

Crazy

Stone

1984



Rémi Coulom

<https://www.kayufu.com/>

INITIAL
PROG.

M05

UC 50.001 THOMSON



Thomson MO5 Specs

CPU	Motorola 6809, 1Mhz		
Memory	RAM	Video	16 kb
		Program	32 kb
	ROM	OS	4 kb
		BASIC	12 kb

OK
LIST

```
0  'RUNNING THIS PROGRAM TAKES 9.5"
10  A=0.0
20  B=1.2
30  C=2.3
40  FOR I=1 TO 1000
50  A=A+B*C
60  NEXT I
70  PRINT A
```

OK
RUN
2760.01

OK
PRINT 1.234567
1.23457

OK
PRINT 1E38
1E+38

OK
PRINT 2E38
Error 6

OK

6809 Assembly for Dot Product

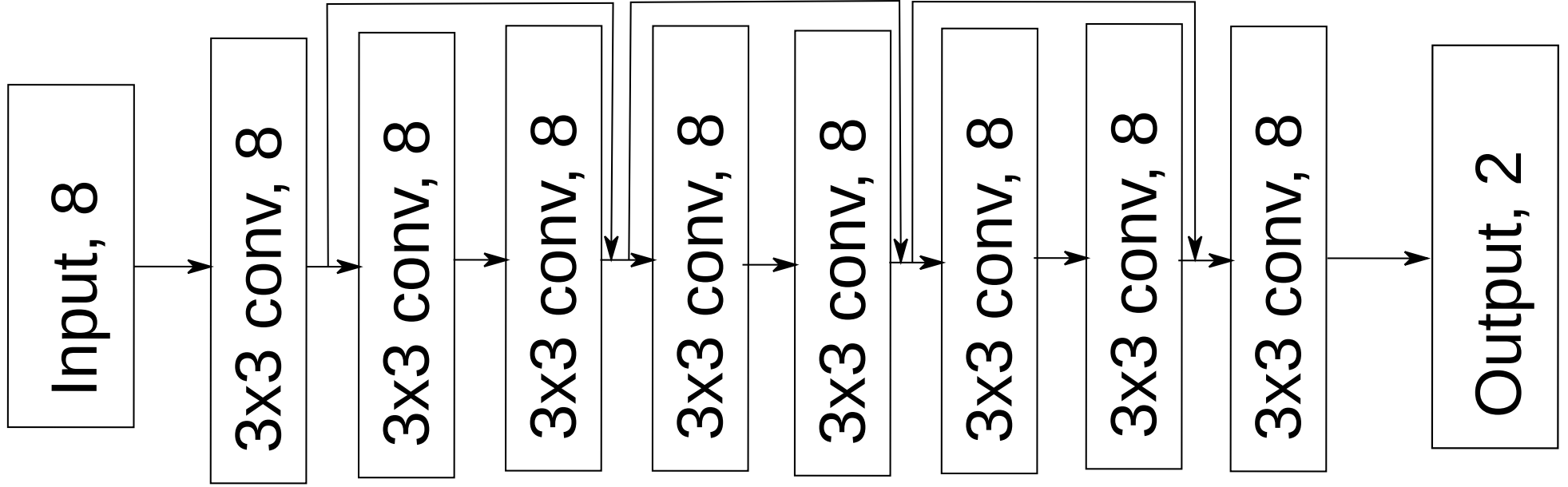
Code		Cycles	Bytes	Pseudo-C
LDB	-11, U	5	2	B = U[-11]
LDA	#\$07	2	2	A = 7
MUL		11	1	D = A * B
LEAX	D, X	8	2	X = X + D
LDB	-10, U	5	2	
LDA	#\$01	2	2	
MUL		11	1	
LEAY	D, Y	8	2	

MUL is unsigned. Result = X – Y.

Performance Summary

Machine	Data Type	Operations per Second
MO5	float32	105
	int8	38,461
NVIDIA H100 NVL	tf32	989,500,000,000,000
	int8	3,958,000,000,000,000

ResNet Architecture

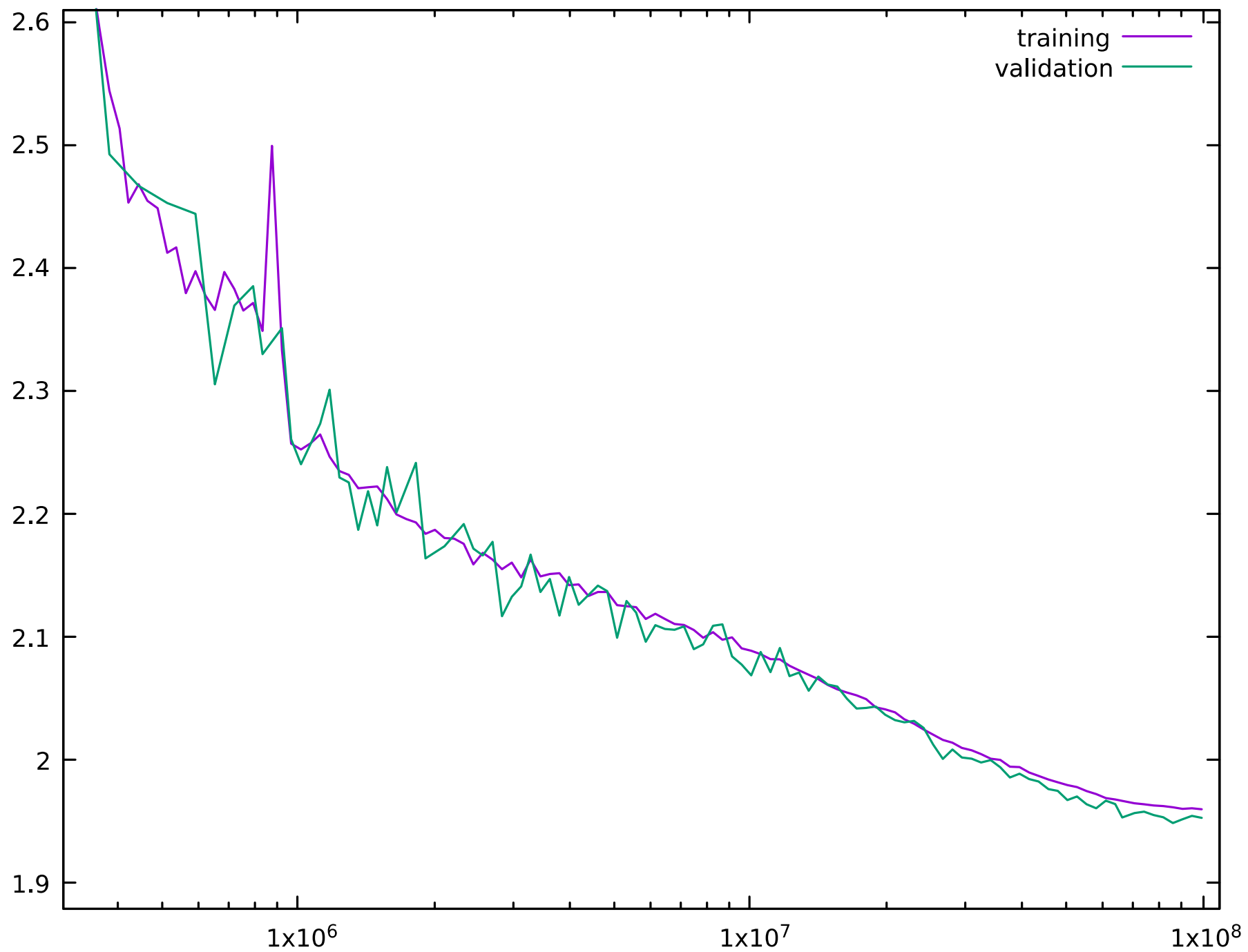


Input

<i>Channel</i>	<i>Feature</i>
0	Empty
1	My stone
2	My stone, 1 liberty
3	My stone, 2 liberties
4	Opponent stone
5	Opponent stone, 1 liberty
6	Opponent stone, 2 liberties
7	Opponent stone, 3 liberties

Output

<i>Channel</i>	<i>Feature</i>
0	Policy
1	Ownership



Activation	Weights	Policy loss
float	float	1.946
8 bits	8 bits	1.951
	7 bits	1.971
	6 bits	2.005
	5 bits	2.212
	4 bits	3.404
7 bits	8 bits	1.954
	7 bits	1.972
	6 bits	2.008
	5 bits	2.209
6 bits	8 bits	1.961
	7 bits	1.981*
	6 bits	2.011
	5 bits	2.222
5 bits	8 bits	1.992
	7 bits	2.017
	6 bits	2.049
4 bits	8 bits	2.121
	7 bits	2.146

Post-training Quantization

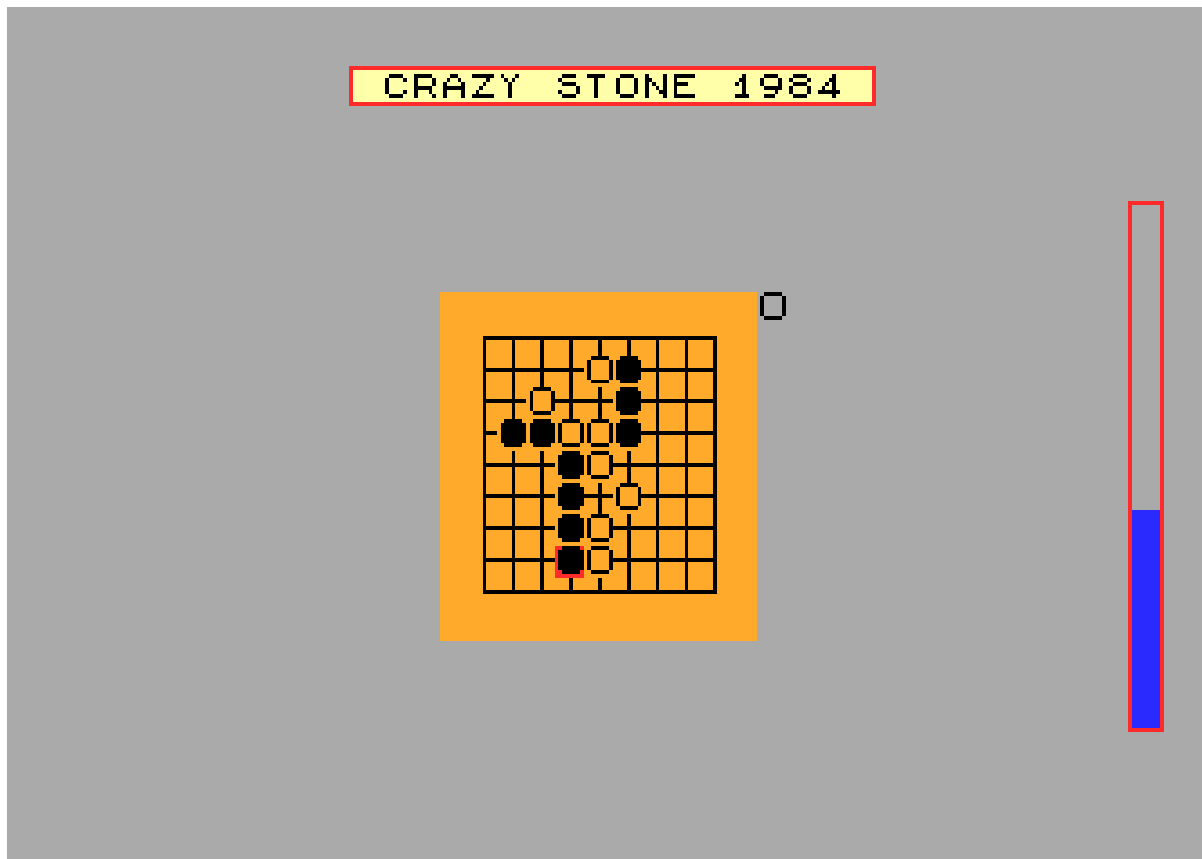
- 16-bit accumulator: risk of overflow
- 13-bit multiplication is safe
- 6-bit activation + 7-bit weight is most accurate



Quantization-Aware Training

TODO

Result



- Binary size: 8kb
- Memory usage: 14kb
- Move in 12 seconds
- Beatable by humans
- Improvable

対局してみませんか？

賞状

_____様

あなたはMO5でクレイジーストーンと
対局し、勝ちました。ここにその栄誉を
讃えます。

レミ・クーロン

賞状

_____様

あなたはMO5でクレイジーストーンと
対局し、頑張りました。ここのその
健闘を讃えます。

レミ・クーロン