 3, 13] [1, 4, 3, 5, 11]  n AQJT7.QJ5.97.KT2  e K9632.AK.QJ4.Q65  s 4.8642.AK6.A9743  w 85.T973.T8532.J8
1N 2♣ 2♠ 130 0 ( 130 ) [6, 2, 1, 4, 13] [1, 3, 4, 5, 9]  n AQ9876.84.2.AQJ5  e JT.A965.QJT7.T76  s 2.QJ3.K543.K8432  w K543.KT72.A986.9
1N 2♣ 2♠ 90 -1 ( 120 ) [5, 2, 3, 3, 12] [2, 4, 4, 3, 11]  n K9763.A5.962.KQ4  e A5.J832.K54.J953  s J2.QT96.AT73.AT6  w QT84.K74.QJ8.872
1N 2♣ 2♠ -50 -11 ( 450 ) [6, 3, 1, 3, 14] [2, 6, 2, 3, 11]  n AKJ932.Q65.6.A93  e Q86.J8.T852.7642  s T4.KT9742.AK.J85  w 75.A3.QJ9743.KQT
1N 2♣ 2♠ -100 -14 ( 990 ) [7, 3, 1, 2, 20] [2, 5, 4, 2, 10]  n AKT8753.AQJ.Q.AT  e 4.83.J85432.6542  s QJ.K7542.KT97.J8  w 962.T96.A6.KQ973
1N 2♣ 2♠ 150 -7 ( 420 ) [5, 4, 1, 3, 16] [2, 2, 4, 5, 10]  n KJT76.Q863.A.AQT  e 52.AJ2.QT832.832  s Q9.K7.J975.KJ764  w A843.T954.K64.95
1N 2♣ 2♠ 130 -7 ( 420 ) [5, 1, 5, 2, 13] [2, 5, 1, 5, 11]  n QJ764.8.AKQ84.J6  e AT3.K52.9765.Q93  s K5.A7643.2.AT752  w 982.QJT9.JT3.K84
1N 2♣ 2♠ -200 -11 ( 300 ) [5, 4, 3, 1, 13] [2, 5, 4, 2, 11]  n AKQ92.KT76.J63.5  e JT84.Q842.942.A9  s 53.AJ953.KT87.K2  w 76..AQ5.QJT87643
1N Average imps -6.6
```

A try with bigger Neural net (from 75 to 100 neurons) and 11 possible bids instead of 6 resulted in
2C – pass on all deals, -7.7 imps/deal, worse..

A try with smaller net with 50 neurons and reducing layers (fully connected+ReLU) from 4 to 3:
2C-pass on all as well..

Suggestions/Ideas/Improvement
- maybe there are some bugs in the code
- trying to invent bidding backwards, reducing search space – no use to try 7NT with 13+9 hcp.
- try other algs like PPO A3C, Curiosity-based, Multi-Agent RL, evolutionary methods