

# 分布式人脸识别及工业级运用经验

图普第五季AI谜题详解及思考

小美 图普科技

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第一名通关玩家Solution解法

大规模人脸训练及ReID的工业经验

# 往期技术谜题回顾



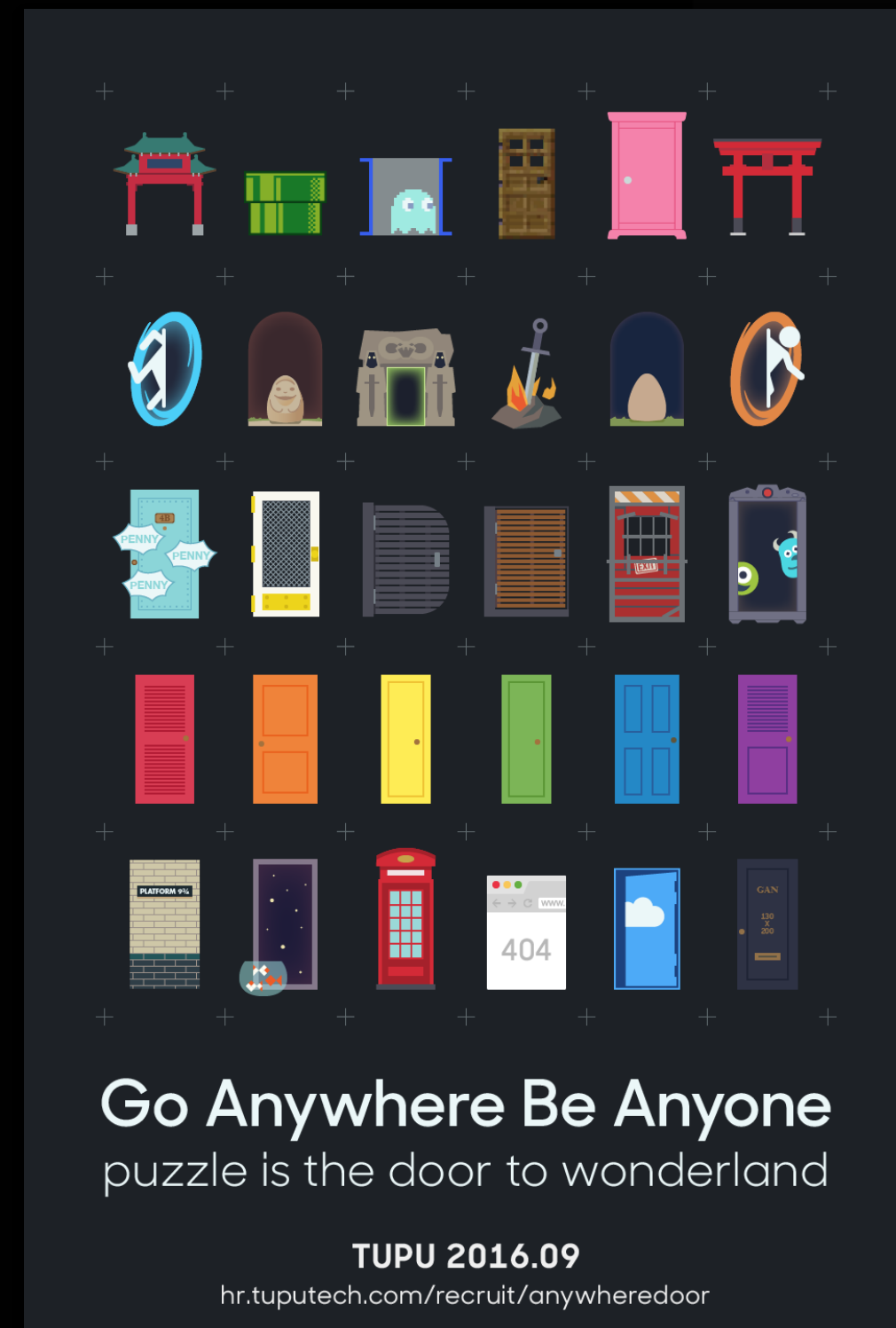
You can go up

```
import DL as gun
import Customers as metric

if __name__ == "__main__":
    result = gun.FCN("001100000111100000110001011000110011001000110000\
011110000110010000110010001100000111100000110011\
011001000110010100110000011110000011001001100010\
00110010")

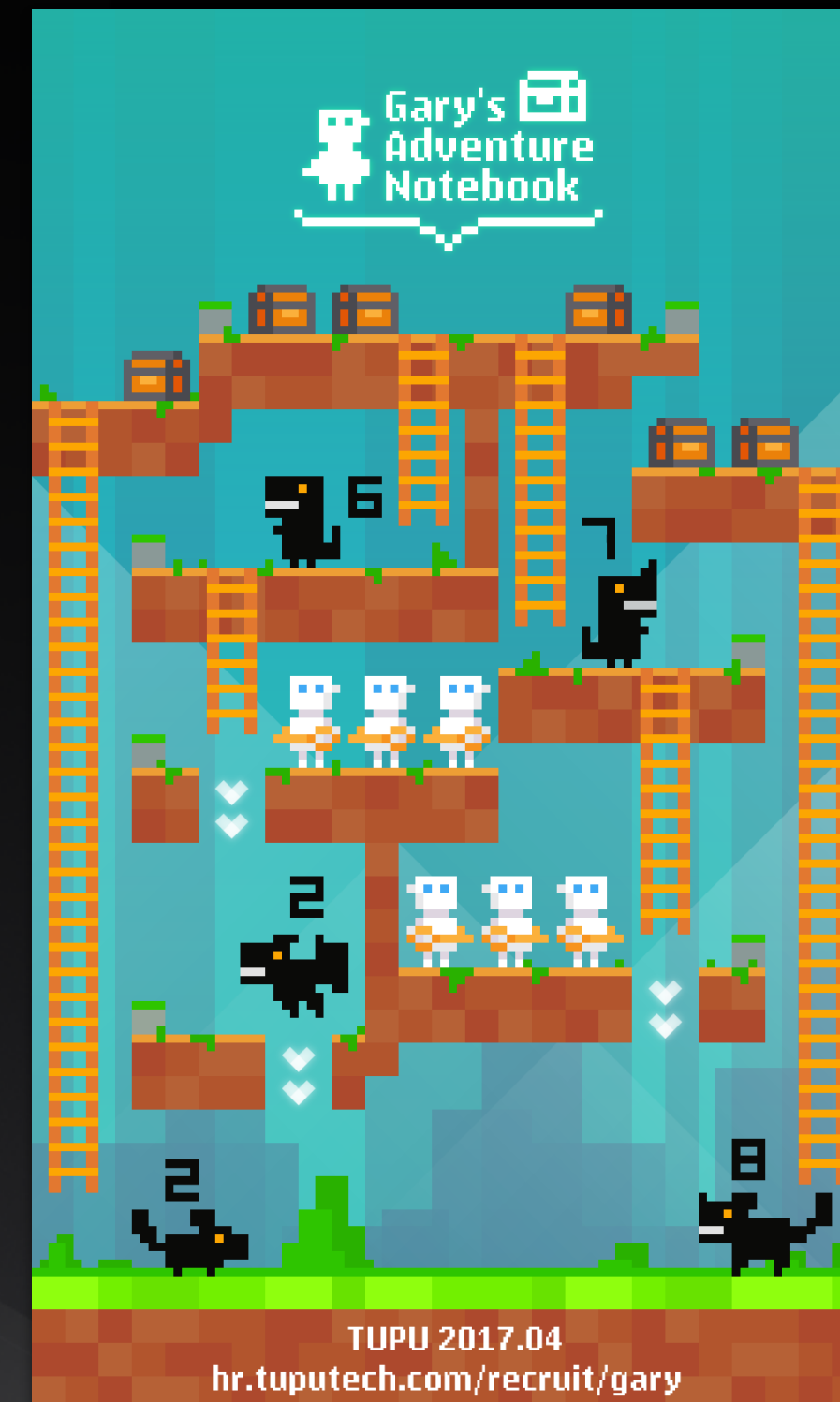
score = request("hr.tuputech.com/recruit/mario", result)
if metric.mean_IU(score) > threshold:
    print "Welcome"
```

**TUPU**  
2016.06



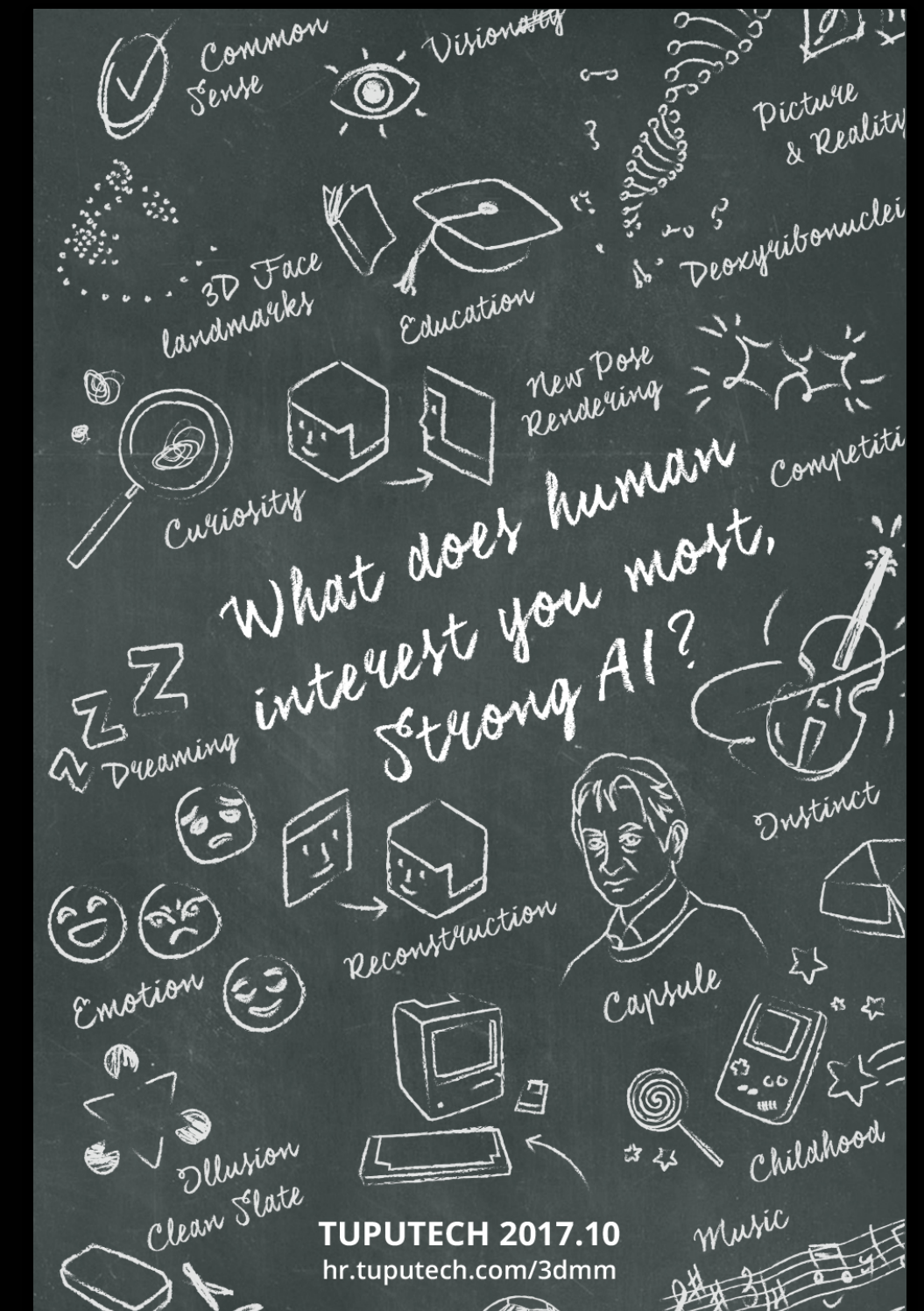
Go Anywhere Be Anyone  
puzzle is the door to wonderland

TUPU 2016.09  
[hr.tuputech.com/recruit/anywheredoor](http://hr.tuputech.com/recruit/anywheredoor)



Gary's Adventure Notebook

TUPU 2017.04  
[hr.tuputech.com/recruit/gary](http://hr.tuputech.com/recruit/gary)



Common Sense, Visionary, Picture & Reality, Deoxyribonuclei, 3D Face landmarks, Education, New Pose Rendering, Curiosity, What does human interest you most, Strong AI?, Competiti, Dreaming, Emotion, Reconstruction, Distinct, Capsule, Childhood, Music, Illusion, Clean Slate

TUPUTECH 2017.10  
[hr.tuputech.com/3dmm](http://hr.tuputech.com/3dmm)



# 往期技术谜题回顾

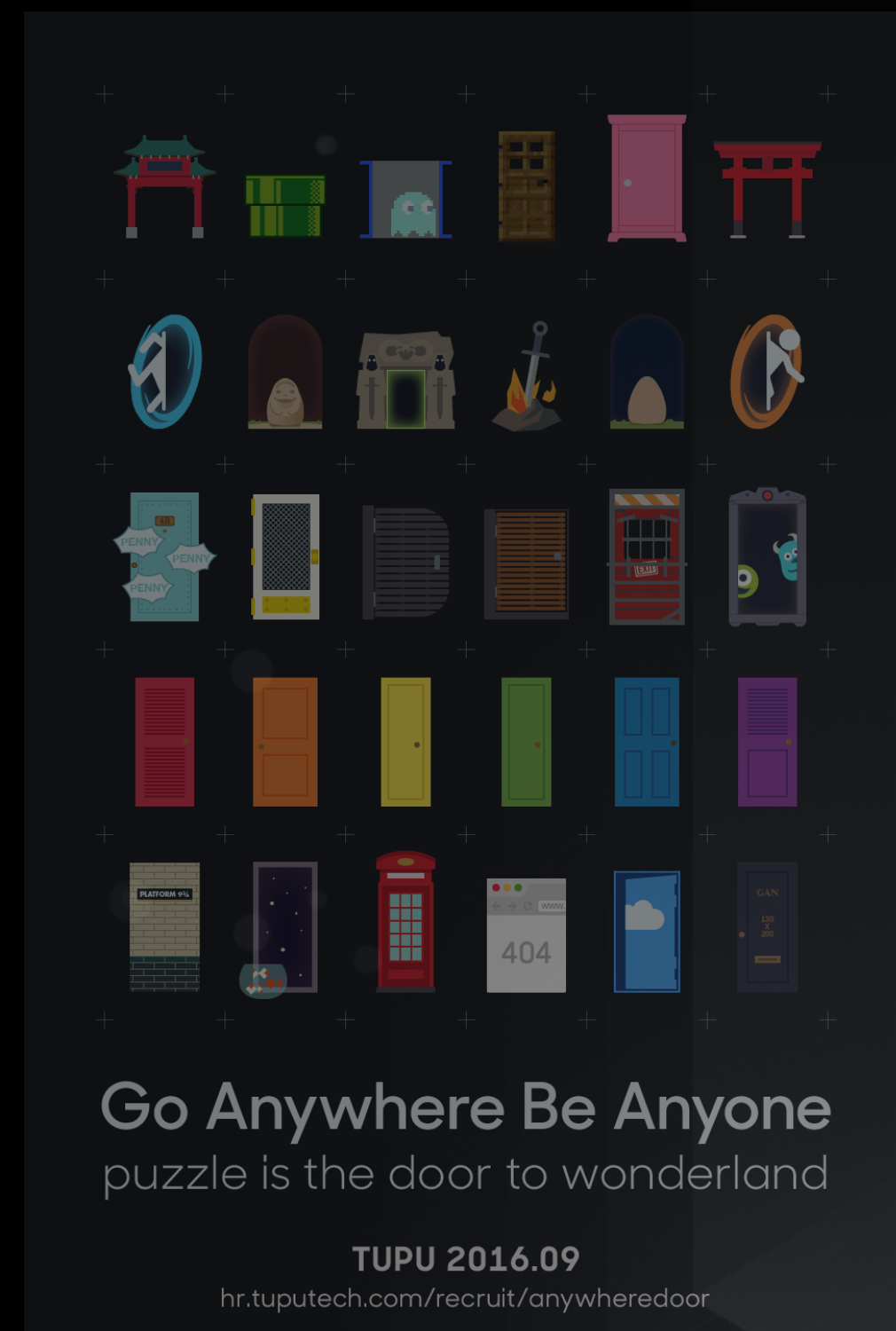


YOU CAN JOIN UP

```
import DL as gun
import Customers as metric

if __name__ == "__join_tupu__":
    result = gun.FCN("001100000111100000110001011000110011001000110000\
011110000110010000110010001100000111100000110011\
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    score = request("hr.tuputech.com/recruit/mario", result)
    if metric.mean_IU(score) > threshold:
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```

TUPU  
2016.06



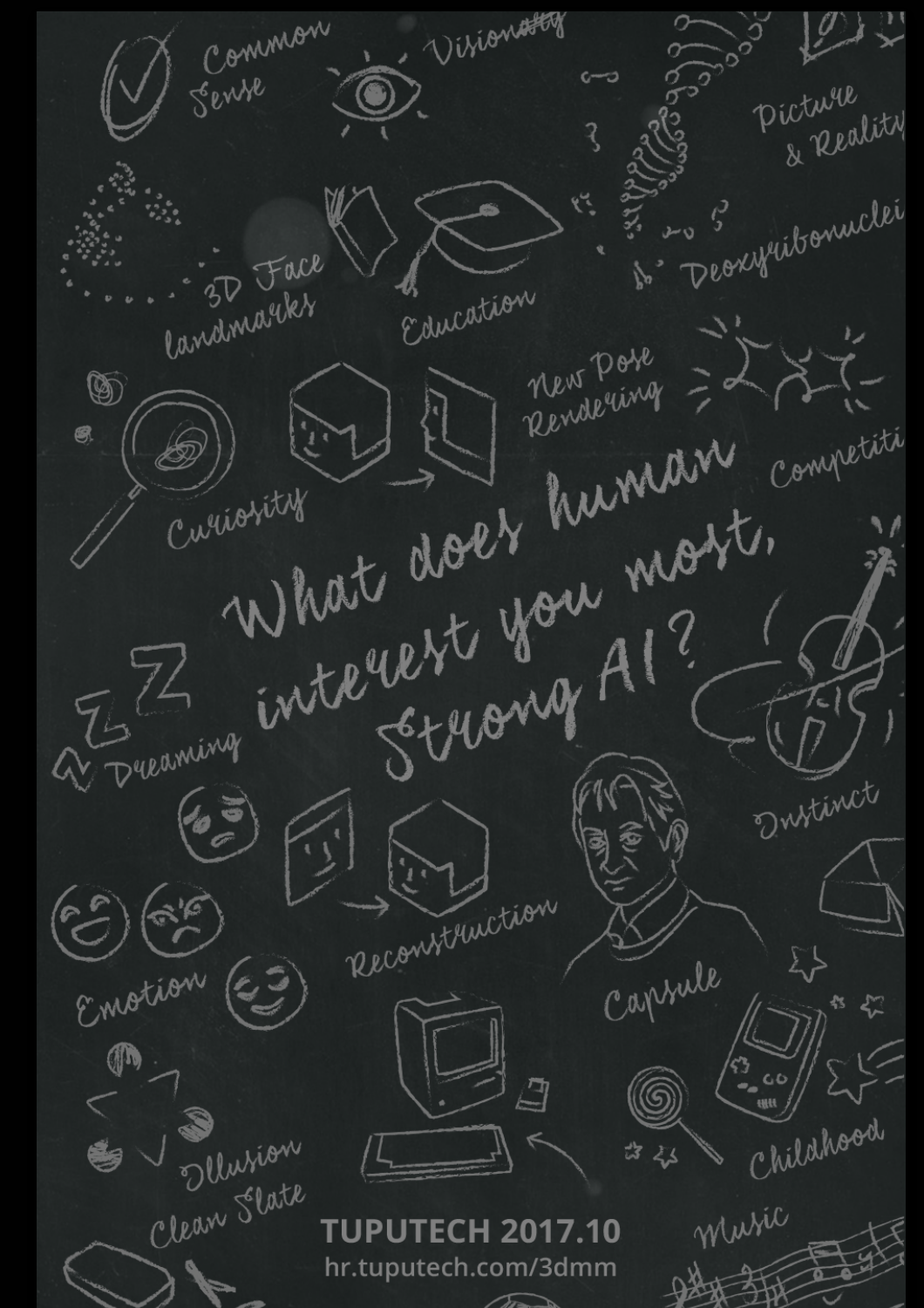
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What does human interest you most, Strong AI?

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hr.tuputech.com/3dmm

## Fully Convolutional Networks

“Fully convolutional networks for semantic segmentation”, Long J. etc. CVPR 2015



# 往期技术谜题回顾



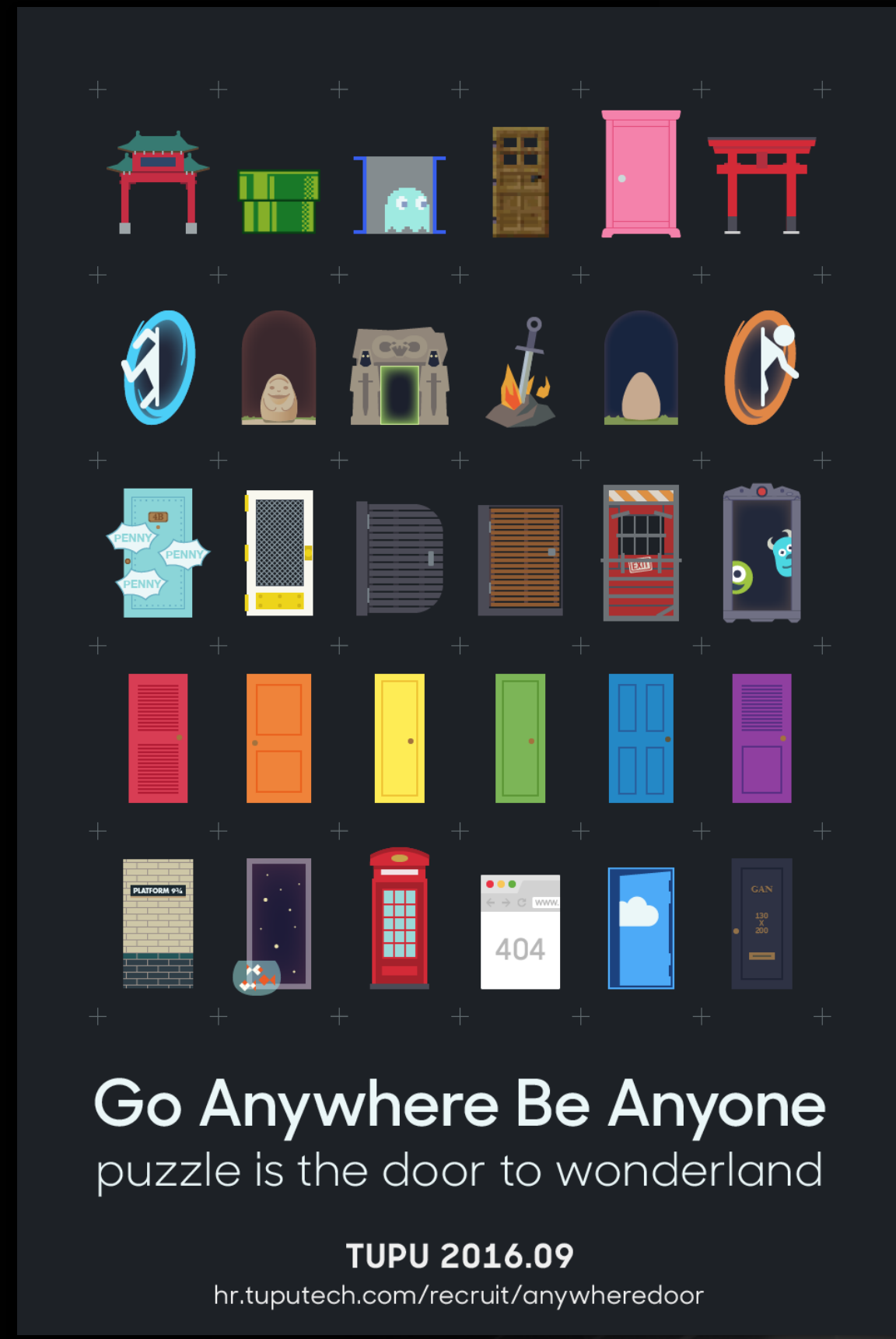
you can you up

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2016.06



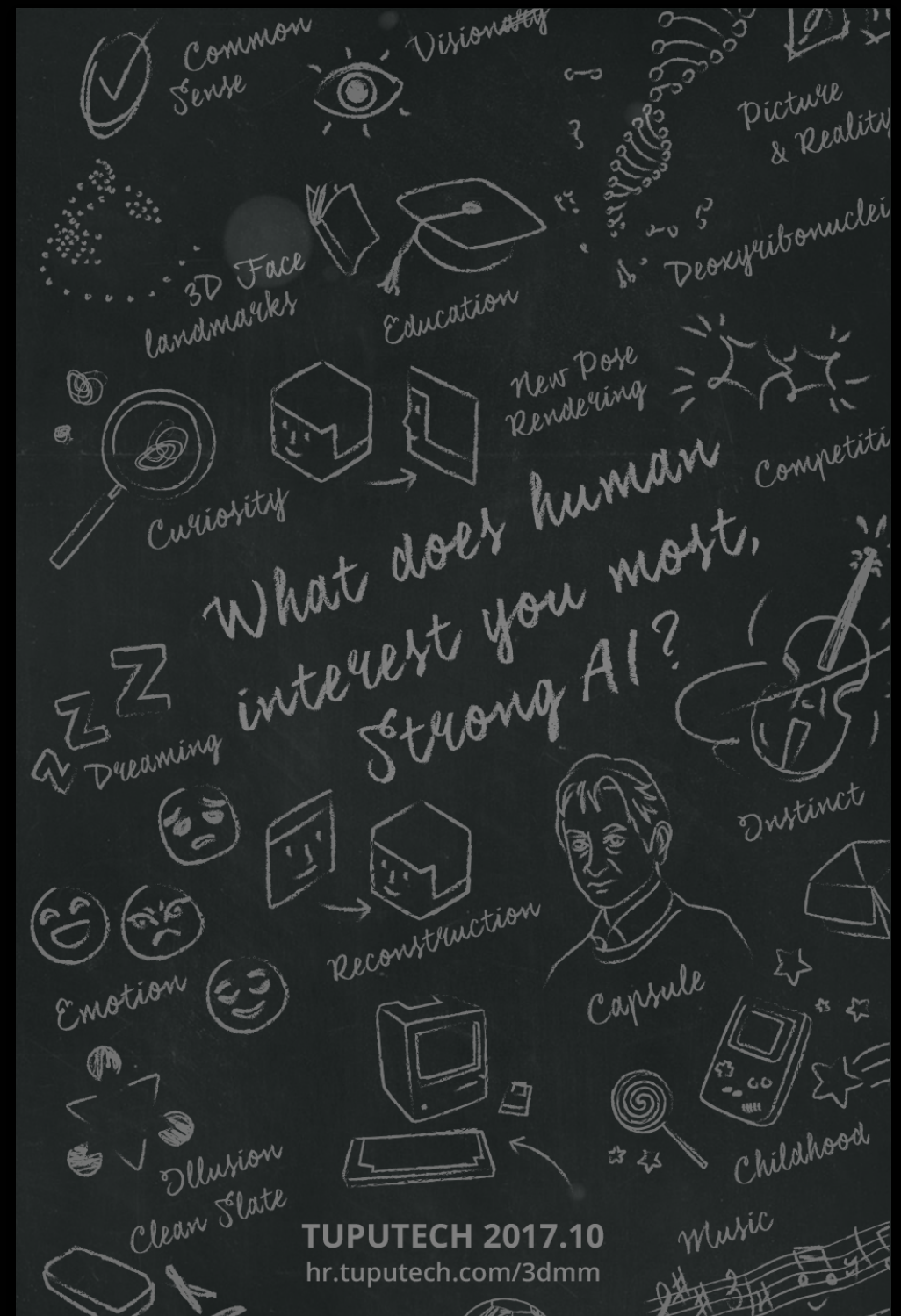
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Generative Adversarial Networks  
“Generative adversarial nets”, Goodfellow, I. etc. NIPS 2014



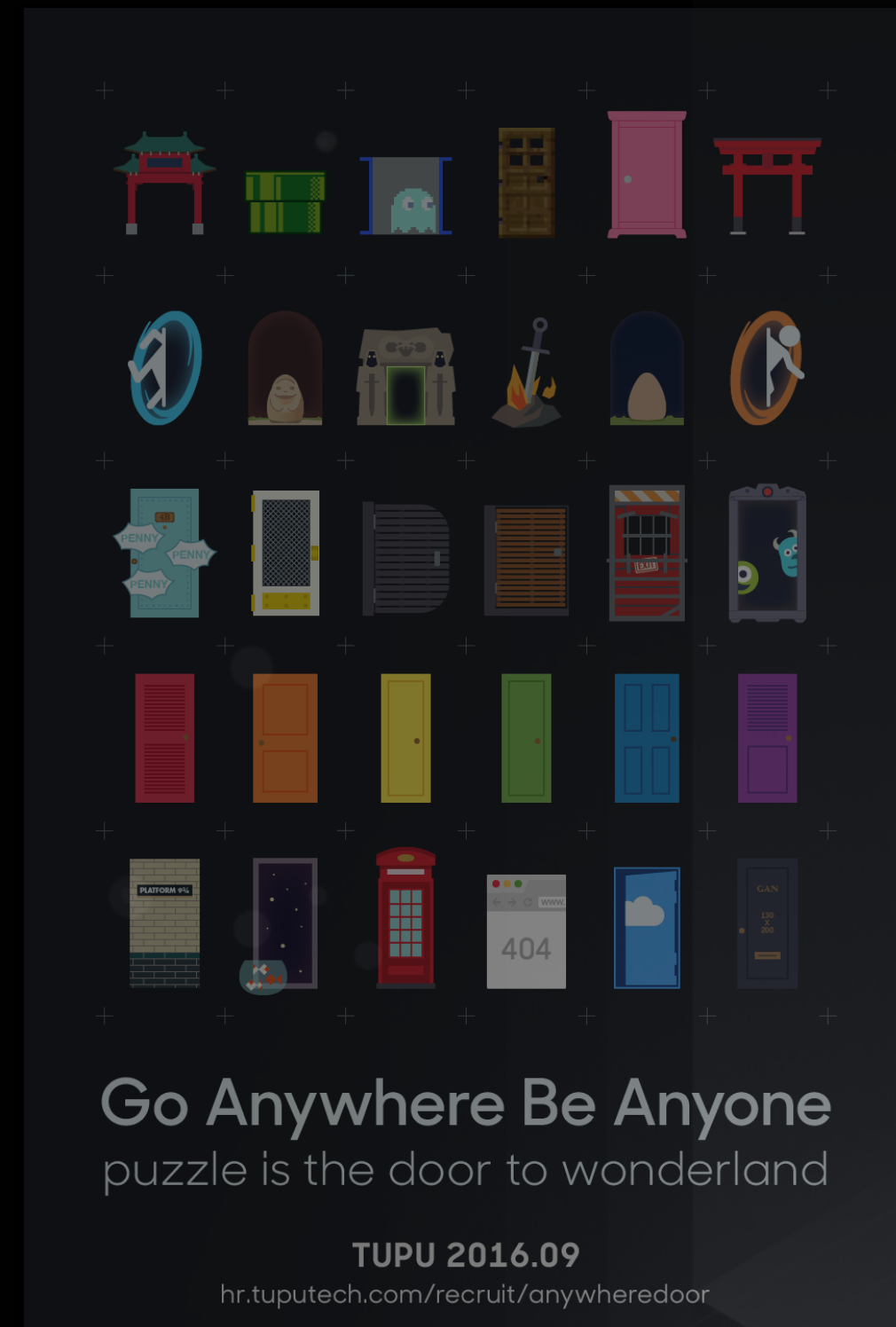
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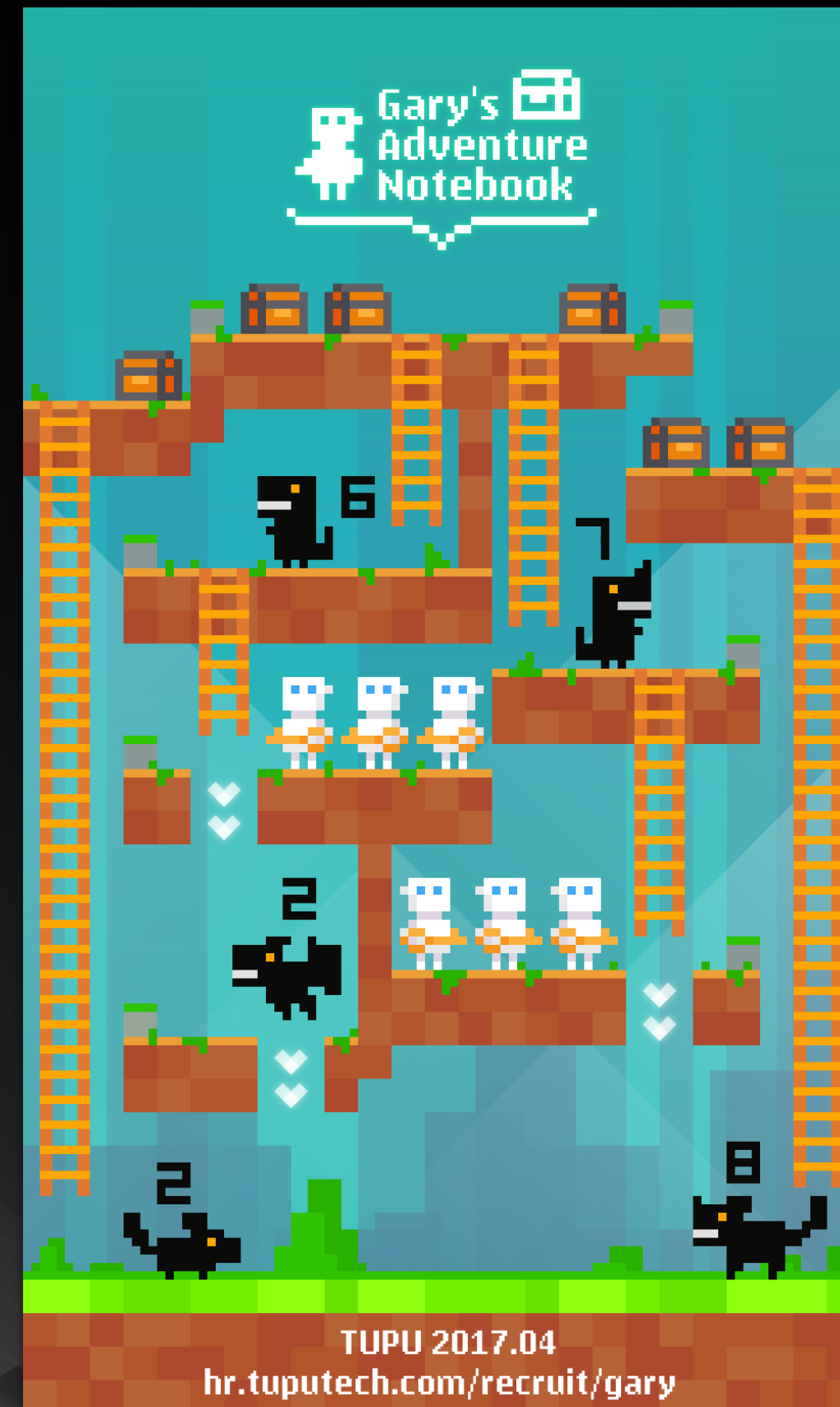
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**TUPU**  
2016.06



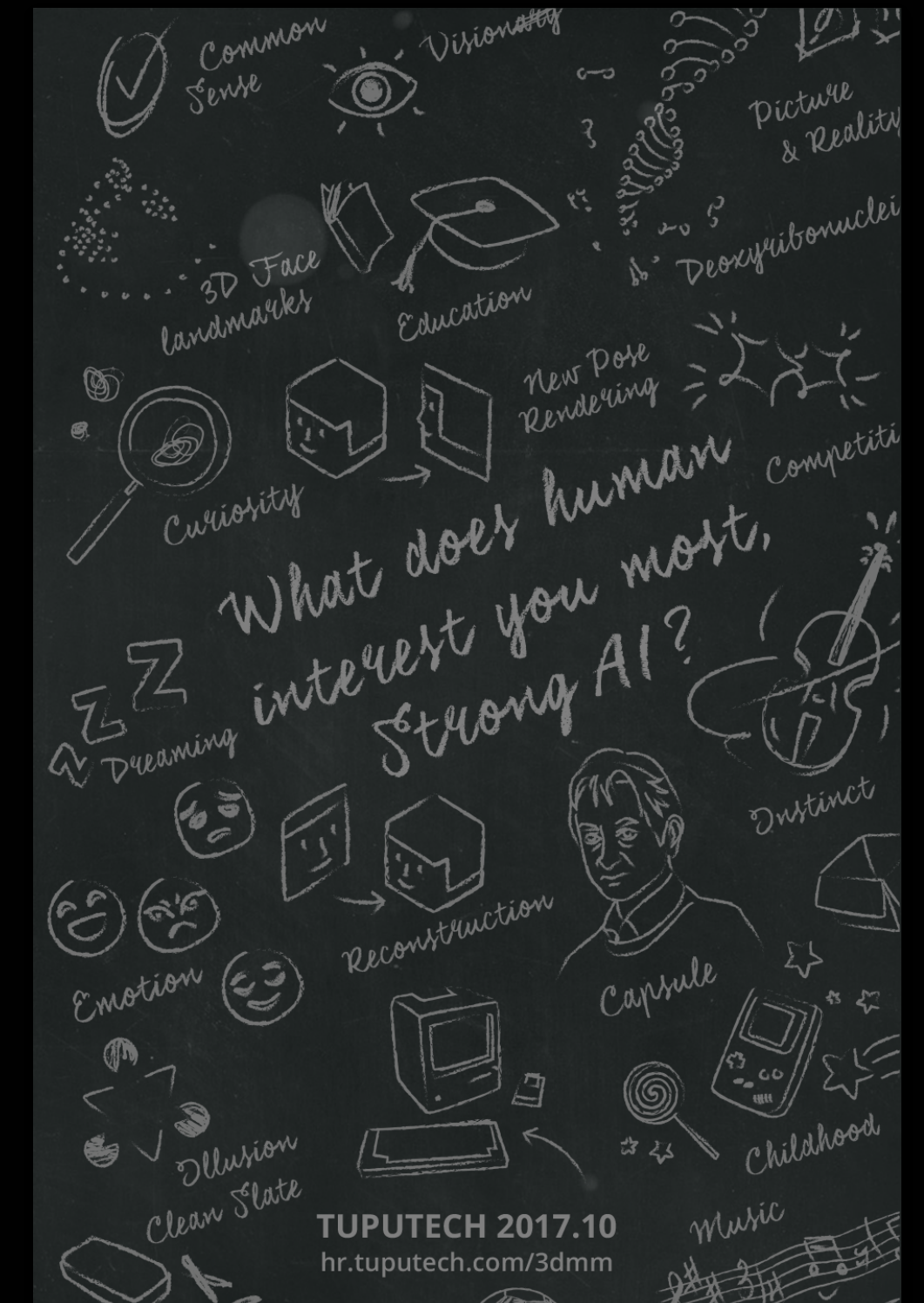
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Wasserstein Distance

“Wasserstein generative adversarial networks”, Arjovsky, M. etc. ICML 2017



# 往期技术谜题回顾



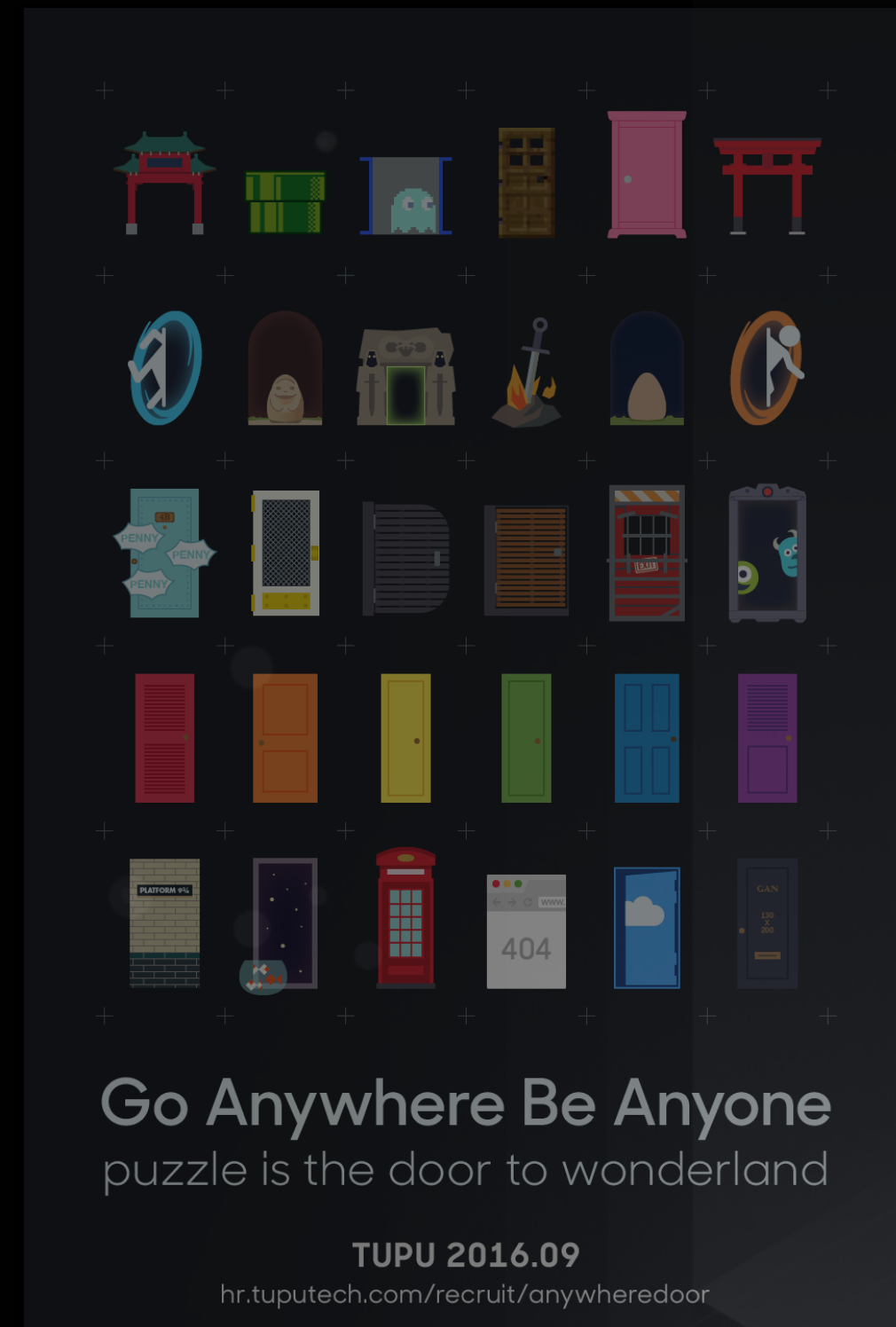
YOU CAN  
YOU  
UP

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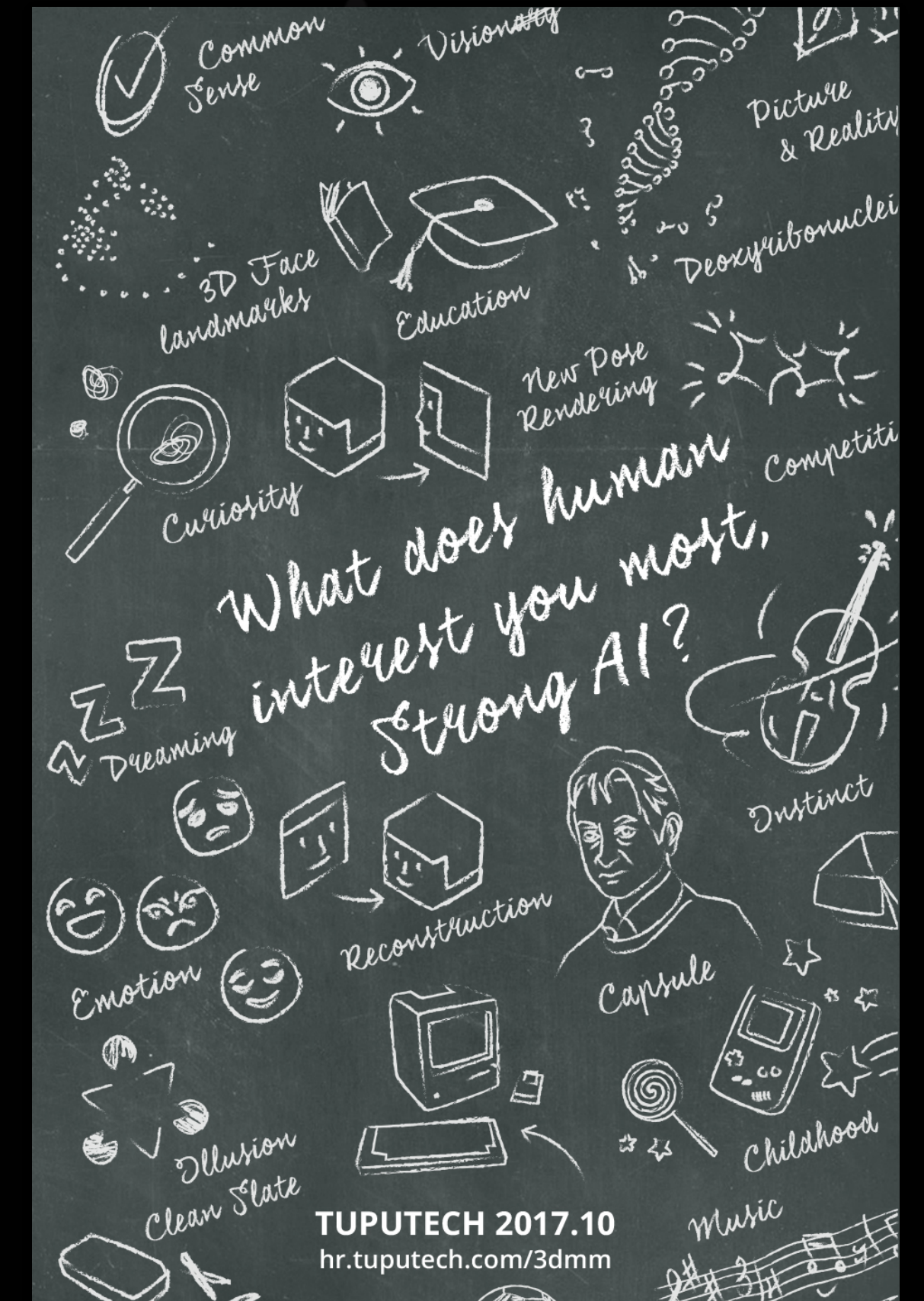
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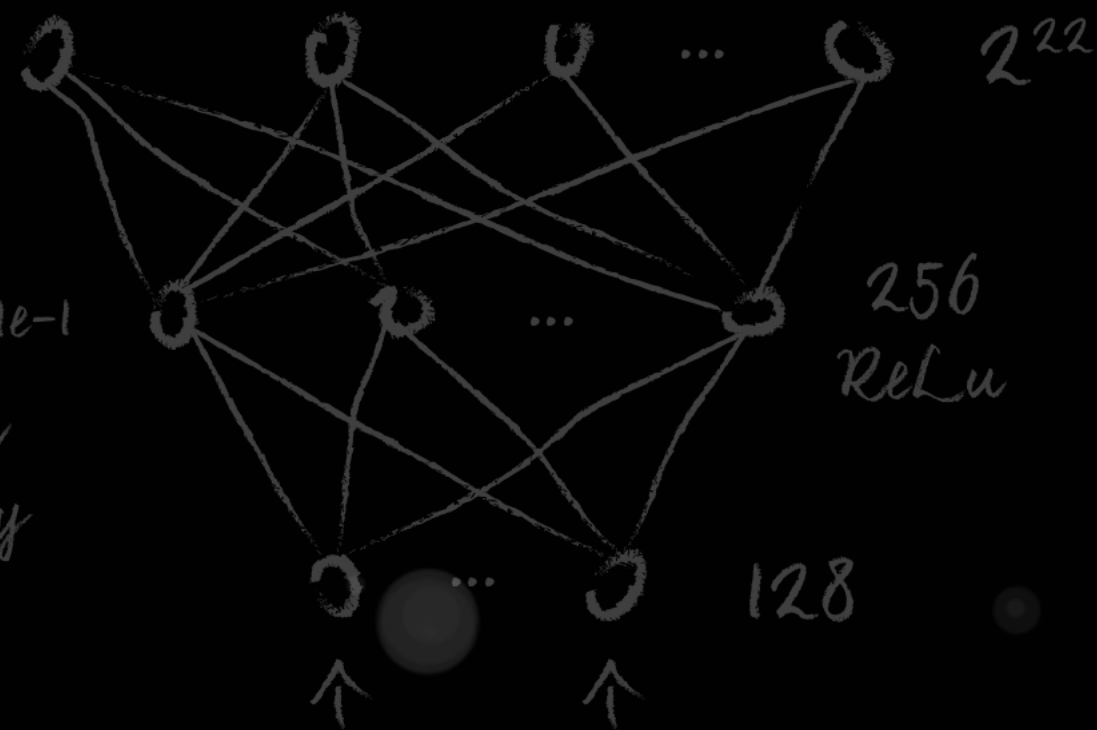
3D Morphable Model



# 题目线索

SGD  
 Step:  $2^{17}$   
 Learning Rate:  $1e-1$   
 no Momentum  
 no weight\_decay  
 no Bias

Cross-Entropy Loss



$W_2$  256

$2^{22}$

0.3	0.1	0.4	0.1	0.5	...	0.8
0.3	0.1	0.4	0.1			0.8
...						...
...						
0.3	0.1	0.4	0.1	0.5	...	0.8

$W_1$  128

256

0.3	0.1	0.4	0.1	0.5	...	0.6
0.3	0.1	0.4	-			0.6
0.3	0.1	...				...
-						
0.3	0.1	0.4	0.1	0.5	...	0.6

batch size =  $2^5$

Step 1

128

0.2	0.7	0.1	...	0.5
0.9		0.6	...	
...				
0.5	0.5	0.3		0.8

$y$  0 1 2 ... 31

Step 2

0.2	0.7	0.1	...	0.5
0.9				
...	0.7			
0.5				0.8

$y$  32 33 ... 63

Step  $2^{17}$

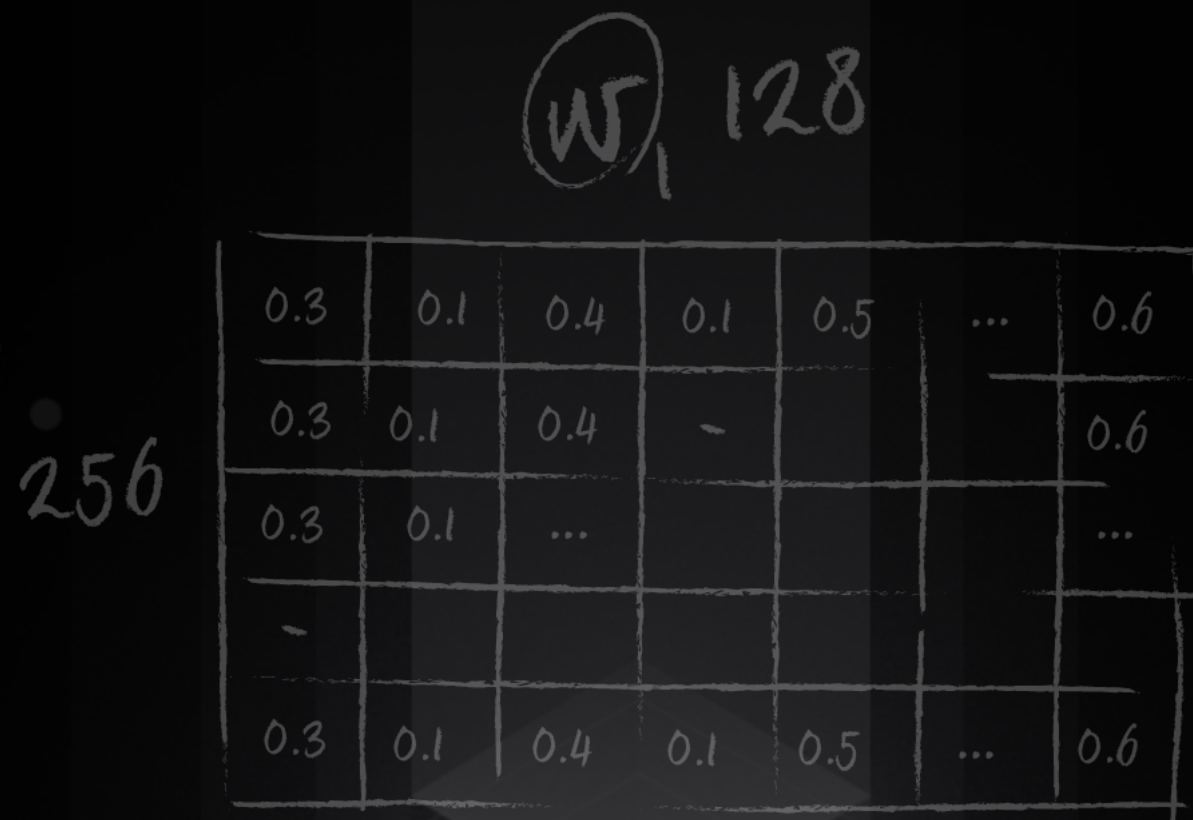
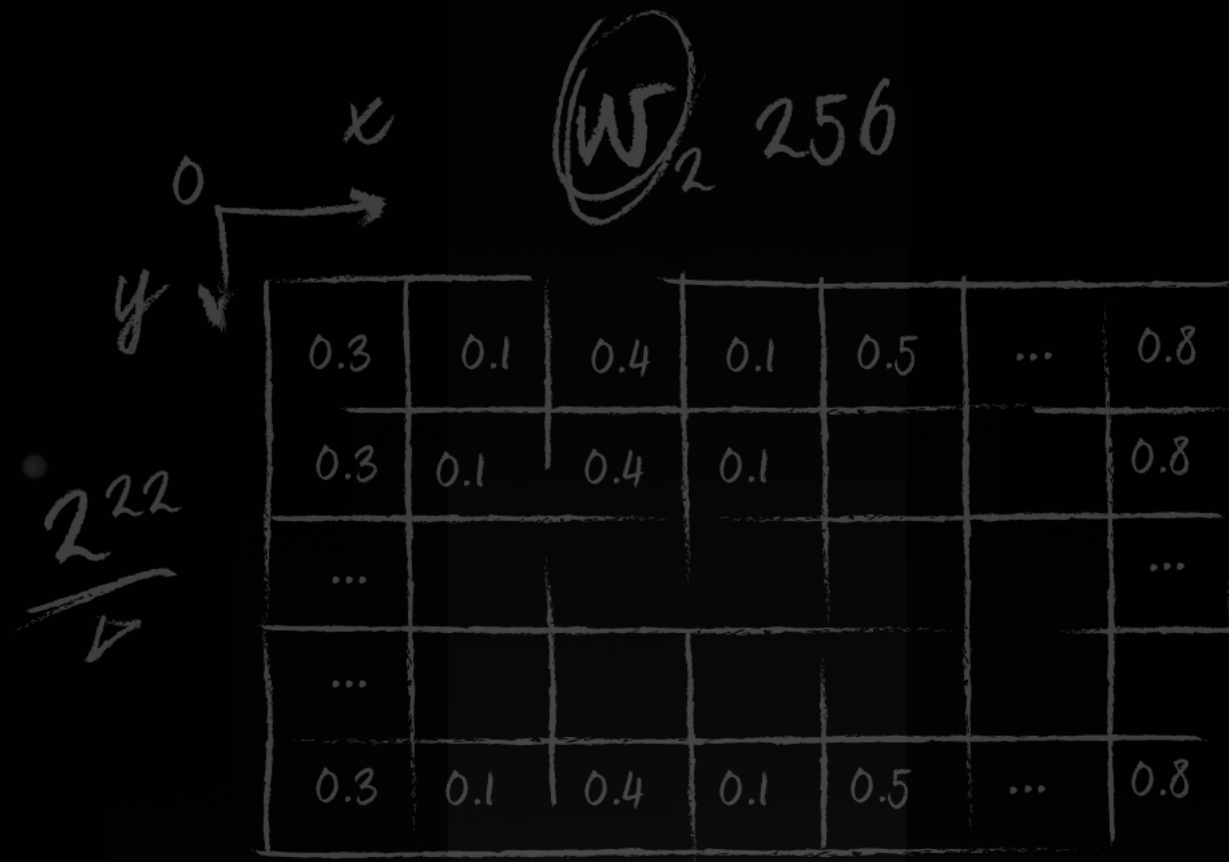
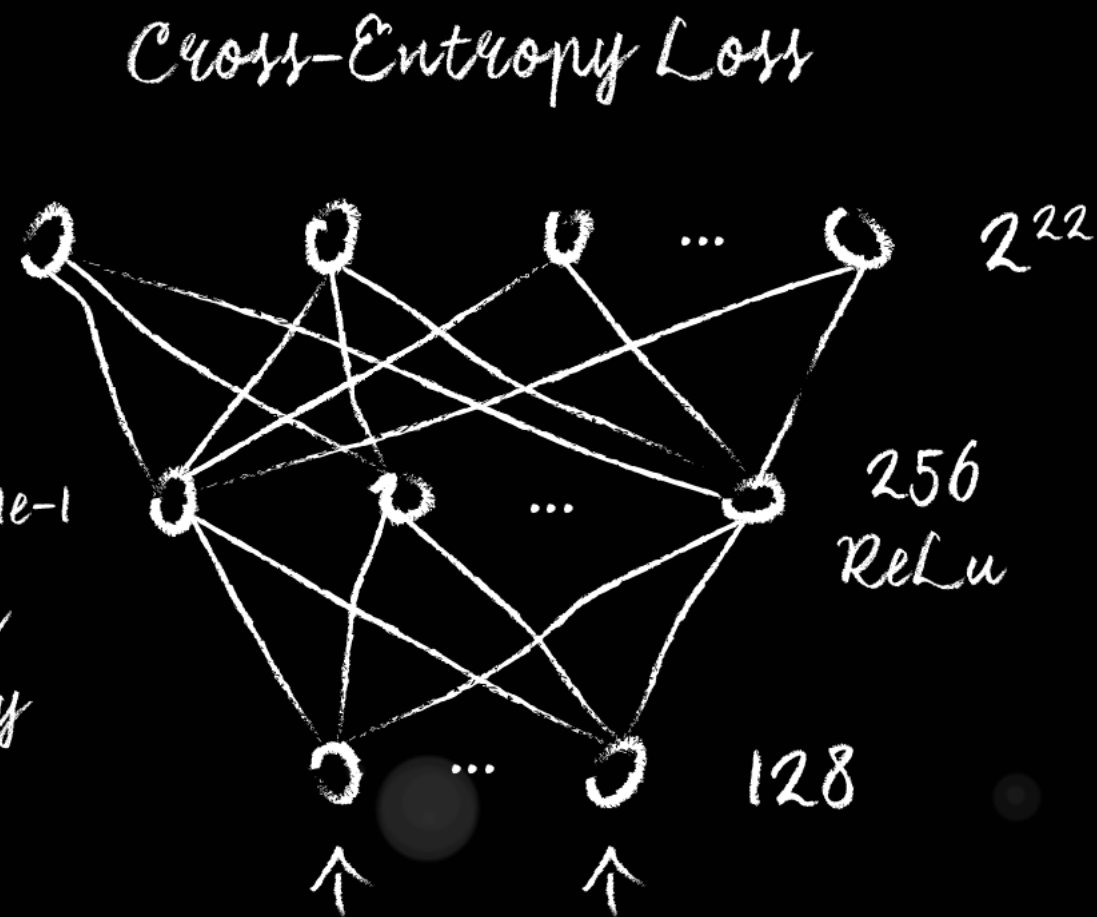
0.2	0.7	0.1	...	0.5
...				
0.5				0.8

$y$  ...  $2^{22}-2$   $2^{22}-1$

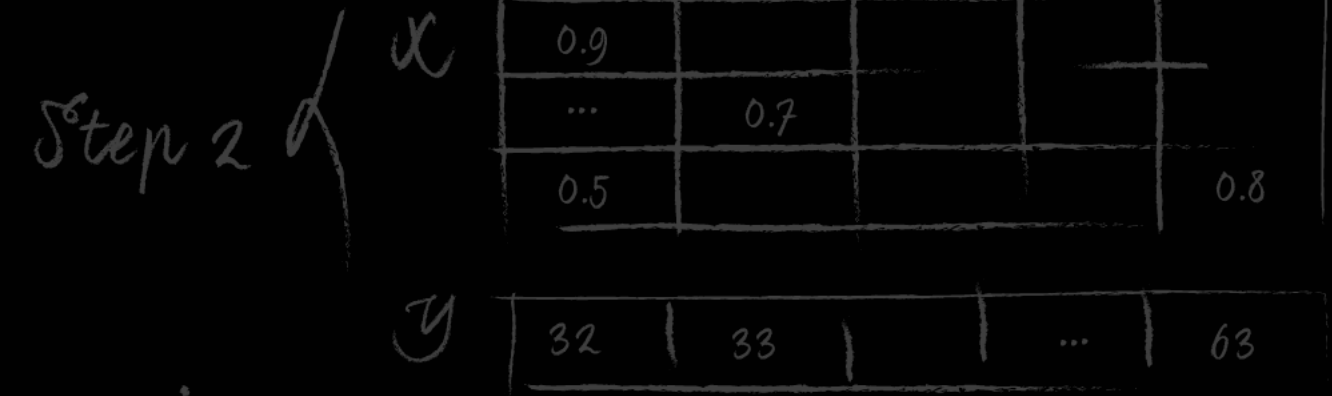
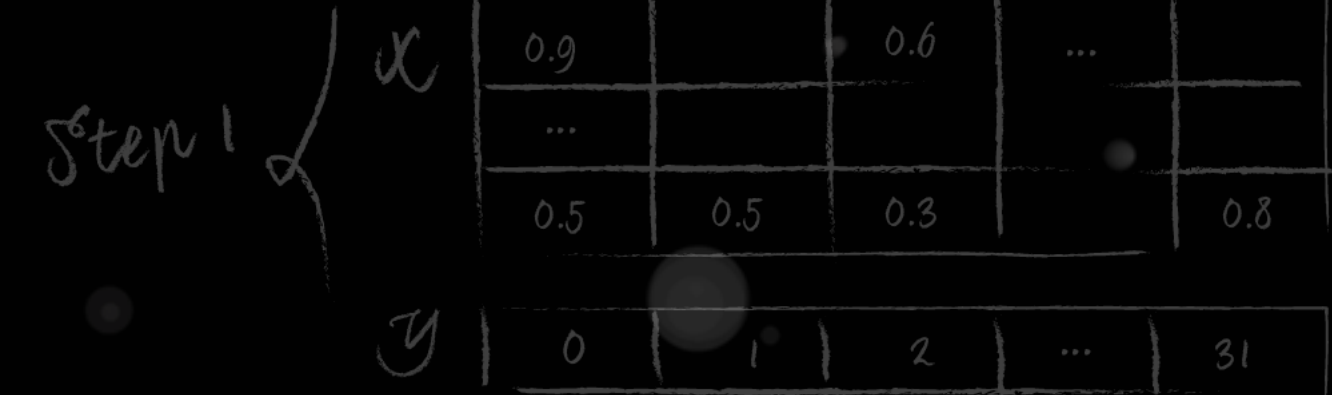


# 题目线索

SGD  
 Step:  $2^{17}$   
 Learning Rate:  $1e-1$   
 no Momentum  
 no weight\_decay  
 no Bias



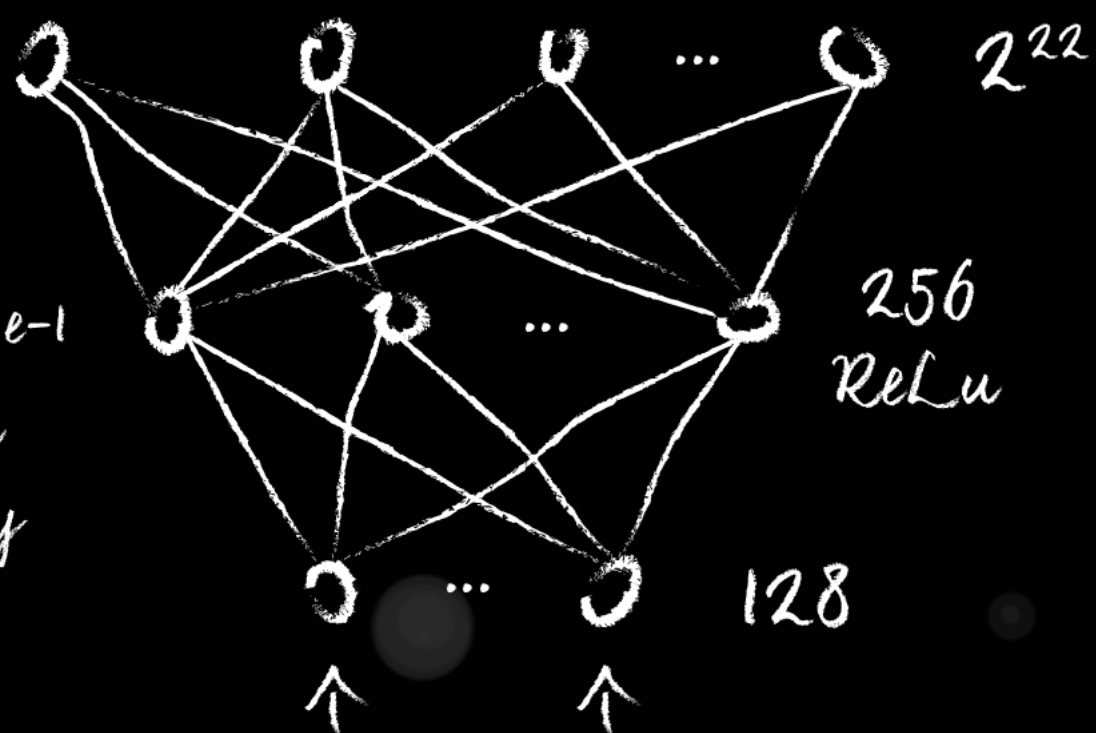
batch size =  $2^5$



# 题目线索

SGD  
 Step:  $2^{17}$   
 Learning Rate:  $1e-1$   
 no Momentum  
 no weight\_decay  
 no Bias

Cross-Entropy Loss



$2^{22}$

$W_2$  256

0.3	0.1	0.4	0.1	0.5	...	0.8
0.3	0.1	0.4	0.1			0.8
...						...
...						
0.3	0.1	0.4	0.1	0.5	...	0.8

$W_1$  128

256

0.3	0.1	0.4	0.1	0.5	...	0.6
0.3	0.1	0.4	-			0.6
0.3	0.1	...				...
-						
0.3	0.1	0.4	0.1	0.5	...	0.6

batch size =  $2^5$

Step 1

128

0.2	0.7	0.1	...	0.5
0.9		0.6	...	
...				
0.5	0.5	0.3		0.8

0 1 2 ... 31

Step 2

0.2	0.7	0.1	...	0.5
0.9				
...	0.7			
0.5				0.8

32 33 ... 63

Step  $2^{17}$

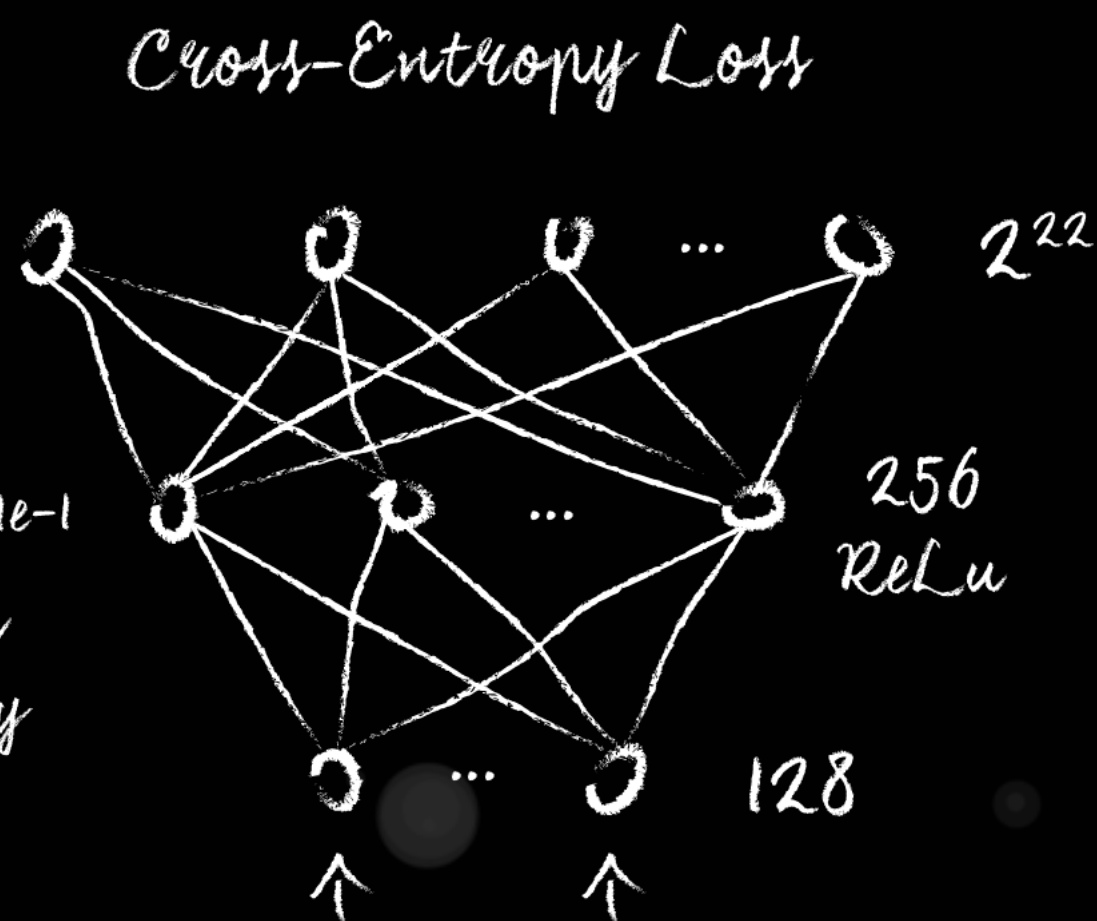
0.2	0.7	0.1	...	0.5
...				
0.5				0.8

...  $2^{22}-2$   $2^{22}-1$



# 题目线索

SGD  
 Step:  $2^{17}$   
 Learning Rate:  $1e-1$   
 no Momentum  
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$2^{22}$

$W_2$  256

0.3	0.1	0.4	0.1	0.5	...	0.8
0.3	0.1	0.4	0.1			0.8
...						...
...						
0.3	0.1	0.4	0.1	0.5	...	0.8

$W_1$  128

256

0.3	0.1	0.4	0.1	0.5	...	0.6
0.3	0.1	0.4	-			0.6
0.3	0.1	...				...
-						
0.3	0.1	0.4	0.1	0.5	...	0.6

batch size =  $2^5$

128

Step 1

0.2	0.7	0.1	...	0.5
0.9		0.6	...	
...				
0.5	0.5	0.3		0.8

Step 2

0.2	0.7	0.1	...	0.5
0.9				
...	0.7			
0.5				0.8

Step  $2^{17}$

0.2	0.7	0.1	...	0.5
...				
0.5				0.8

# 题目解析

- **Classification:**

*Multi Layer Perceptron*

- **Euler's formula:**

$$e^{i\pi} + 1 = 0$$

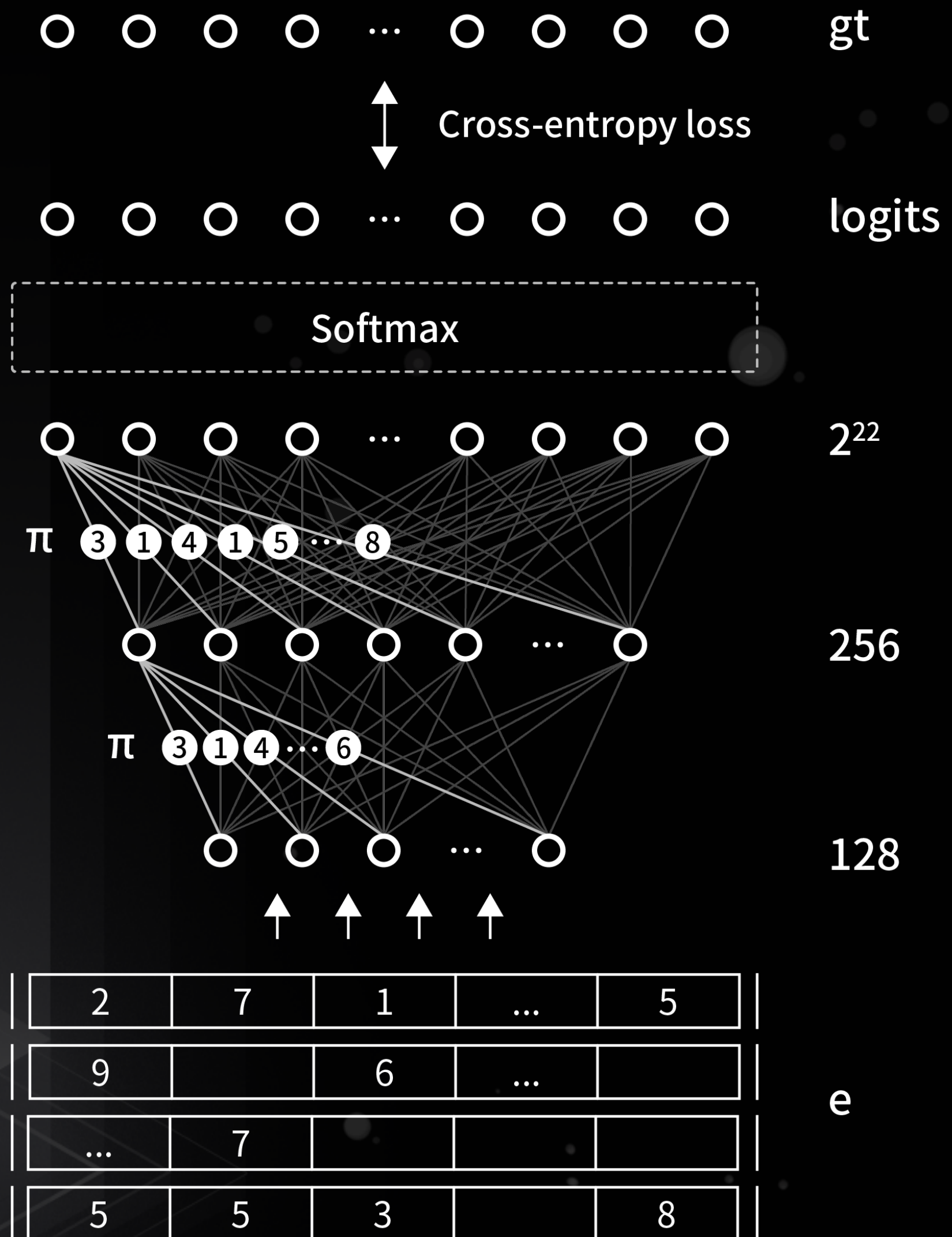
- **Information theory:**

$$H(P, Q) = H(P) + D_{KL}(P || Q)$$

$$H(P, Q) = - E_{x \sim P} \log Q(x)$$

- **Model capacity:**

$$VC(model) > 32$$





# 结果分析

0.47%

谜题通关率

3小时14分

最短通关时间

大约一周

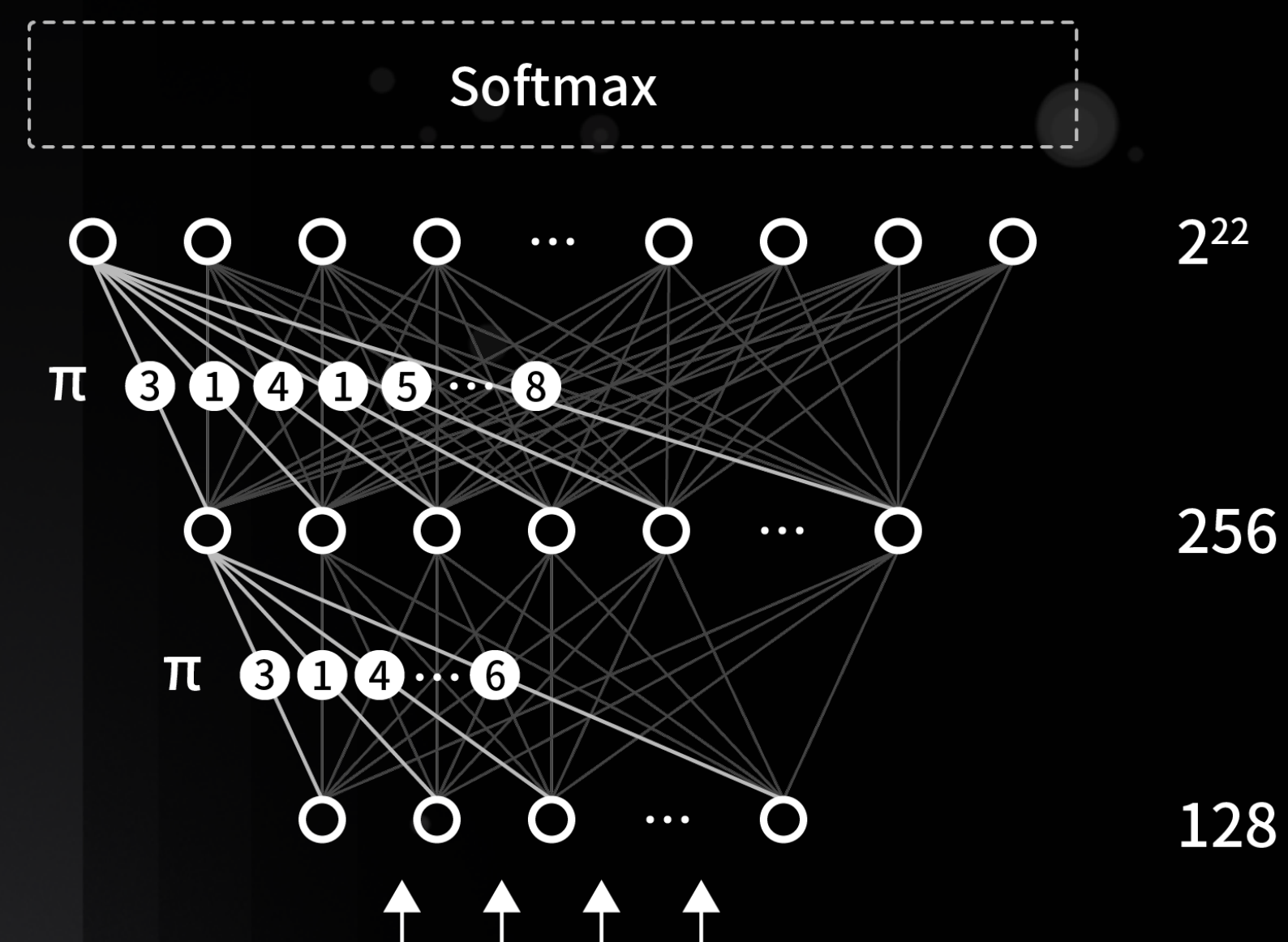
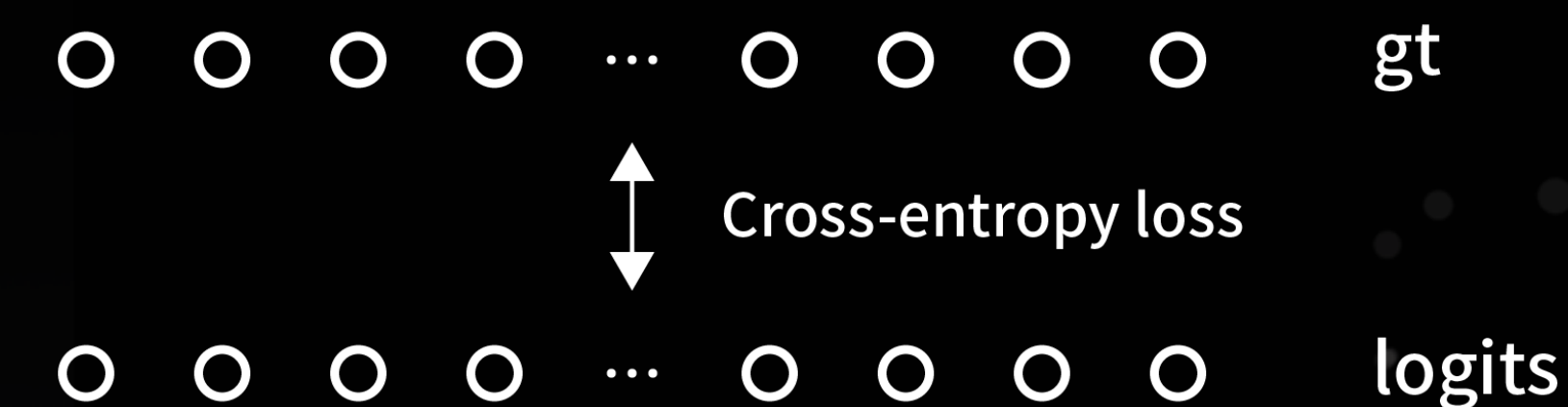
最耗时方案

<10ms

最优方案

# 数据分析

1. 每一个batch的数据重复
2. 每一个batch里的样本的label是随机的且不重复 (disjoint)
3. 每一层的neuron的input weights重复
4. 解答所要求的W1的精度只需要小数点后1位



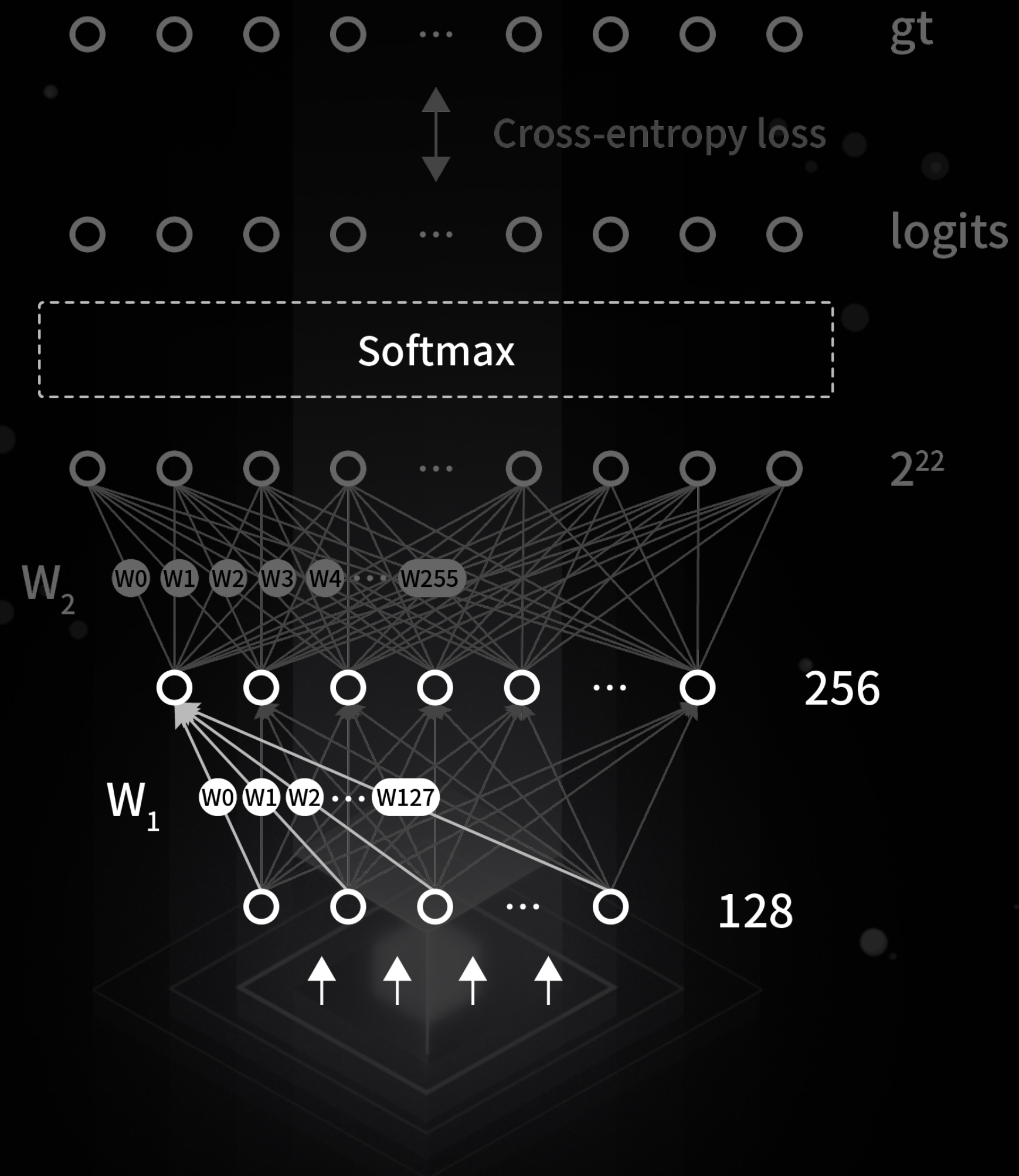
2	7	1	...	5
9		6	...	
...	7			
5	5	3		8

e



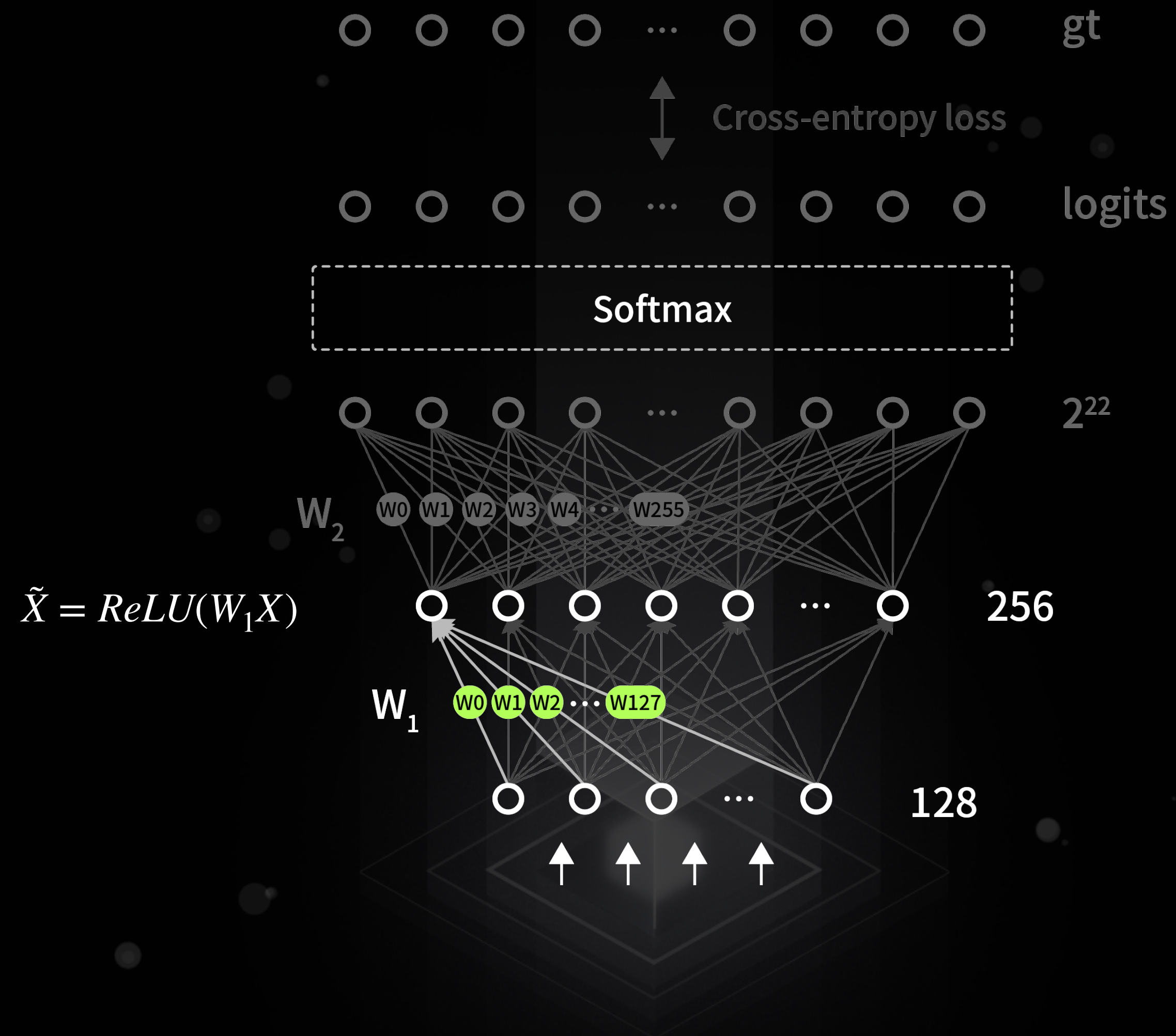
# 简要回顾后向传播

## Forward pass



# 简要回顾后向传播

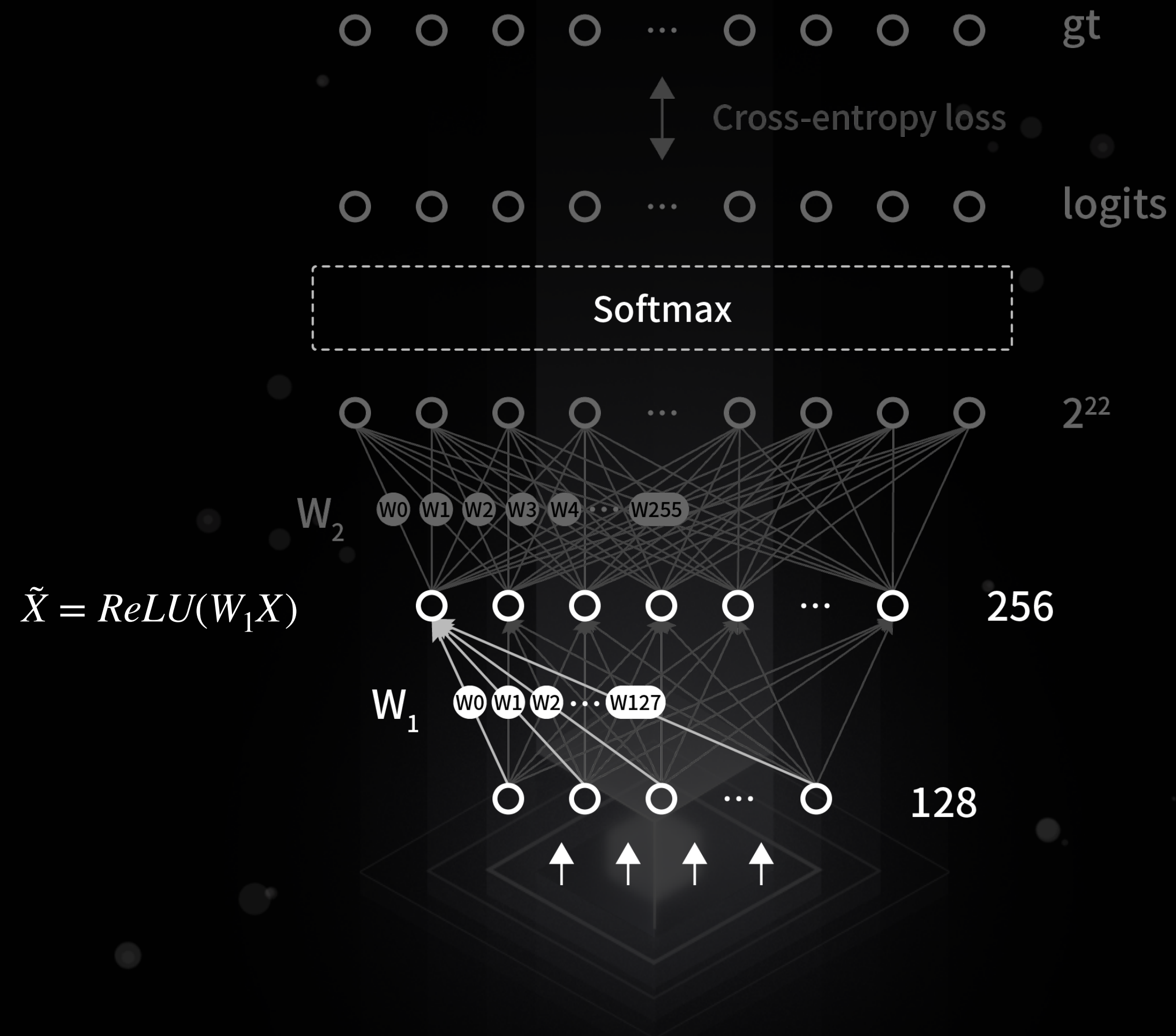
## Forward pass





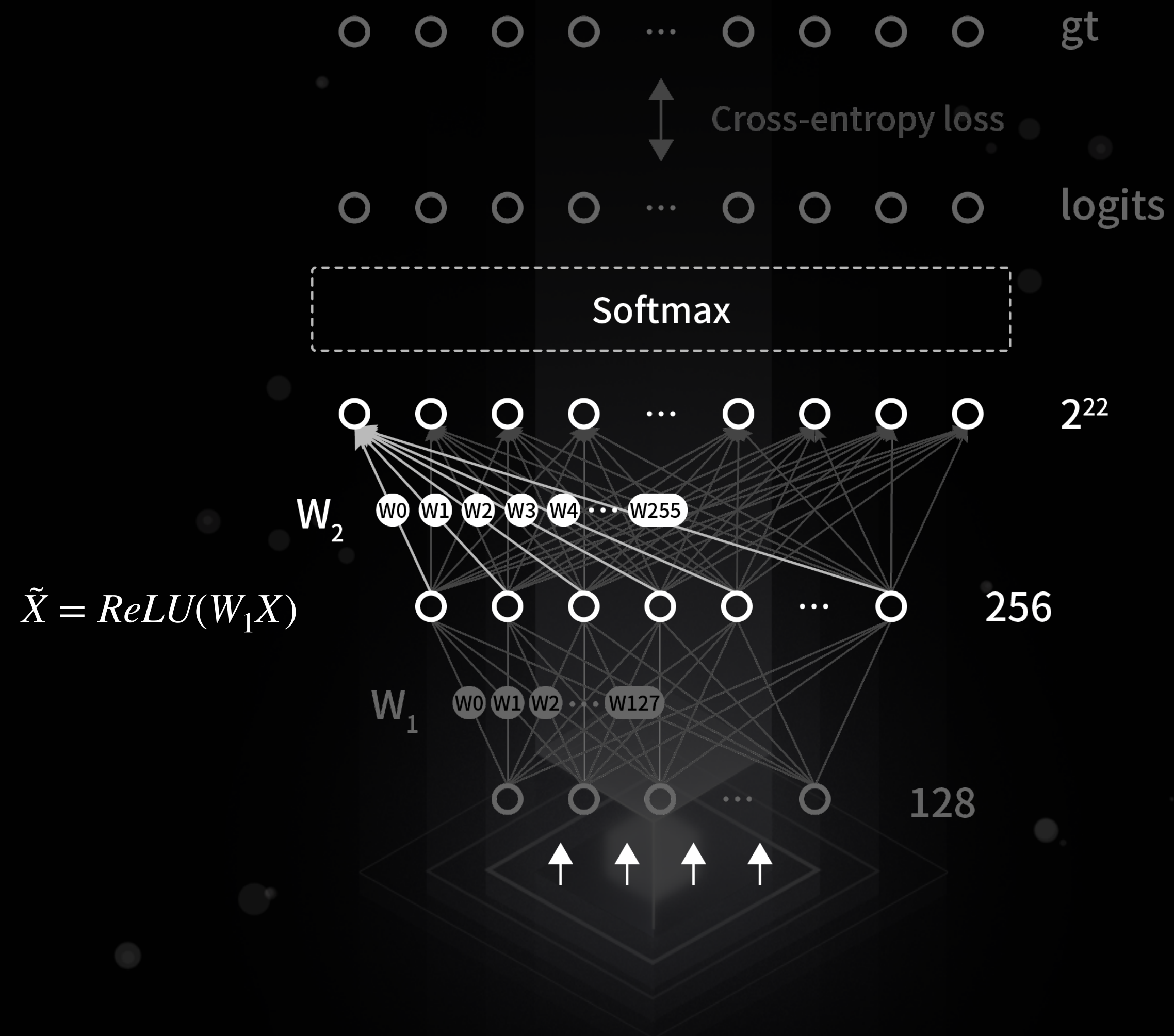
# 简要回顾后向传播

## Forward pass



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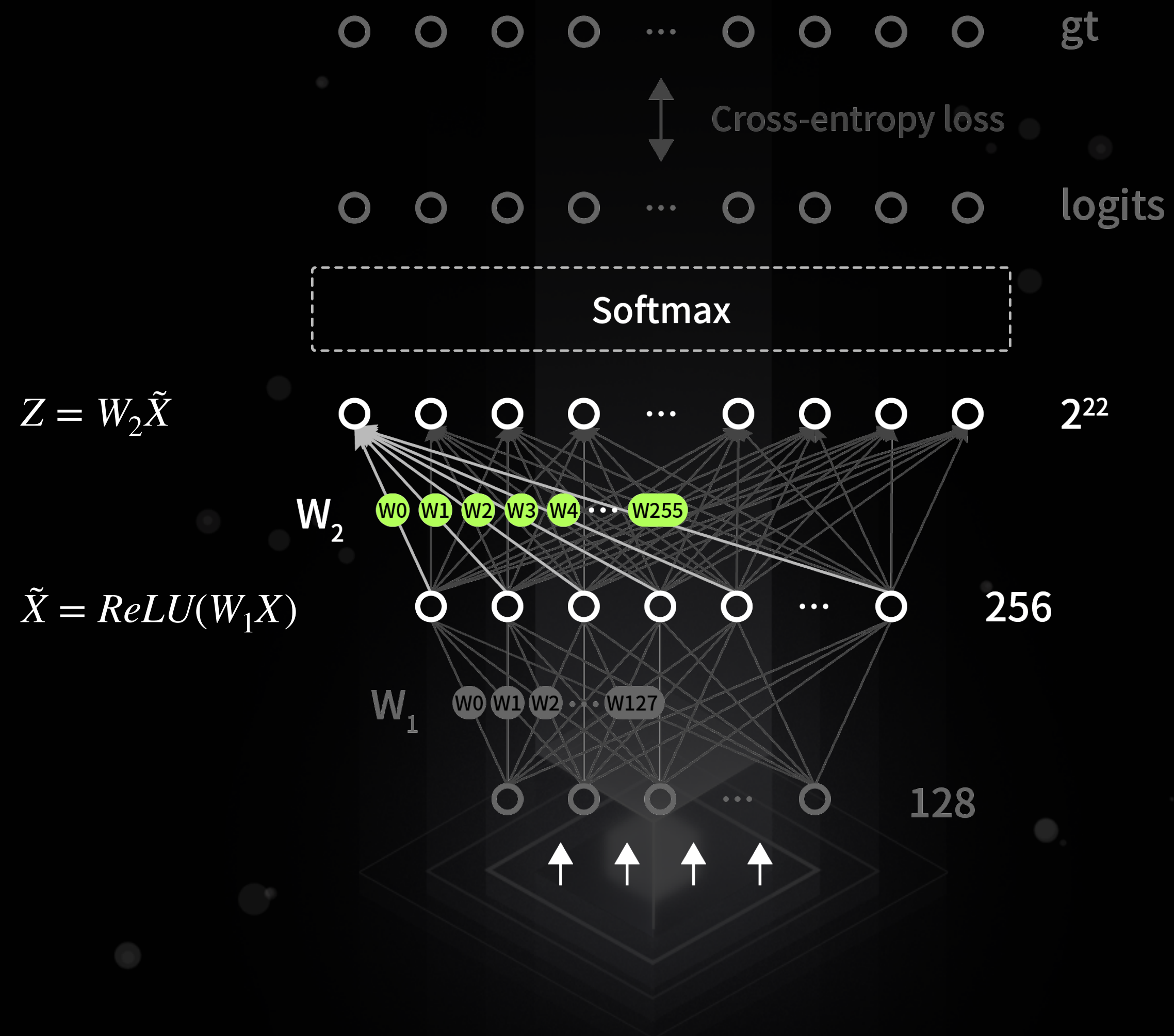
## Forward pass





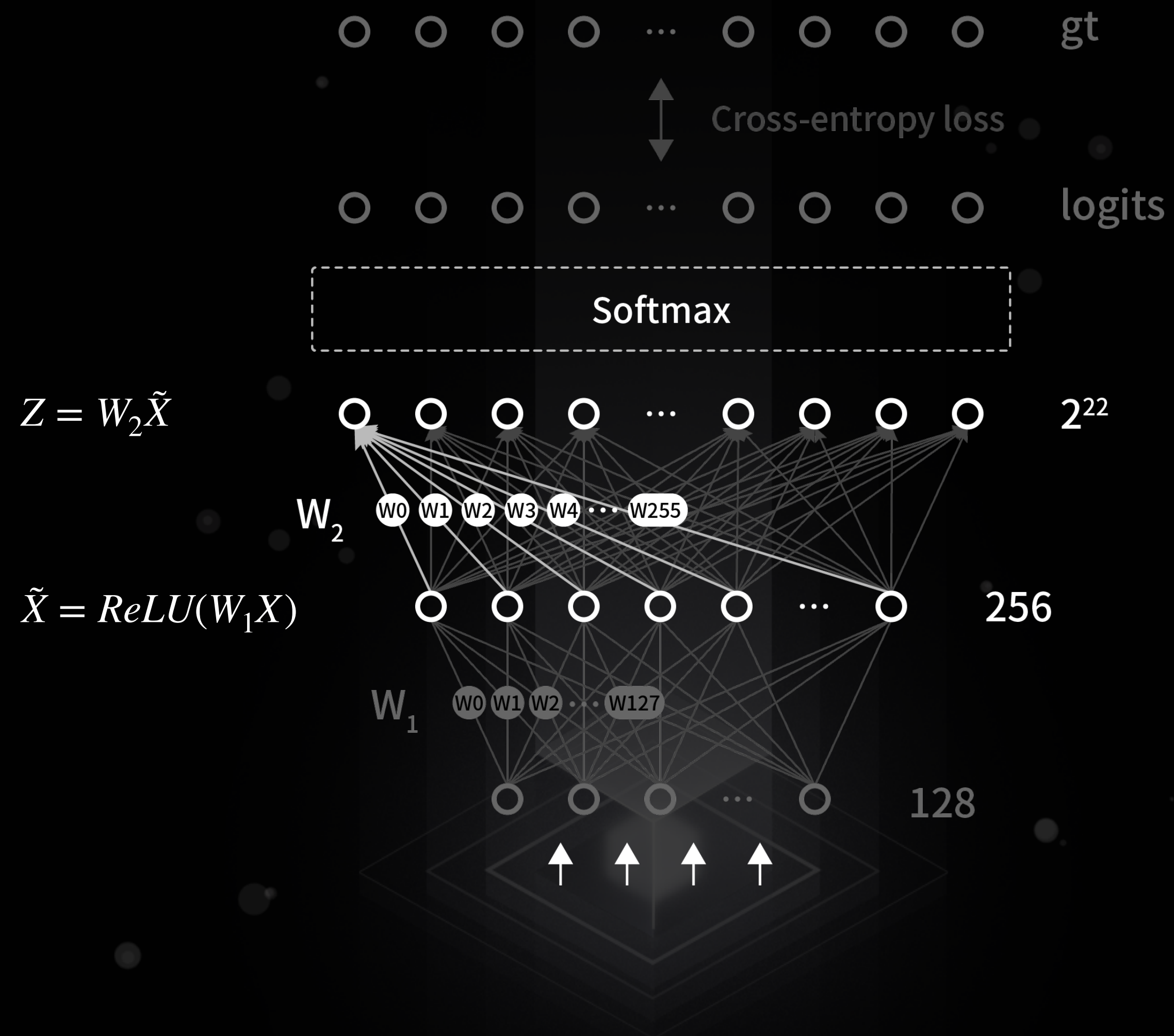
# 简要回顾后向传播

## Forward pass



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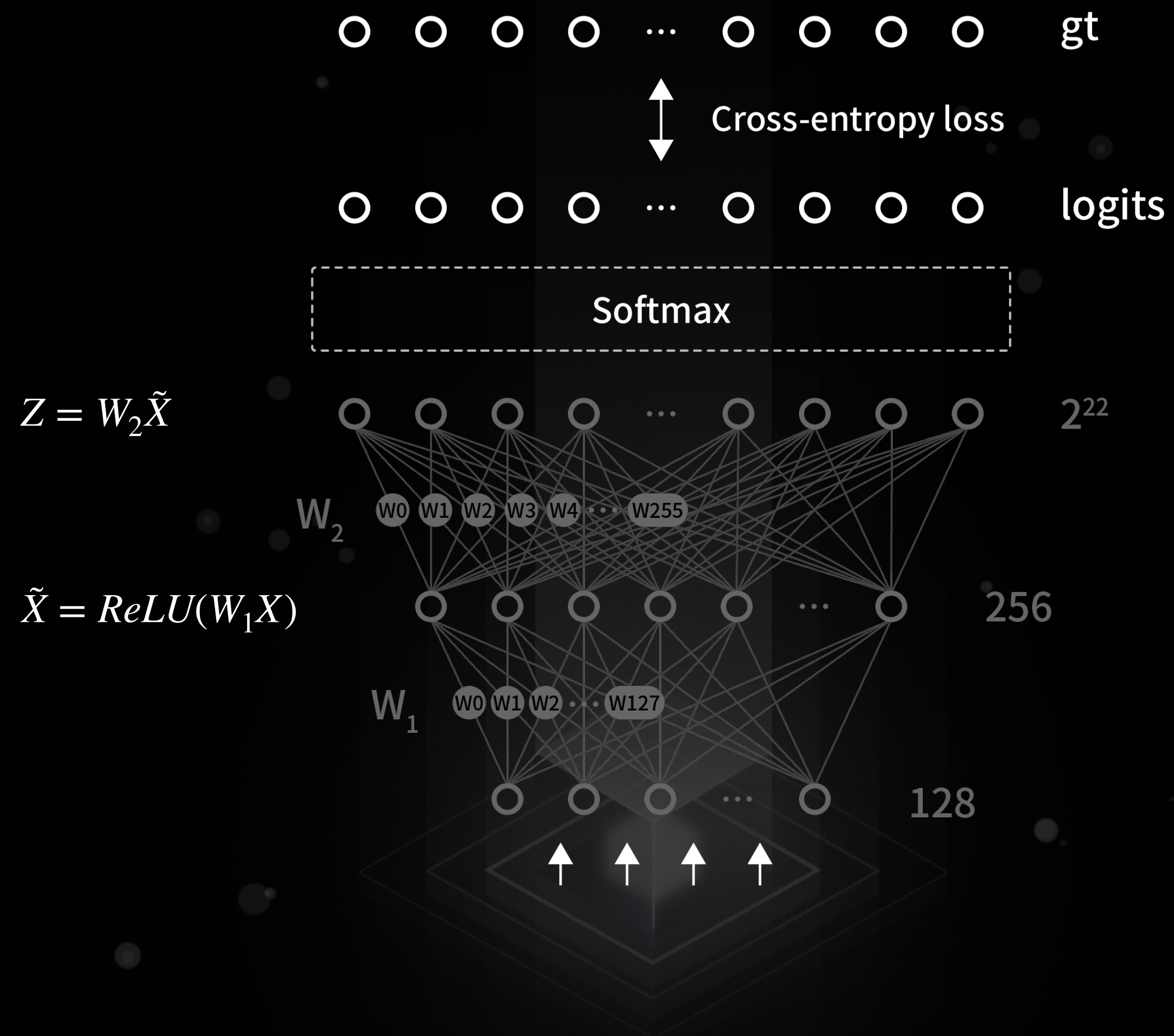
## Forward pass





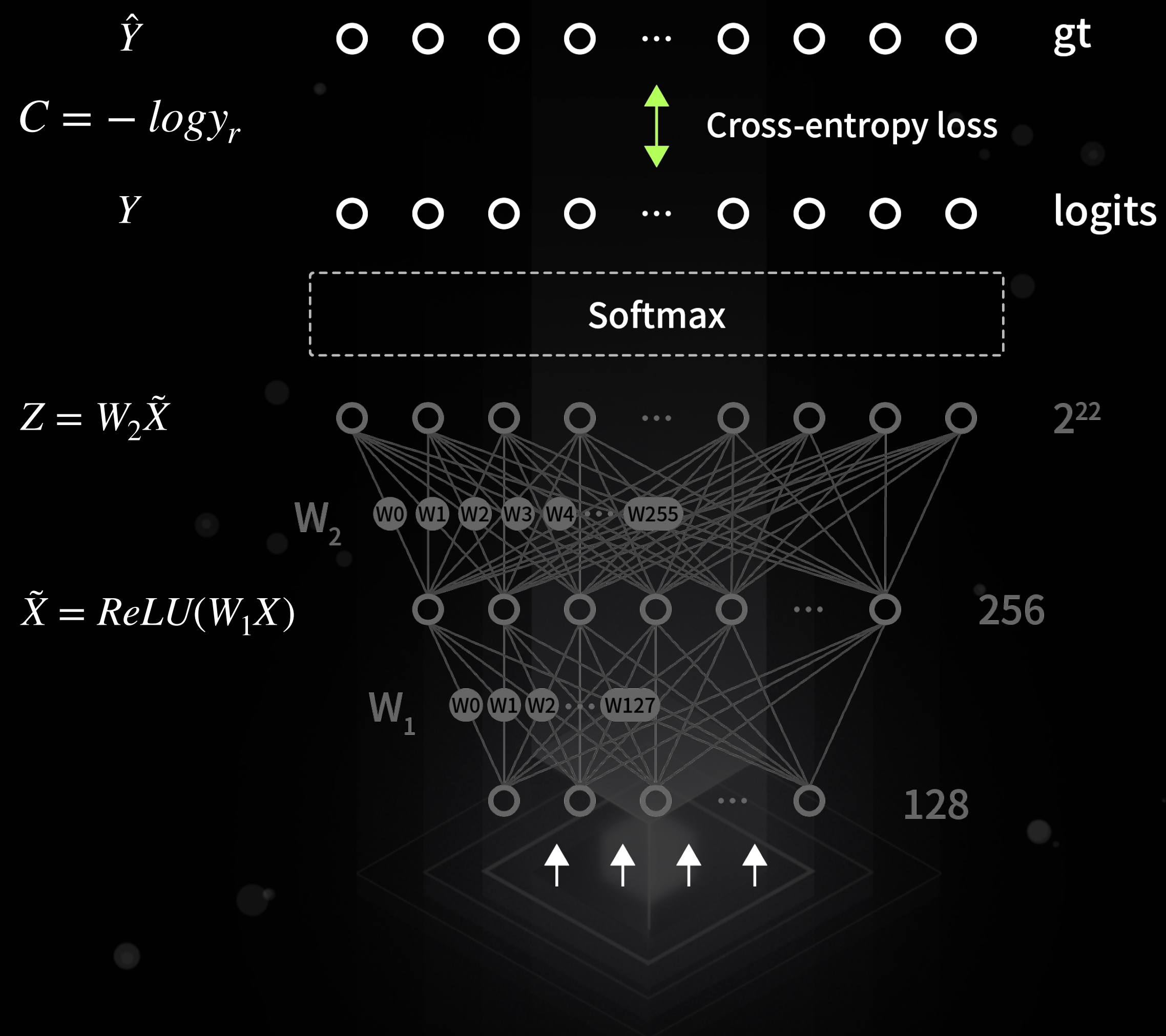
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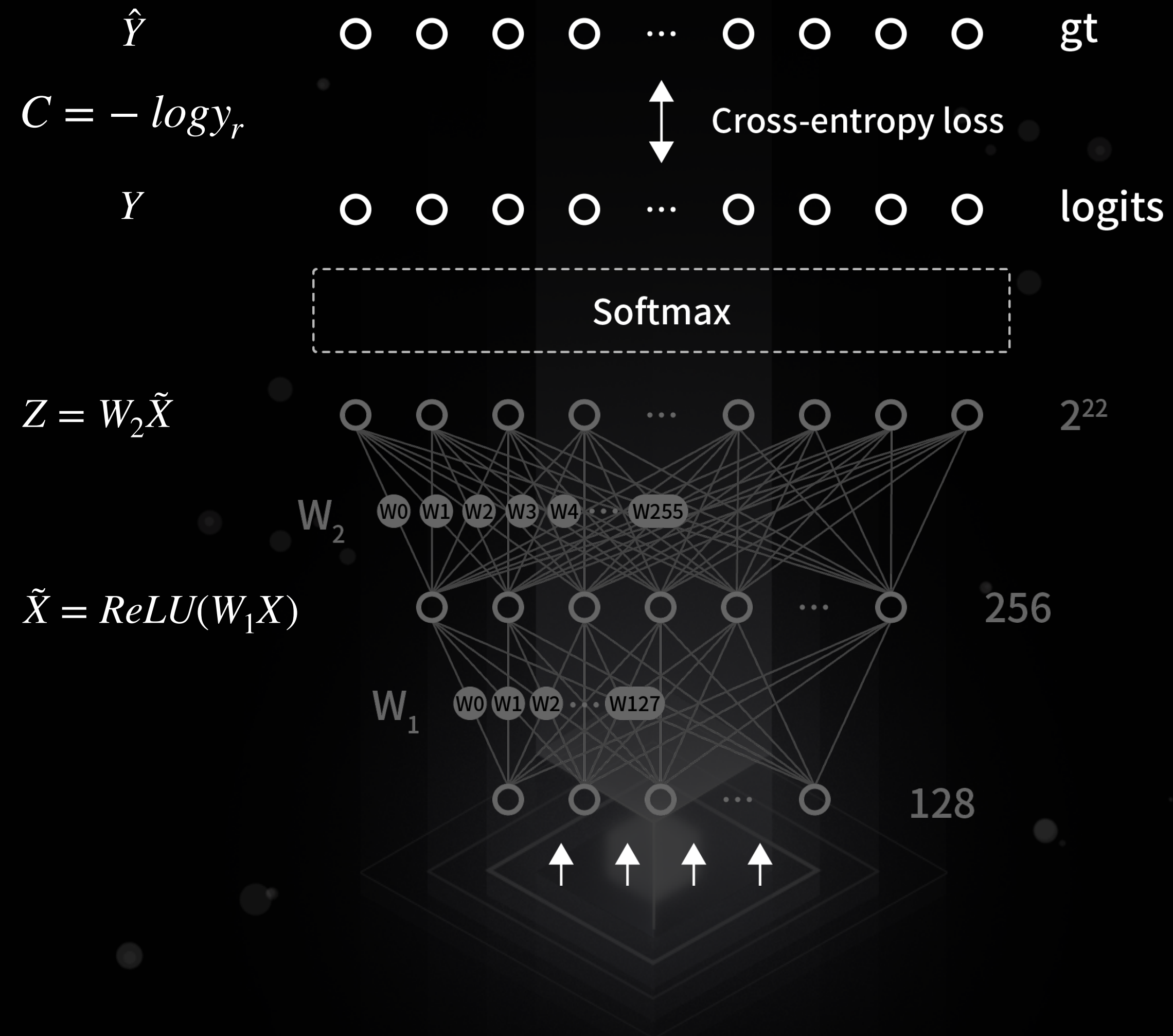
## Forward pass





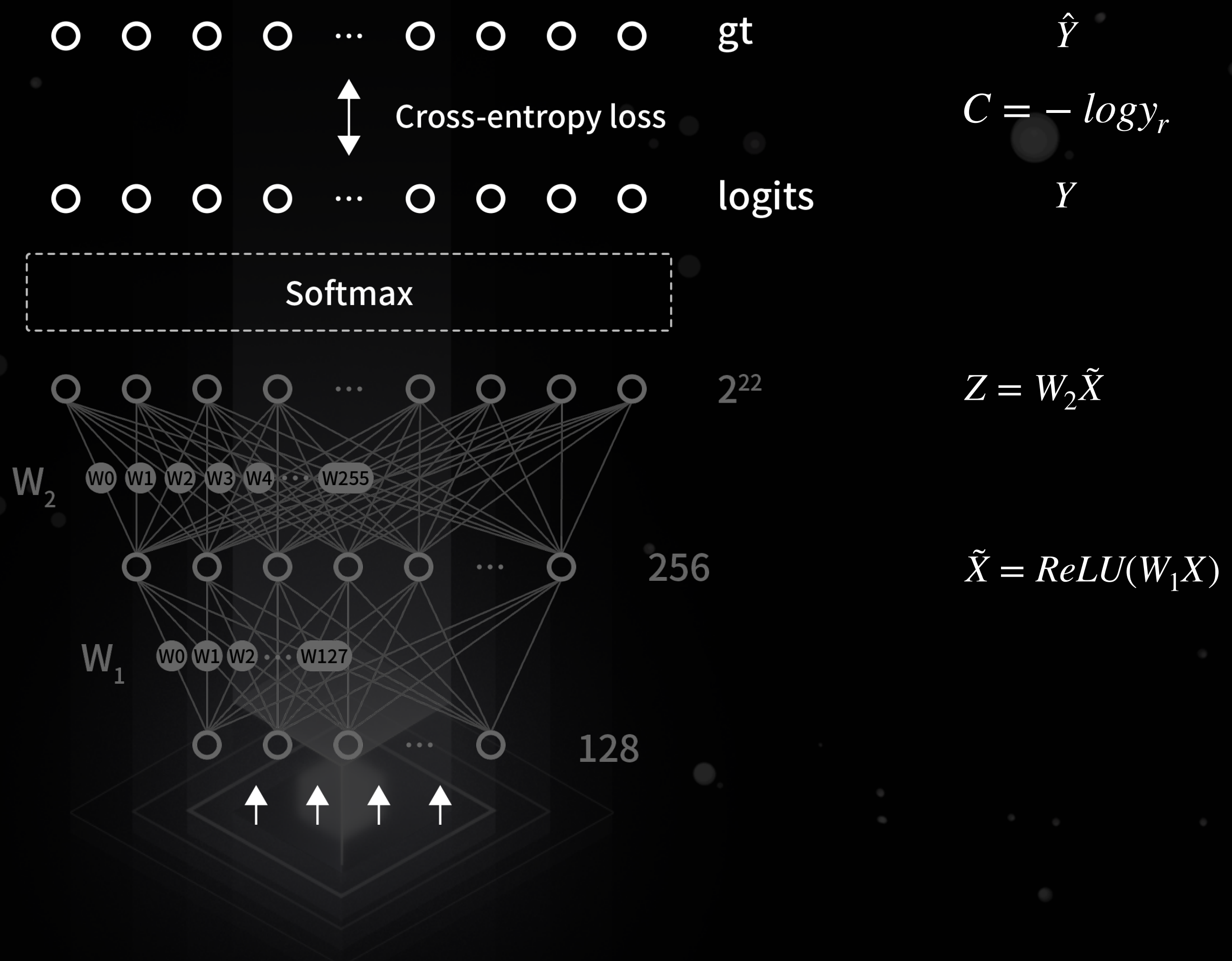
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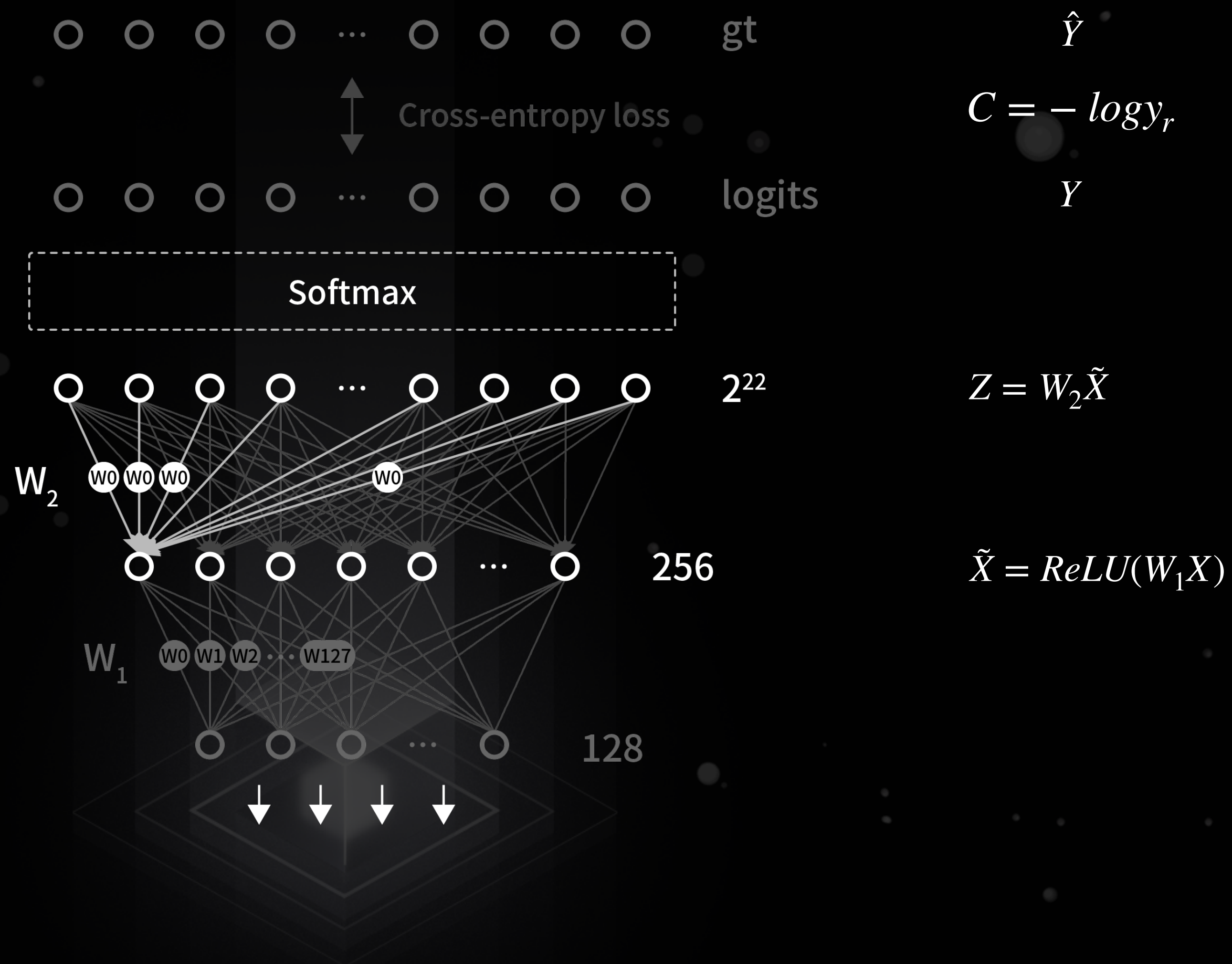
## Backward pass





# 简要回顾后向传播

## Backward pass



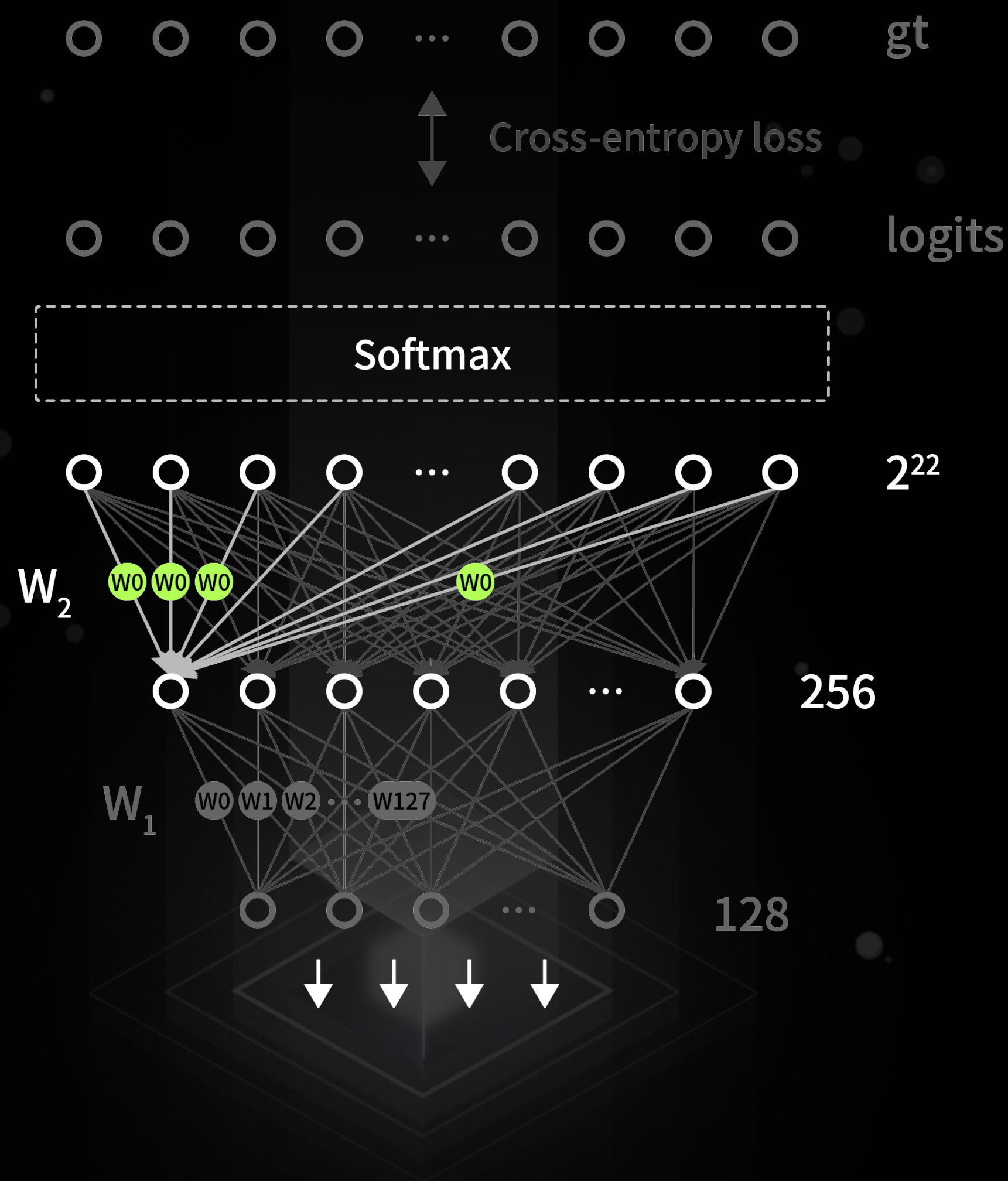
# 简要回顾后向传播

## Backward pass

$$\delta_i^L = \frac{\partial C}{\partial z_i^L}$$

$$i = r : \delta_i^L = y_i - 1$$

$$i \neq r : \delta_i^L = y_i$$



$$\hat{Y}$$
$$C = -\log y_r$$
$$Y$$

$$Z = W_2 \tilde{X}$$

$$\tilde{X} = ReLU(W_1 X)$$



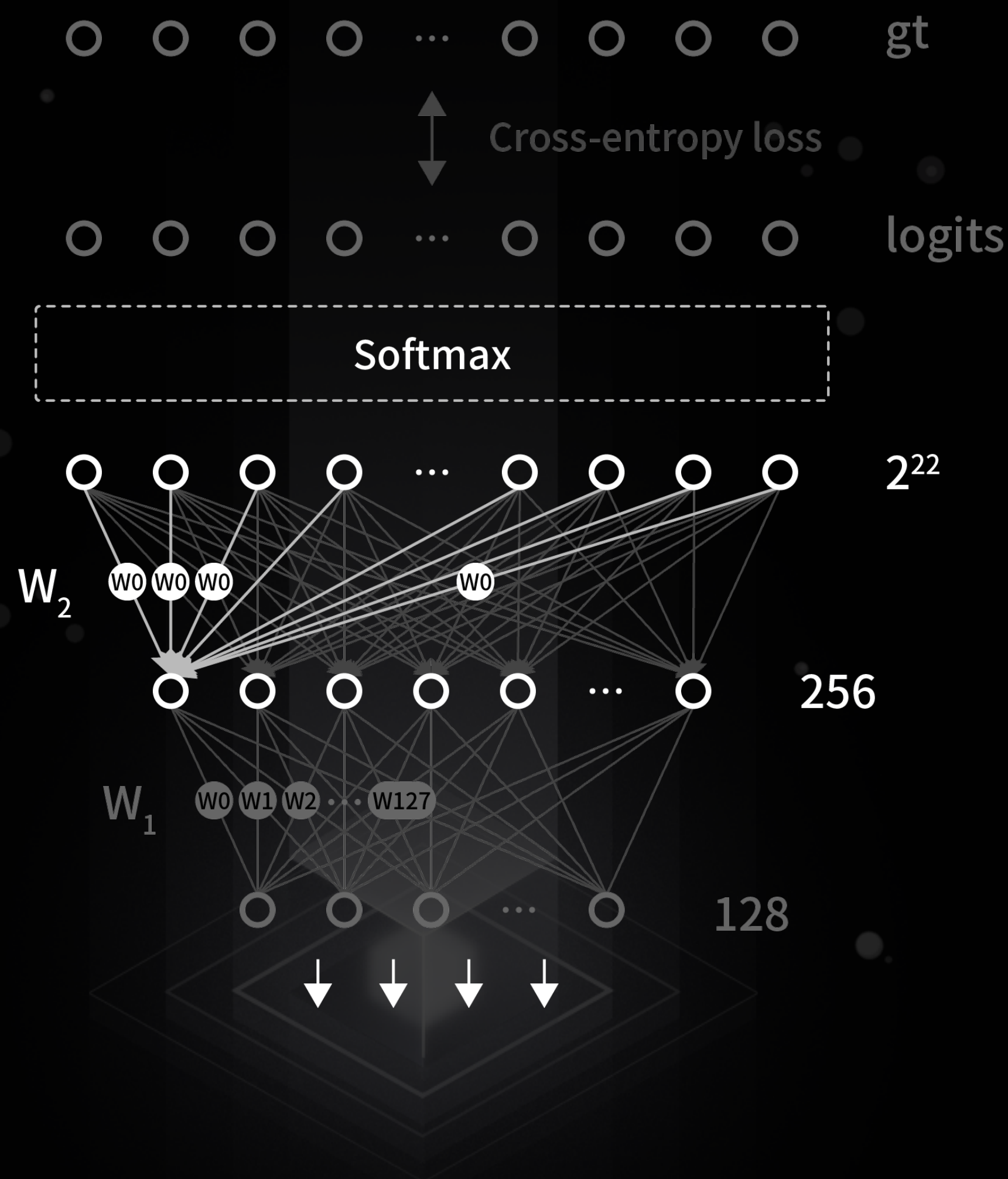
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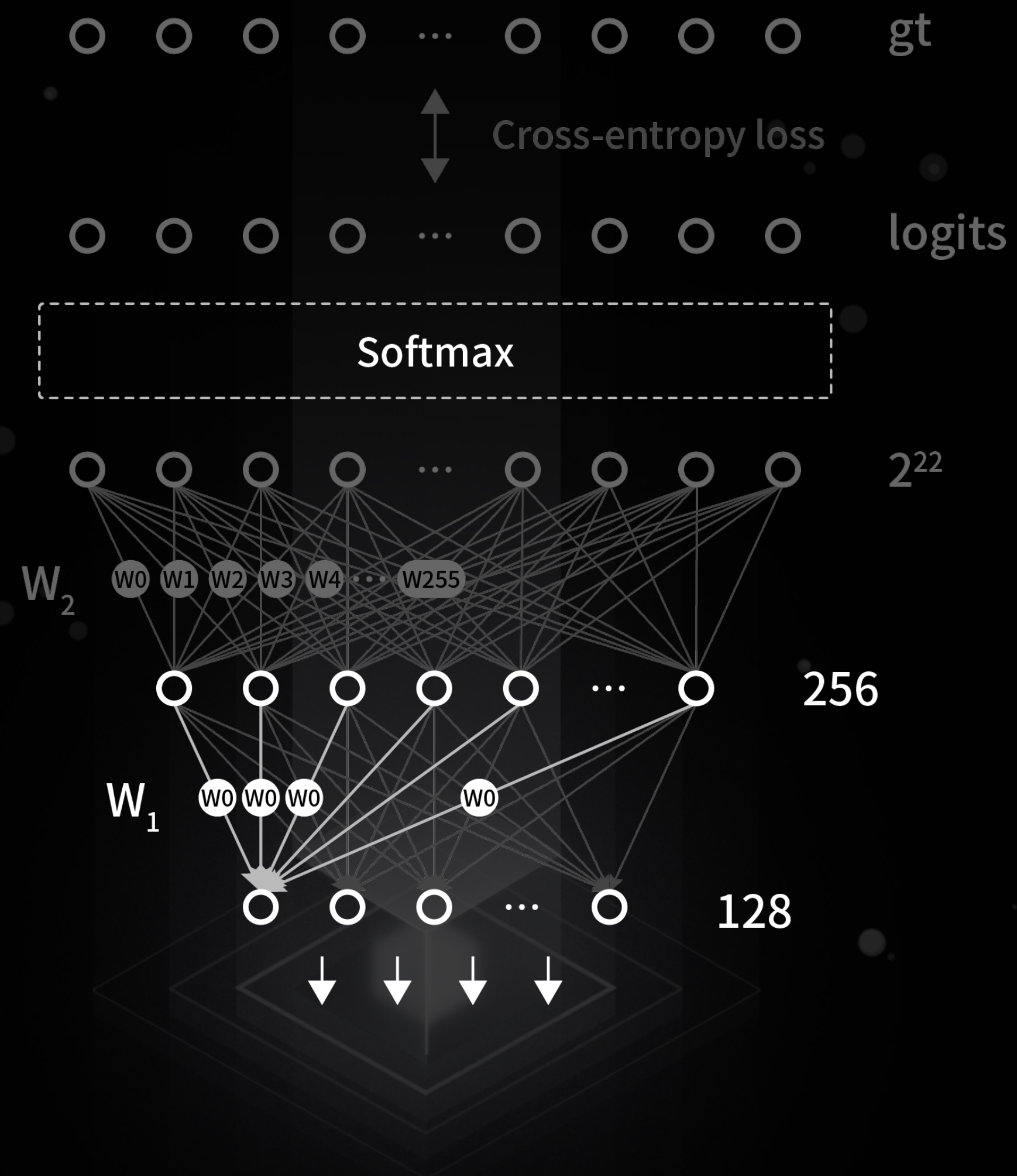
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## Backward pass



$$\hat{Y}$$
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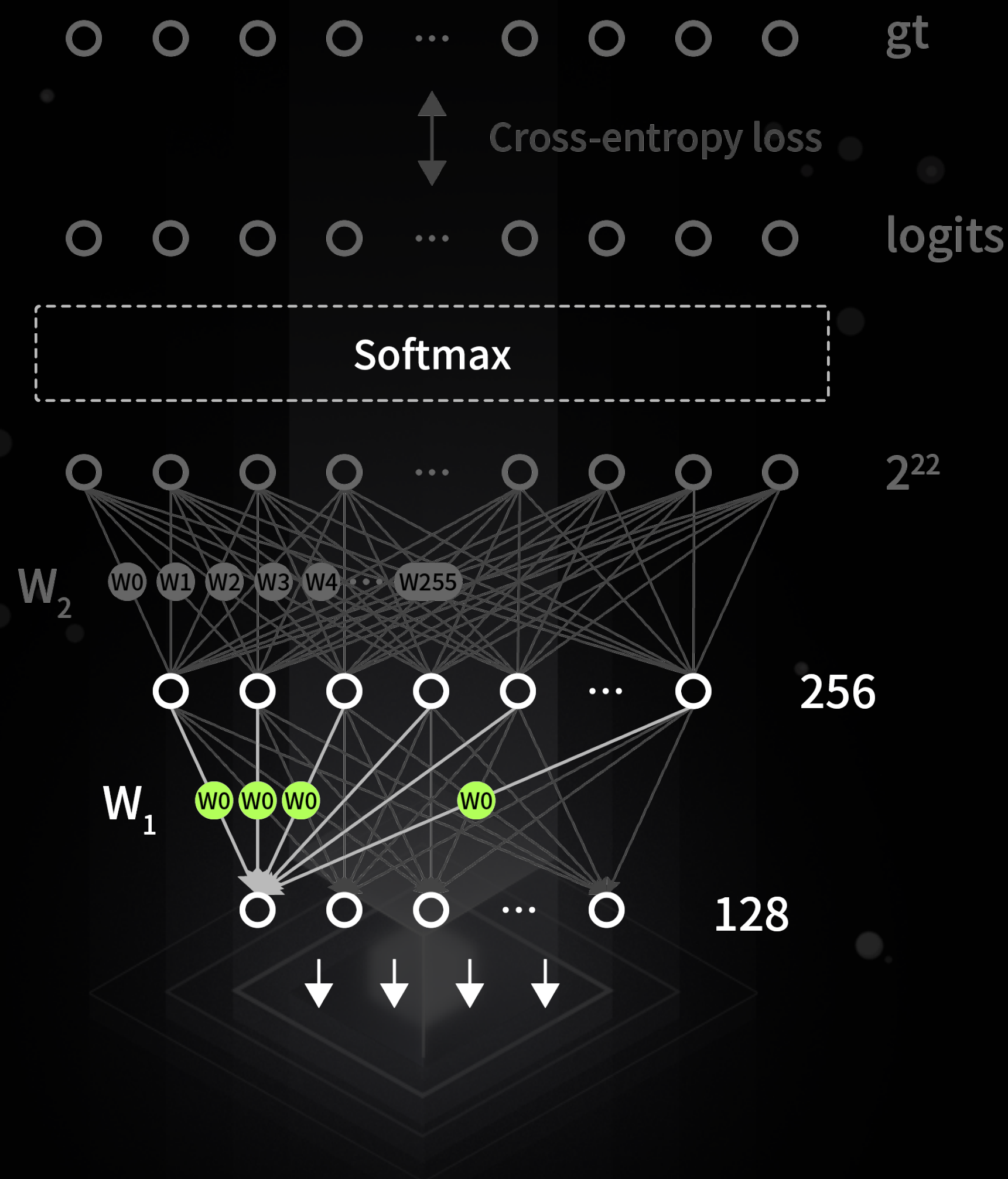


# 简要回顾后向传播

## Backward pass

$$\frac{\partial C^r}{\partial w_{ij}^l} = \frac{\partial z_i^l}{\partial w_{ij}^l} \frac{\partial C^r}{\partial z_i^l}$$
$$\frac{\partial z_i^l}{\partial w_{ij}^l} = \tilde{x}_j^{l-1} \delta_i^L$$

$$\delta_i^L = \sigma'(z_i^l) \sum w_{ki}^{l+1} \delta_k^{l+1}$$



$$\hat{Y}$$
$$C = -\log y_r$$
$$Y$$

$$Z = W_2 \tilde{X}$$

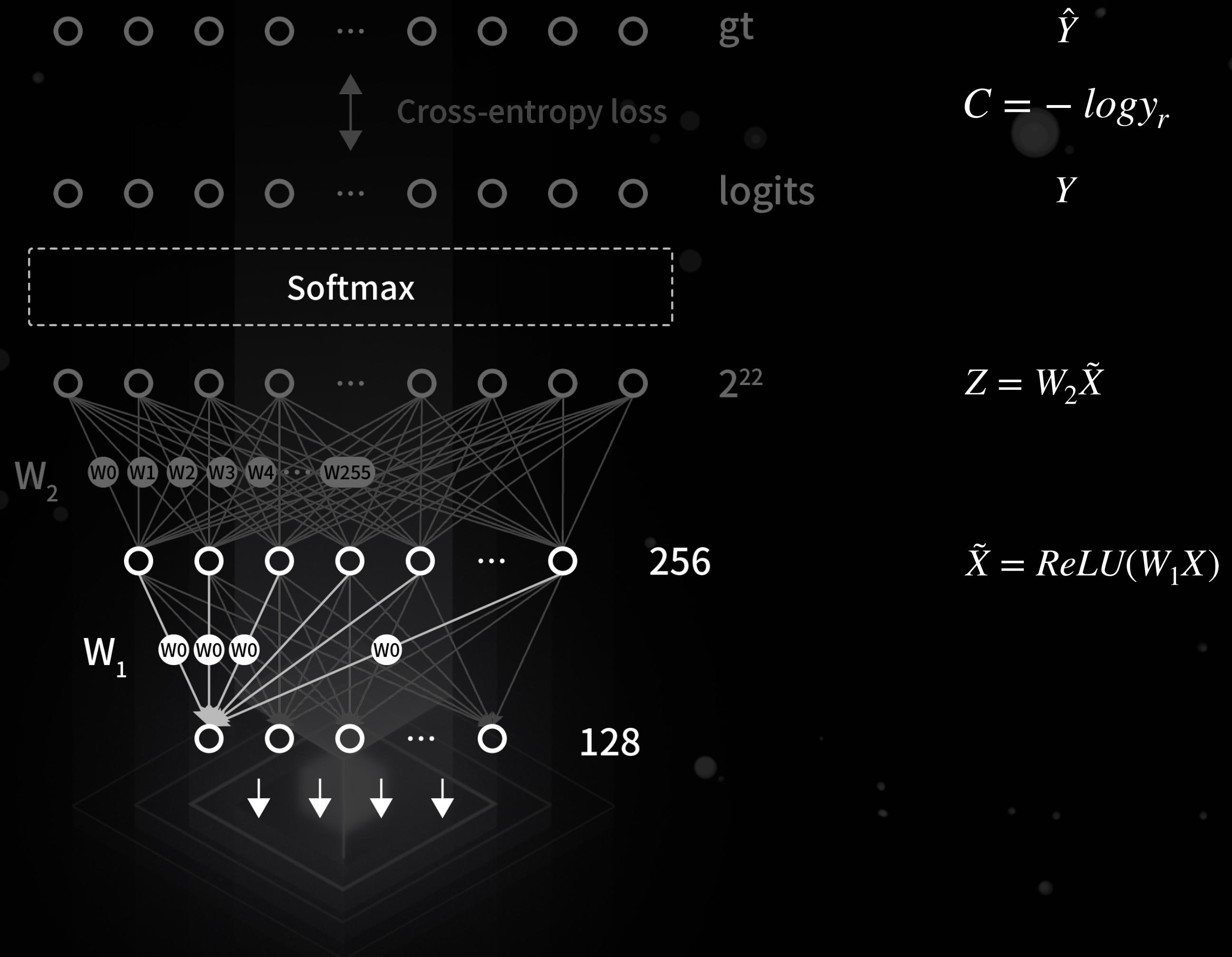
$$\tilde{X} = \text{ReLU}(W_1 X)$$

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## Backward pass

$$\frac{\partial C^r}{\partial w_{ij}^l} = \frac{\partial z_i^l}{\partial w_{ij}^l} \frac{\partial C^r}{\partial z_i^l}$$
$$\frac{\partial z_i^l}{\partial w_{ij}^l} = \tilde{x}_j^{l-1} \quad \delta_i^L$$

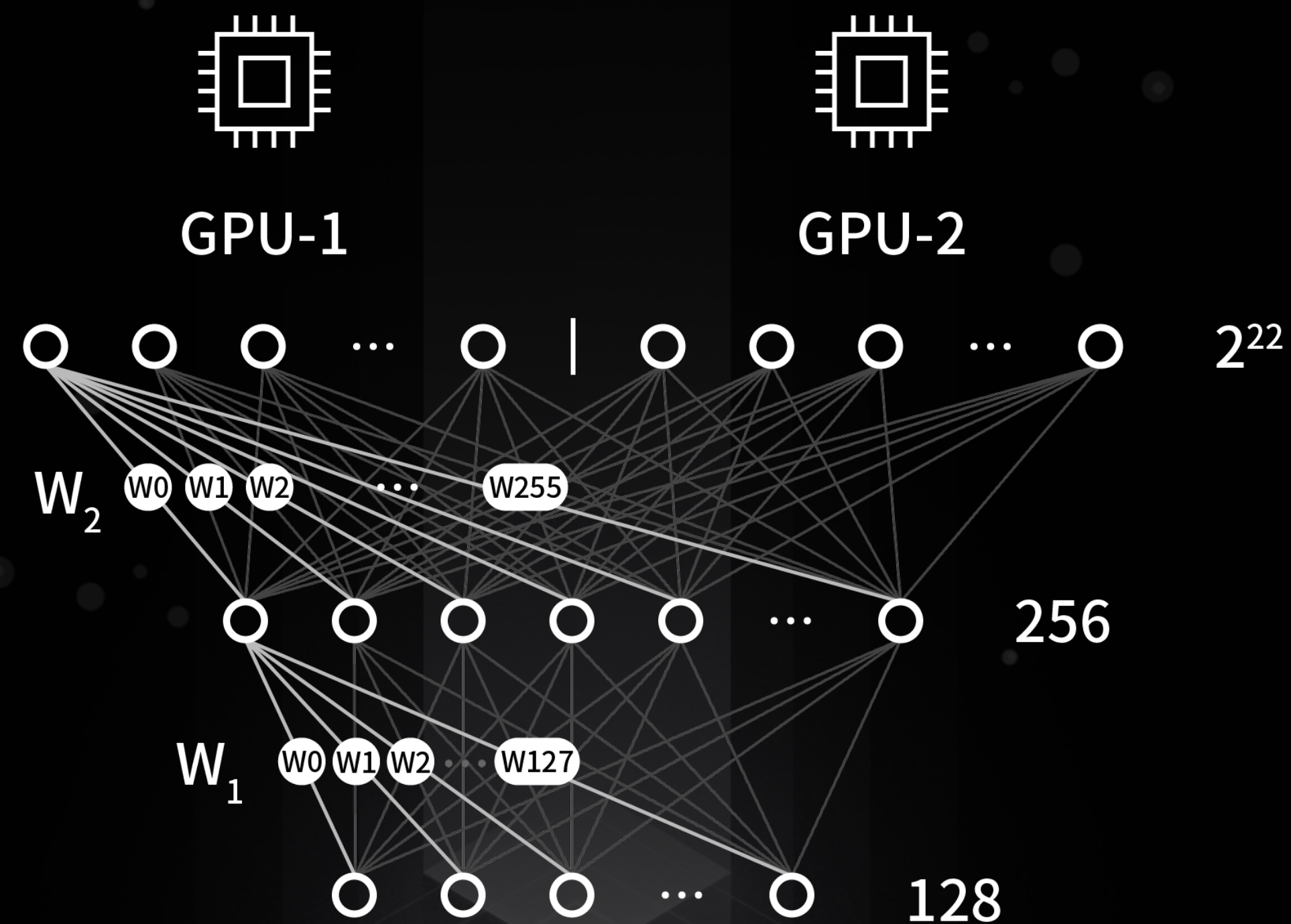
$$\delta_i^L = \sigma'(z_i^l) \sum w_{ki}^{l+1} \delta_k^{l+1}$$





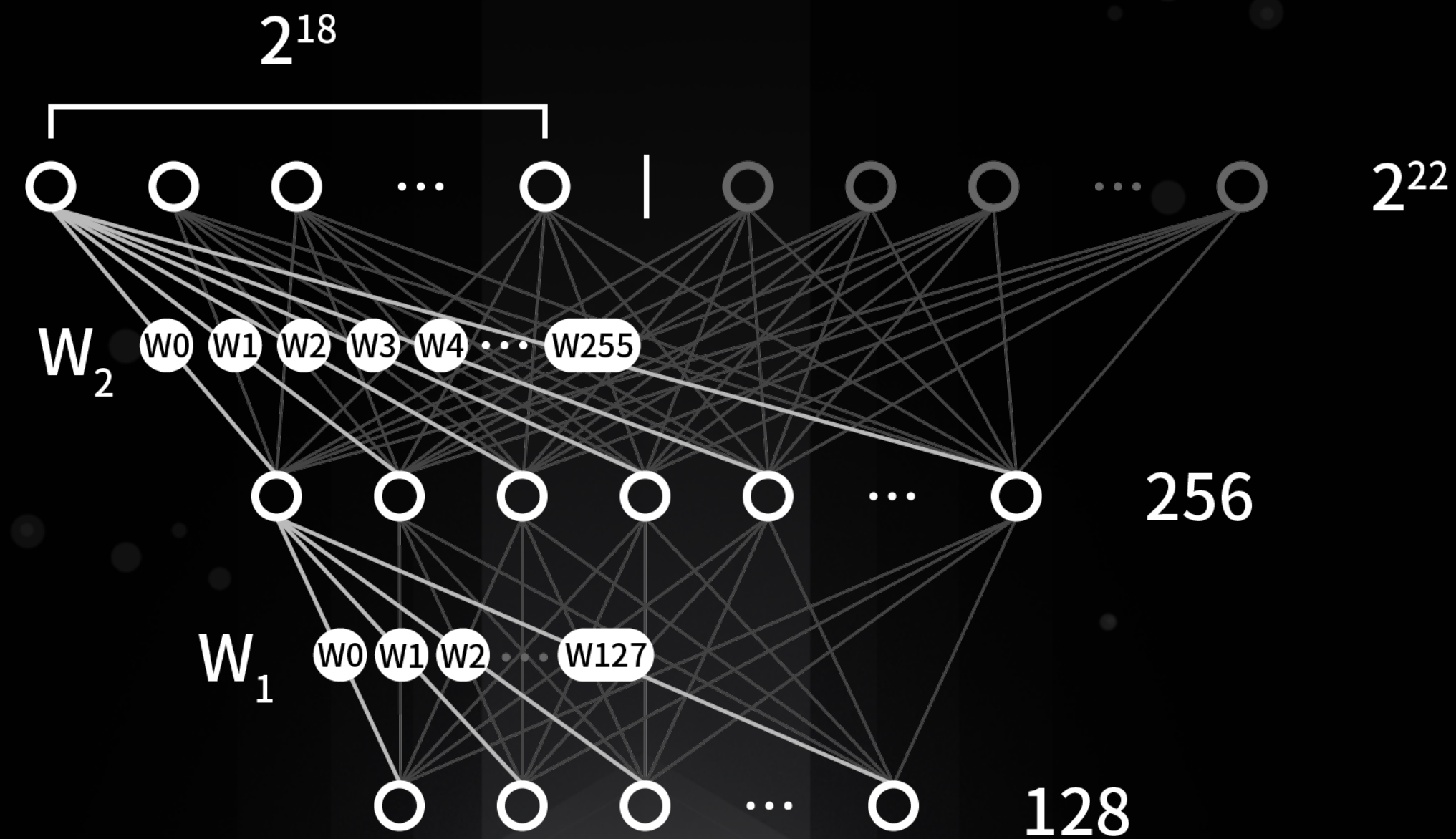
# 模型并行方案

Credit: Bob, TUPUTECH



# 小模型单卡

Credit: Mr. Zhang, ZJU (Rank: 4th)



1. 答案中对 $W_1$ 要求的精度不高
2. 对 $W_2$ 进行删减不会太大影响error signals



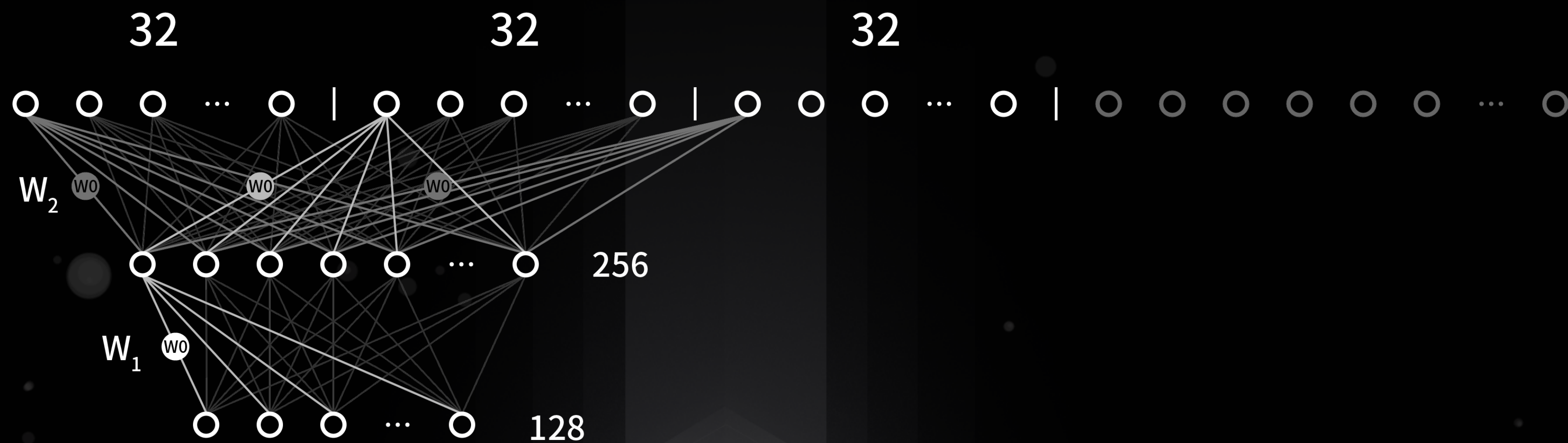
# 渐序增长模型

Credit: Mr. Wu, NJUST (Rank: 28th)



# 渐序增长模型

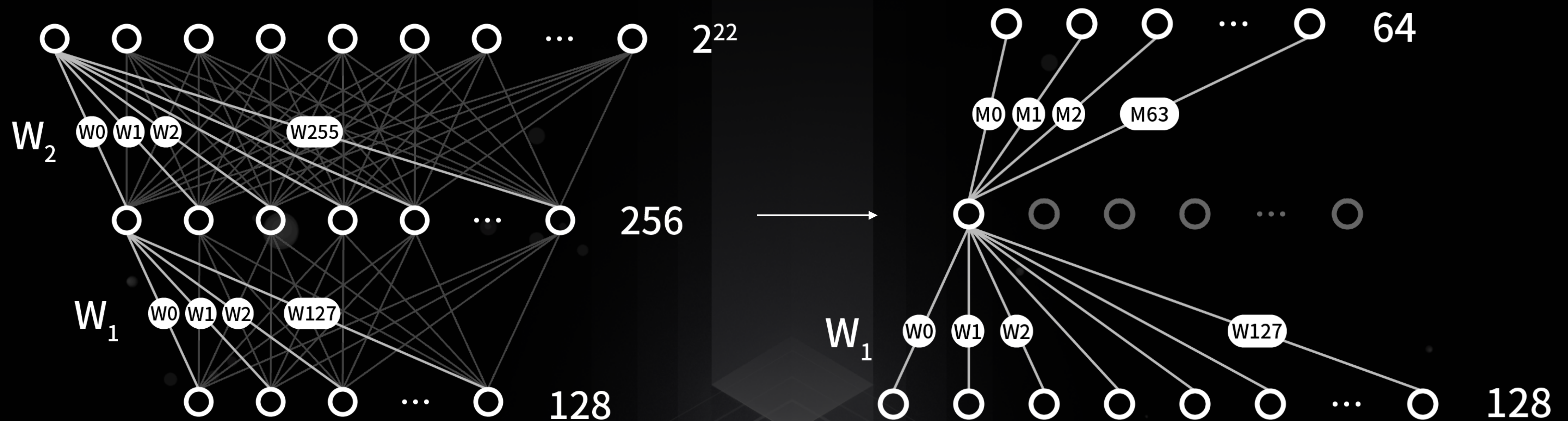
Credit: Mr. Wu, NJUST (Rank: 28th)





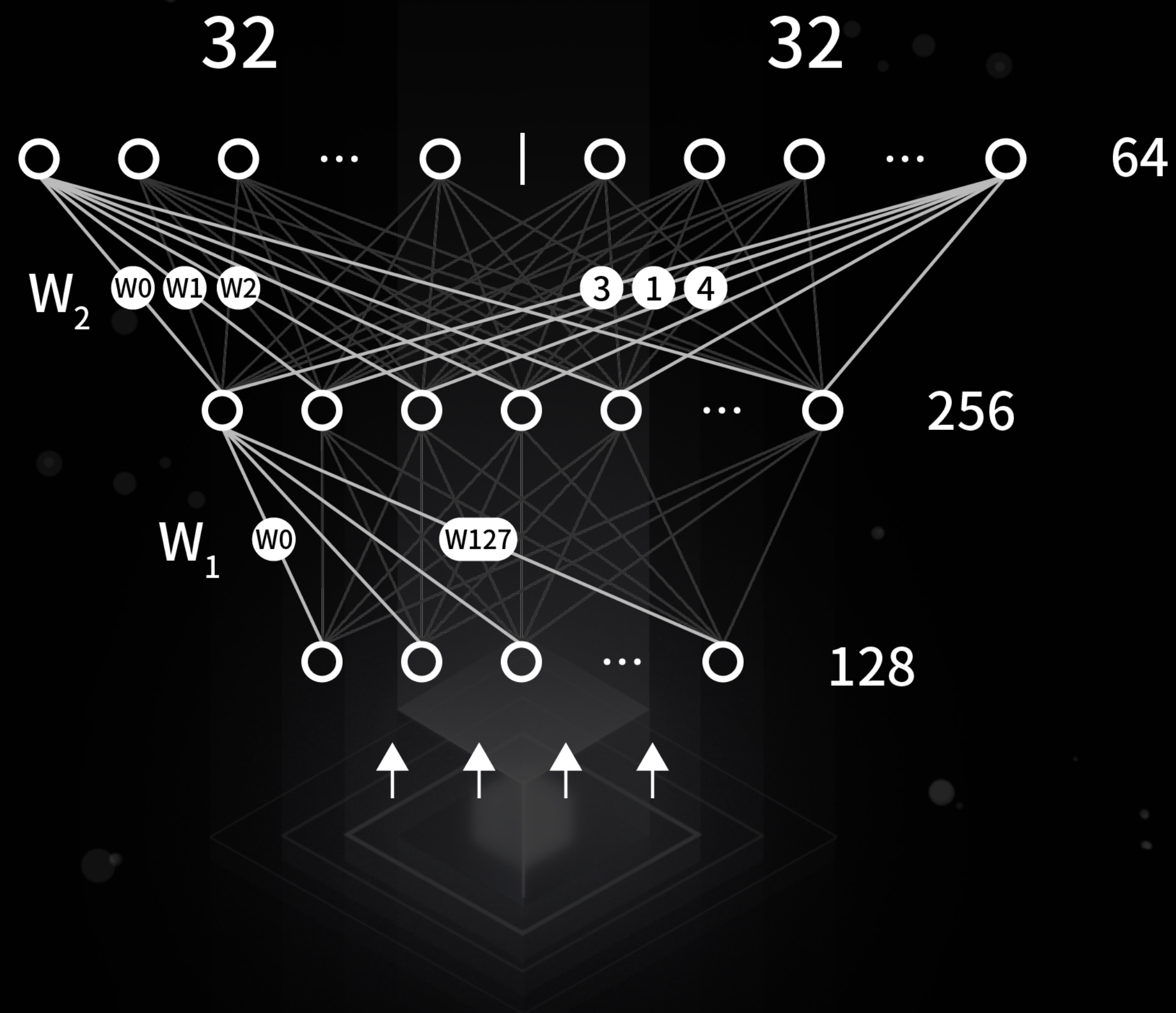
# 极致小模型

Credit: Mr. Bai, Georgia Tech (Rank: 3rd)



# 极致小模型

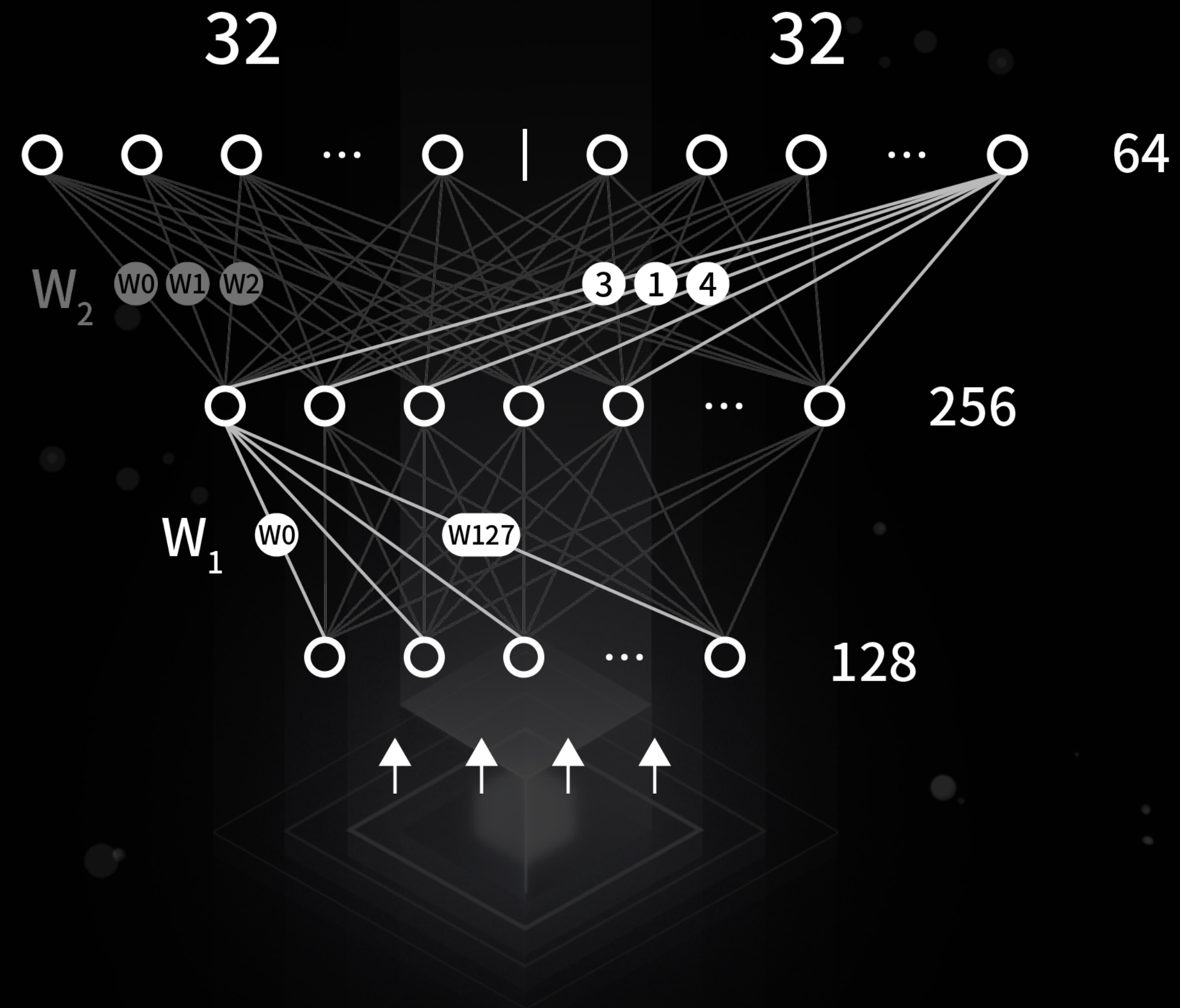
Credit: Mr. Bai, Georgia Tech (Rank: 3rd)





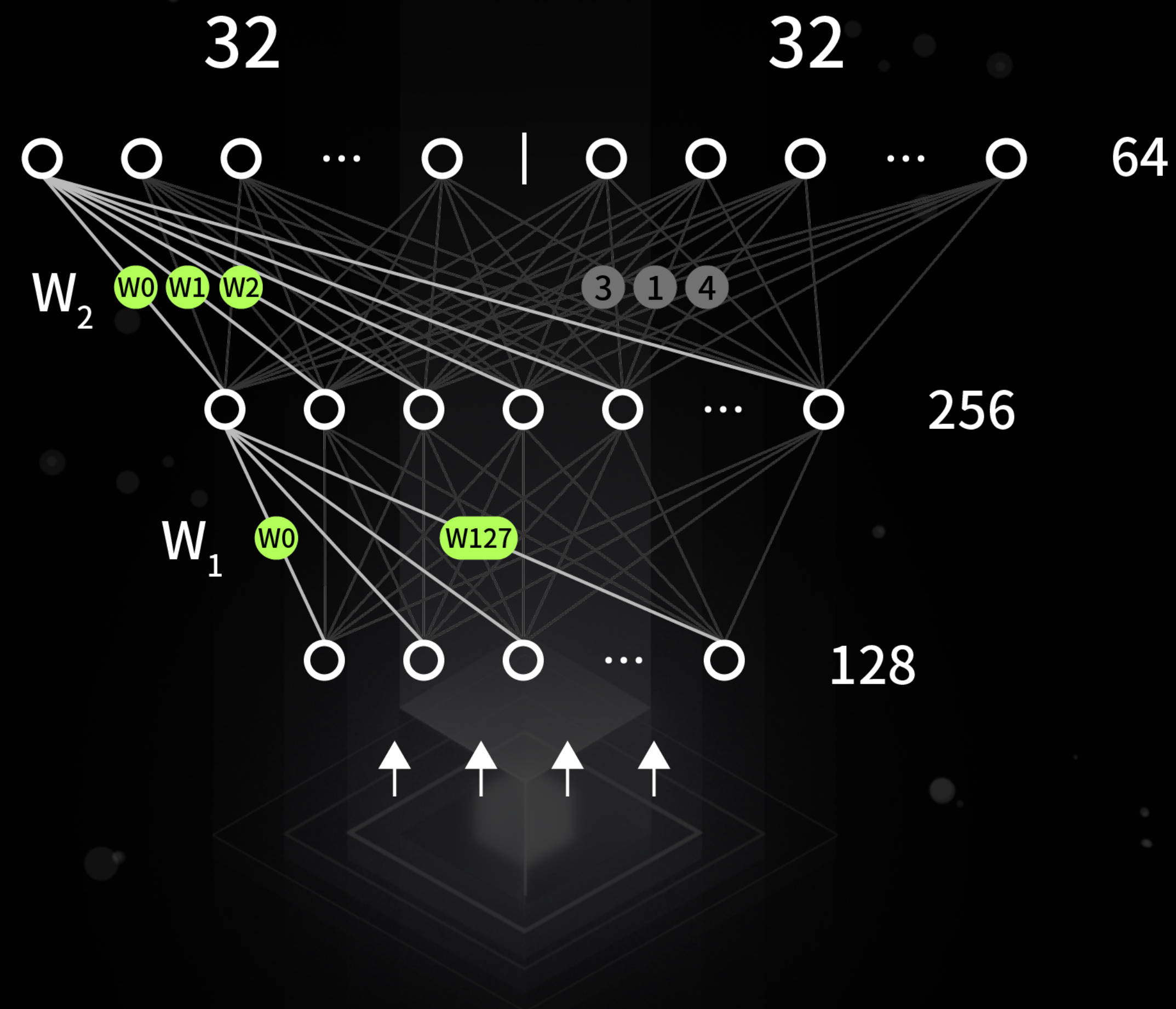
# 极致小模型

Credit: Mr. Bai, Georgia Tech (Rank: 3rd)



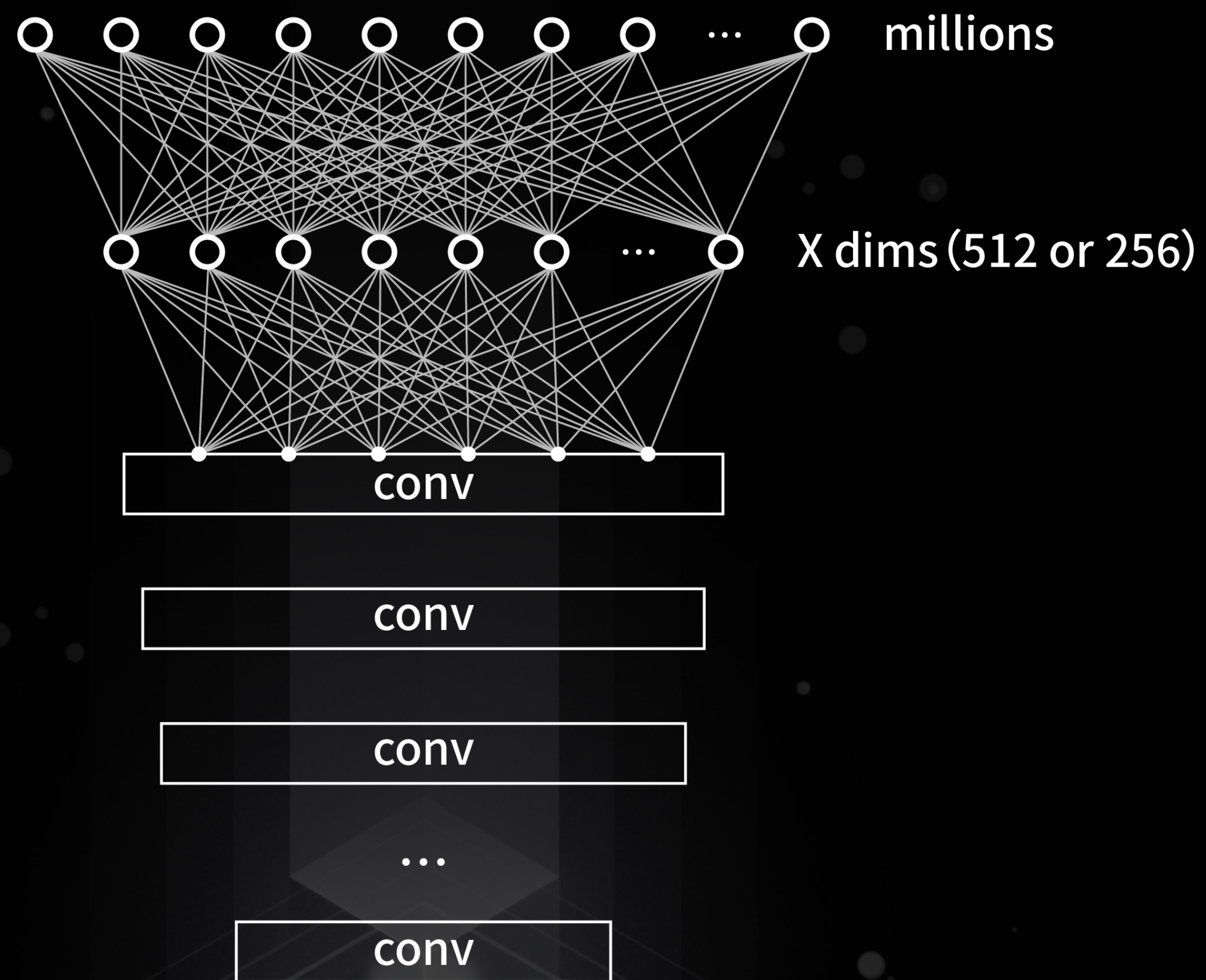
# 极致小模型

Credit: Mr. Bai, Georgia Tech (Rank: 3rd)





# 背后的工业级问题



人脸超大类别训练

# 背后的工业级问题

1. 首个在MegaFace上突破99%人脸团队
2. MegaFace Rank 1st in identification track (2018.04)
3. LFW Rank 1st 99.883%

机器之心 原创  
2018/07/09 AM 10:26

## 刷新世界纪录，图普科技夺MegaFace百万级人脸识别冠军

近期，图普科技在国际权威海量人脸识别数据库MegaFace中，以99.087%的最新成绩在百万级别人脸识别测试中拔得头筹，参加这项测试的还有来自Google、微软中国、百度、腾讯等公司的AI团队。

Identification Rate vs. Distractors Size

Algorithm	Date Submitted	Set 1	Set 2	Set 3	Data Set Size
TUPUTECH V1 (iBUG cleaned data)	4/24/2018	99.087%			Large
TUPUTECH v2	4/25/2018	99.078%			Large
BingMMLab V1(iBUG cleaned data)	4/10/2018	98.998%			Large
Orion Star Technology (clean)	3/21/2018	98.355%			Large
iBUG_DeepInsight	2/8/2018	98.063%	98.056%	98.053%	Large
ULUFace	5/7/2018	97.4869%	97.4869%	97.4869%	Large
MTDP_ITC(Clean)	4/17/2018	97.0807%			Large
EM-DATA	4/4/2018	96.653%			Large
SuningUS_AILab	3/21/2018	96.2618947%	96.2618947%	96.2618947%	Large
Kankan AI Lab	4/24/2018	95.045%			Large
StartDT-AI	4/16/2018	93.8226%			Large
Intellivision	2/11/2018	93.125%	93.123%	93.136%	Large
ULSee - Face Team	3/27/2018	92.172%			Large
Vocord - deepVo V3	04/27/2017	91.763%	91.711%	91.704%	Large
MTDP_ITC	12/21/2017	87.098%	83.677%	87.184%	Large
TUPUTECH	12/22/2017	86.558%	86.557%	86.579%	Large

数据来源: Megaface



# 思考

Credit: TUPUTECH Team

