The Go Transformer: Natural Language Modeling for Game Play

Matthew Ciolino, David Noever, Josh Kalin

Go

What is Go?

The 2500-year old board game of Go attracts strategy play by 450 million participants, mainly from Asia.

For the machine learning community, the game holds special attraction as enumerating all possible moves exceeds the iconic benchmark of all combinatorial calculators, namely more Go moves than the number of atoms in the universe.

Go is a game for two players with just a few simple rules. You start with an empty board and then place pieces alternately, vying to map out more territory. However, if you overstretch, your pieces can be captured and taken off the board.

GPT Transformer Applications

- **Text Generation**
- **Chatbots**
- **Machine Translation**
- **Text Summarization**
- **Question Answering**
- **Reading Comprehension**
- **Natural Language Inference**
- **Arithmetic (GPT-3)**

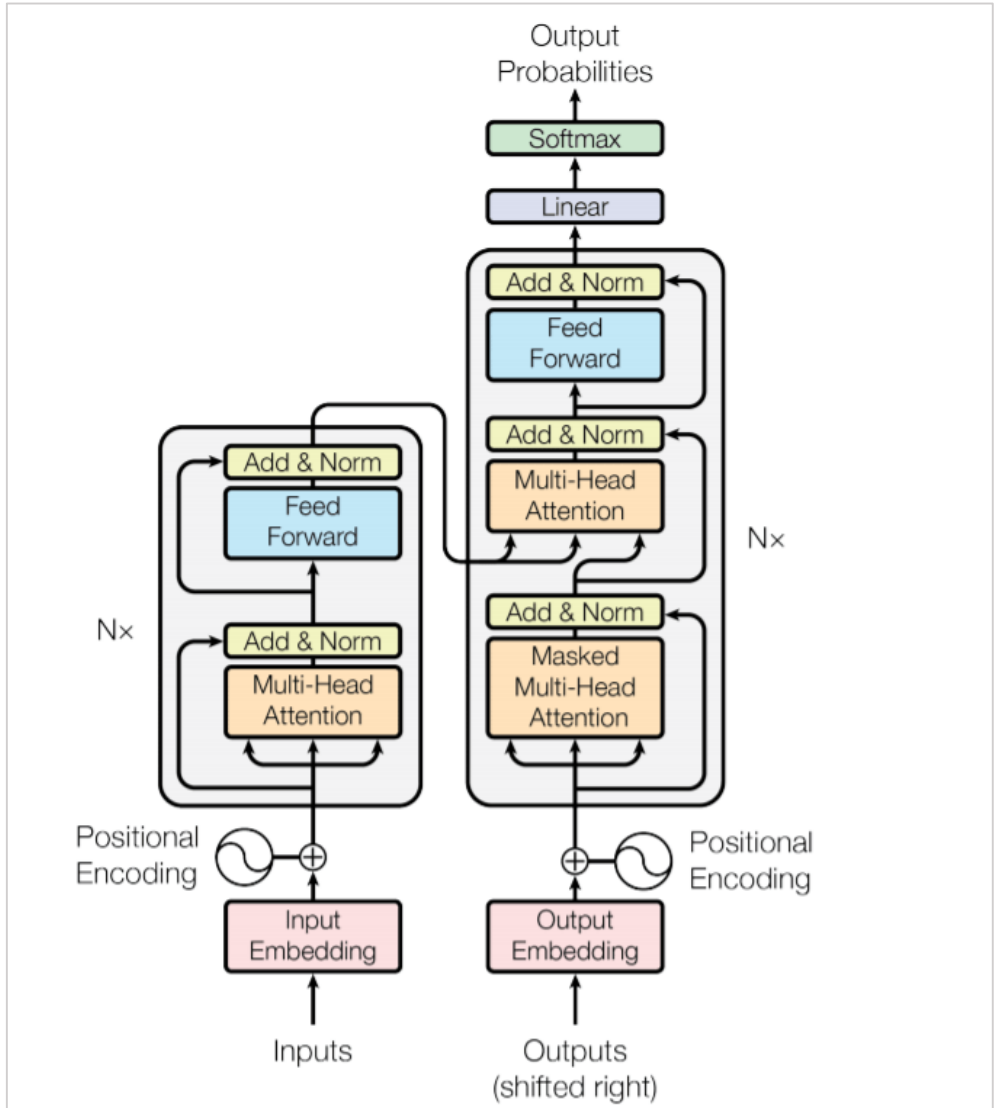
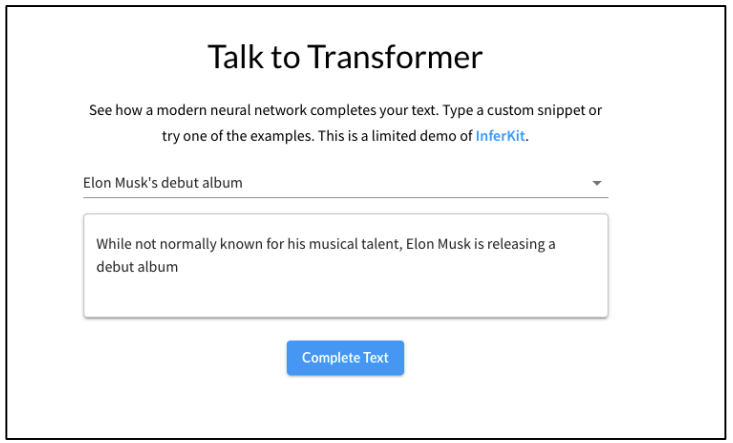


Figure 1: The Transformer - model architecture.

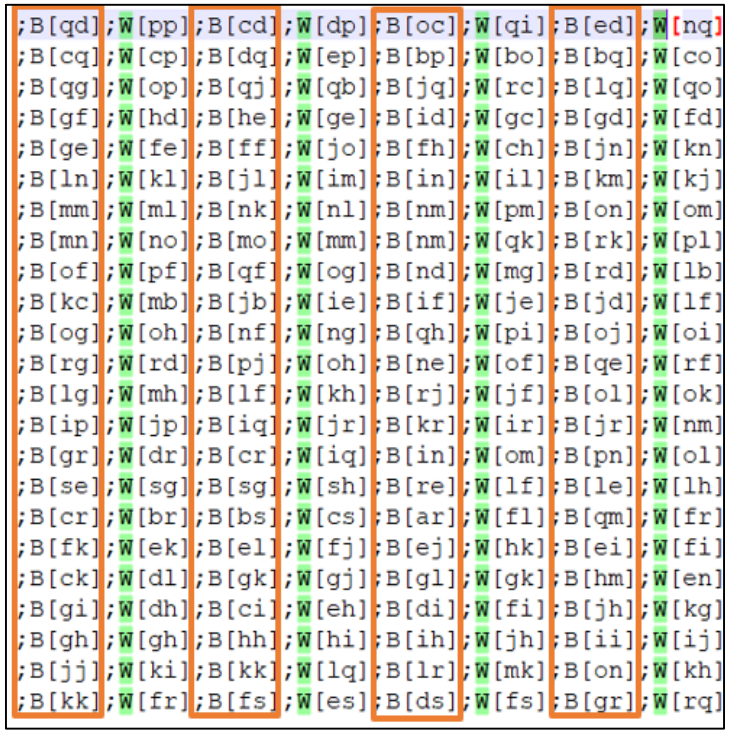
GPT Text Generation



Text Generation Applications

- Text Adventure
  - AI Dungeon https://play.aidungeon.io/main/landing
- Paper Generation
  - ArXiv https://transformer.huggingface.co/model/arxiv-nlp
- Tweet Impersonation
  - Fake Trump https://twitter.com/deepdrumpf?lang=en
- Game Play (From text archives)
  - Go, Chess, Checkers, Bridge …

Go Text Format



Smart Game Format (SGF)

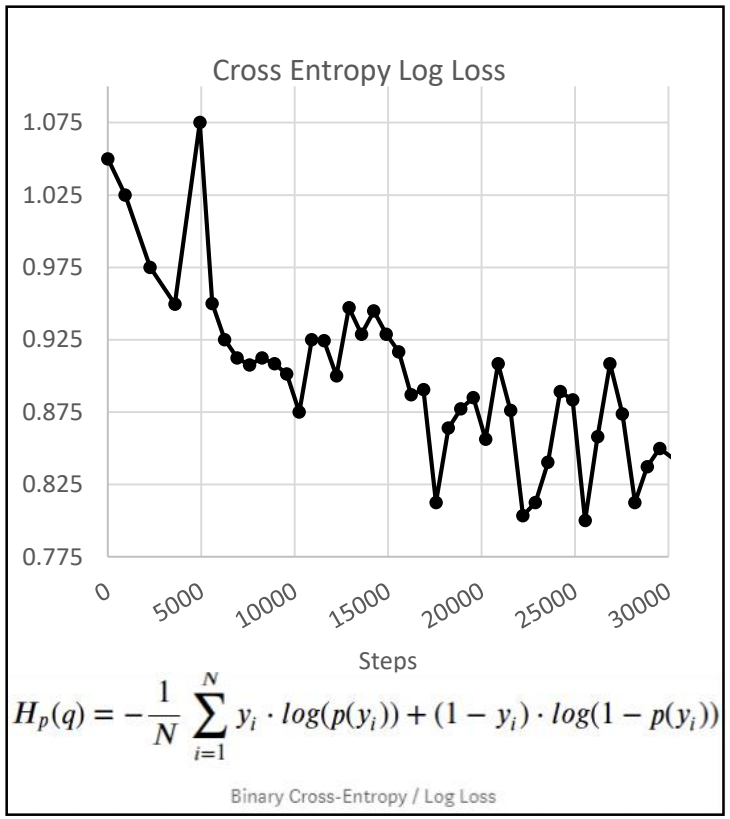
```
EV[Japanese National Team Training]
RO[3]
PB[Seki Kotaro]
BR[2p]
PW[Aoki Hirotaka]
WR[1p]
KM[6.5]
RE[B+R]
DT[2019-05-11]

;B[dp];W[pd];B[dc];W[pp];B[qc];W[qd];B[pc];W[nc];B[oc];W[od]
;B[nb];W[ce];B[cd];W[de];B[fd];W[di];B[mc];W[nd];B[rc];W[fq]
;B[cn];W[dq];B[cq];W[cr];B[bq];W[ep];B[dr];W[eq];B[br];W[nq]
```

EV: Event
RO: Round
PB: Black's Player Name
BR: Black Rank
PW: White's Player Name
WR: White Rank
KM: Compensation Points
RE: Results in ELO Gain
DT: Date

Alternating Black and White game play. B[row,col]; and W [row,col];.

Alphabetic representation of rows and columns on the 19x19 board.

The Transformer

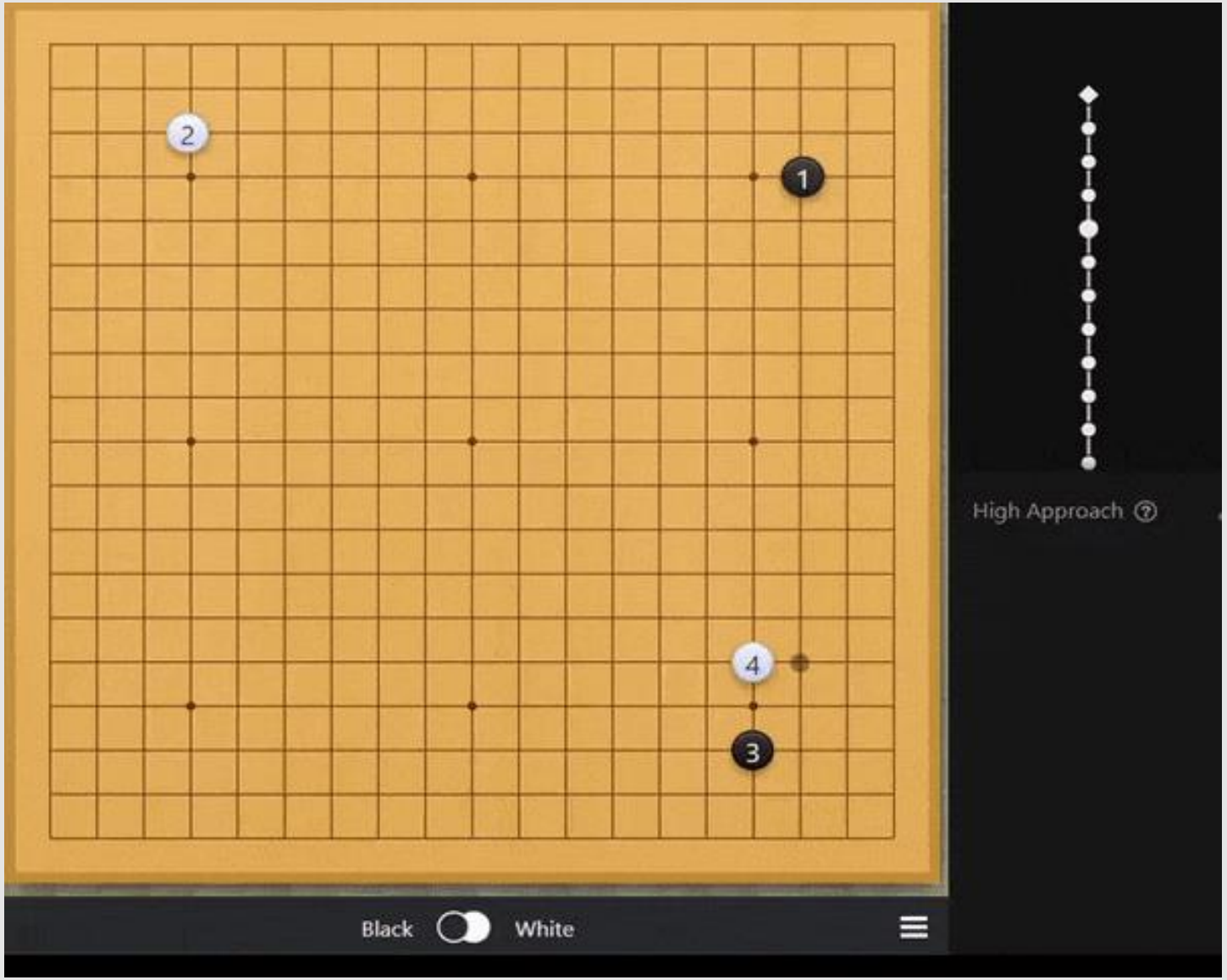


Dataset, Preprocessing and Training

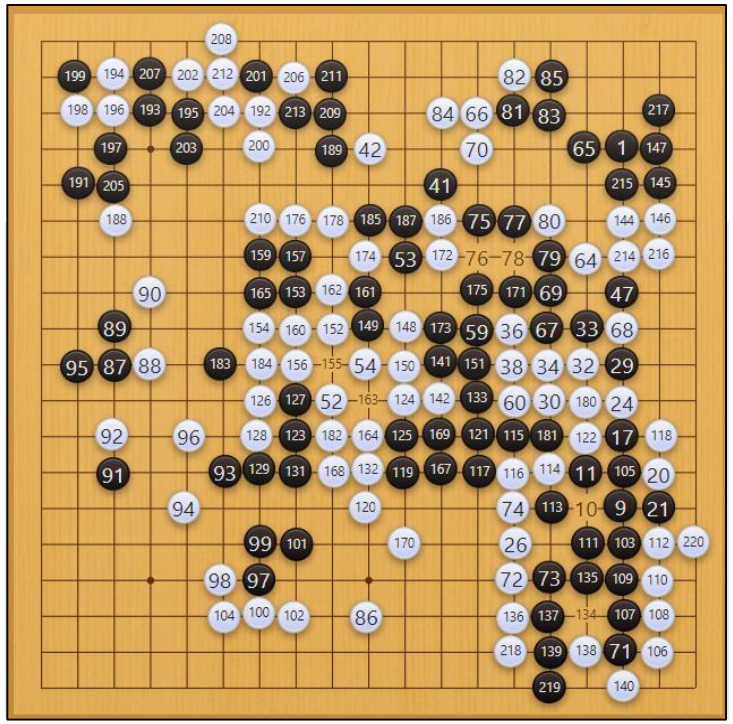
- 56,638 Go Games from Championship Repository (6 years)
- Game on a single line (line breaks to pipe)
- GPT-2 Simple Package with 744M Architecture on V100s
- Evaluating ability to describe coherent games moves and playing formations

Gameplay

- Once trained, we can generate valid go games with novel play.
- With the Sabaki Go visualizer, which includes macro-move commentary, we can view the first GPT-2 based Go game ever generated.



Discussion



The resulting model generates a nearly complete and coherent game sequence without any human knowledge, heuristic rules or strategic guidance.

The transformer architecture can be considered a breadth-search of possible moves from the current state while methods like MCTS relies on a depth search of decisions and rewards.

Since GPT-2 Simple can only generate 1024 tokens per request (about 3-4 paragraphs), it currently doesn't lend itself to fine-tuning a complete game for Go unless the move sequences were shorter (game ~ 1200 character).

Future Work

Go:

- Paper: https://arxiv.org/abs/2007.03500v2
- Video: https://deeperbrain.com/demo/full_go.mp4

Chess:

- Paper: https://arxiv.org/abs/2008.04057
- Colab: https://rb.gy/dsdphc
- Video: https://deeperbrain.com/demo/dual.html

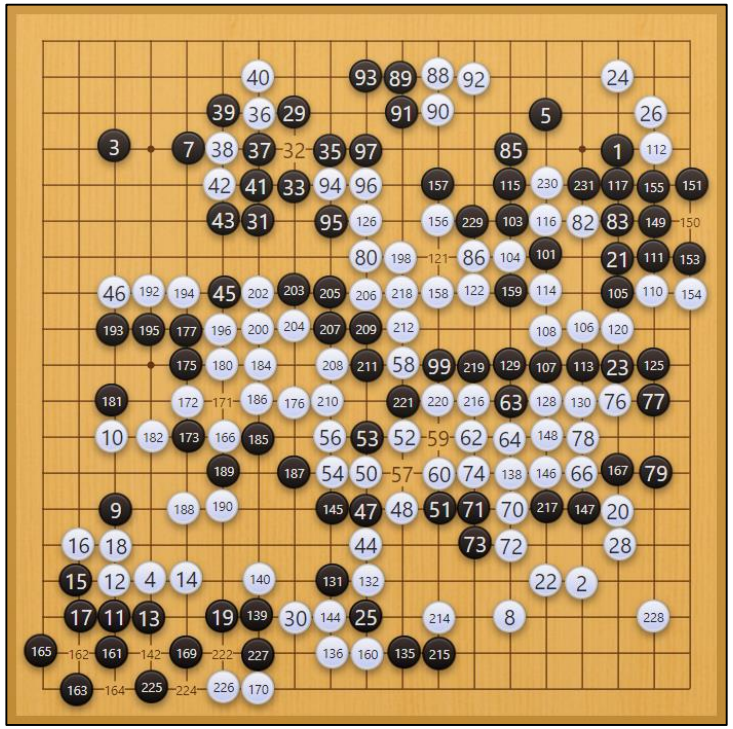
Checkers:

- Colab: https://rb.gy/dzgptt

Text Game Format	Supported Games with Possible Training Data
Smart Game Format (SGF)	Amazons, Ataxx, Backgammon, Byte, Chase, Chess, Dvonn, Exxit, Focus, Gess, Gipf, Go, Gobblet, Gomoku+Renju, Hex, Hive, Hnefatafl, Jungle, Kropki, Kuba, Lines of Action, Neutron, Nine Men's Morris, Octi, Othello, Philosopher's Football, Phutball, Plateau, PÜNCT, Quadrature, Sahara, Shogi, Tamsk, Tantrix, Trax, Tripples, Tumbling Down, TwixT, Xiangqi, Yinsh, Zèrtz,
Portable Game Notation (PGN)	Chess
Portable Draughts Notation	Checkers, Draughts
Bridge Notation (Richard's or Portable)	Bridge
Video Games and Simulator Grammars	Multiple vintage games but SimCity 2000, Pirates, Minecraft, ZZT, etc.

Questions

Generated Go



Example Generated Go SGF

```
(;
;B[qd];W[pp];B[cd];W[dp];B[oc];W[qi];B[ed];W[nq];B[cn];W[cl]
;B[cq];W[cp];B[dq];W[ep];B[bp];W[bo];B[bq];W[co];B[fq];W[qn]
;B[qg];W[op];B[qj];W[qb];B[jq];W[rc];B[lq];W[qo];B[hc];W[hq]
;B[gf];W[hd];B[he];W[ge];B[id];W[gc];B[gd];W[fd];B[fc];W[gb]
;B[ge];W[fe];B[ff];W[jo];B[fh];W[ch];B[jn];W[kn];B[km];W[jm]
;B[ln];W[kl];B[jl];W[im];B[in];W[il];B[km];W[kj];B[ll];W[lm]
;B[mm];W[ml];B[nk];W[nl];B[nm];W[pm];B[on];W[om];B[nn];W[nn]
;B[mn];W[no];B[mo];W[mm];B[nm];W[qk];B[rk];W[pl];B[rm];W[jg]
;B[of];W[pf];B[qf];W[og];B[nd];W[mg];B[rd];W[lb];B[kb];W[lc]
;B[kc];W[mb];B[jb];W[ie];B[if];W[je];B[jd];W[lf];B[lj];W[lk]
;B[og];W[oh];B[nf];W[ng];B[qh];W[pi];B[oj];W[oi];B[nh];W[rh]
;B[rg];W[rd];B[pj];W[oh];B[ne];W[of];B[qe];W[rf];B[re];W[qi]
;B[lg];W[mh];B[lf];W[kh];B[rj];W[jf];B[ol];W[ok];B[nj];W[pk]
;B[ip];W[jp];B[iq];W[jr];B[kr];W[ir];B[jr];W[nm];B[gq];W[gp]
;B[gr];W[dr];B[cr];W[iq];B[in];W[om];B[pn];W[ol];B[rf];W[sf]
;B[se];W[sg];B[sg];W[sh];B[re];W[lf];B[le];W[lh];B[nh];W[jr]
;B[cr];W[br];B[bs];W[cs];B[ar];W[fl];B[qm];W[fr];B[er];W[gs]
;B[fk];W[ek];B[el];W[fj];B[ej];W[hk];B[ei];W[fi];B[gi];W[fj]
;B[ck];W[dl];B[gk];W[gj];B[gl];W[gk];B[hm];W[en];B[fm];W[fn]
;B[gi];W[dh];B[ci];W[eh];B[di];W[fi];B[jh];W[kg];B[gi];W[gi]
;B[gh];W[gh];B[hh];W[hi];B[ih];W[jh];B[ii];W[ij];B[ji];W[ik]
;B[jj];W[ki];B[kk];W[lq];B[lr];W[mk];B[on];W[kh];B[mj];W[lk]
;B[kk];W[fr];B[fs];W[es];B[ds];W[fs];B[gr];W[rq])
```