Review Series of Recent Deep Learning Papers:

Parameter Prediction Paper: Image Question Answering using Convolutional Neural Network with Dynamic Parameter Prediction

Hyeonwoo Noh, Paul Hongsuck, Seo Bohyung Han

CVPR 2016

Reviewed by : Arshdeep Sekhon

[1]Department of Computer Science, University of Virginia

https://qdata.github.io/deep2Read/

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Image QA

- Task: Image Question Answering
- Previous Methods: tasks were of the same type: one of some category of objects, etc
- less efforts on solving various recognition problems simultaneously, which is more complex and realistic

Q: What type of animal is this?
Q: Is this animal alone?

Q: Is it snowing?
Q: Is this picture taken during the day?

Q: What kind of oranges are these?

Q: What is leaning on the wall?

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2. solve the heterogeneous recognition tasks using a single CNN by adapting the weights in the dynamic parameter layer
3. the weights in the dynamic layer are determined by the question
4. A hashing trick to reduce number of parameters

The Model

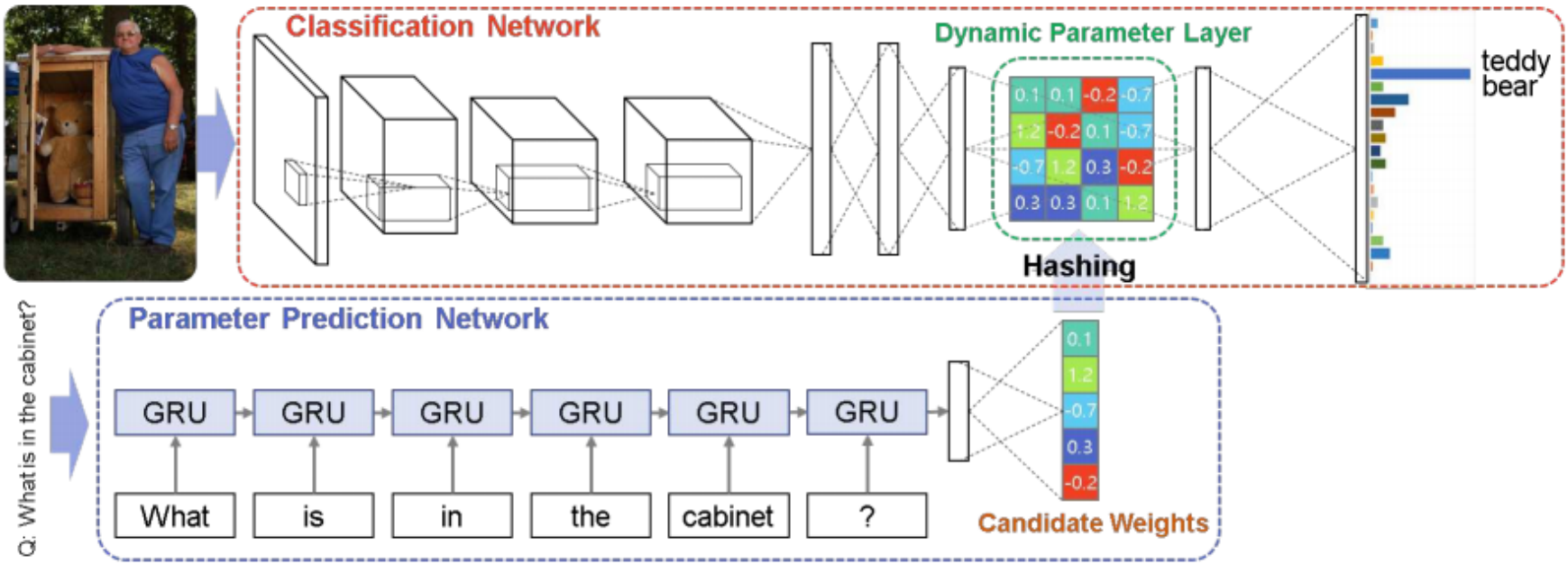
1. Conventional Approach:

$$\hat{a} =_{a \in \Omega} p(a|q, I; \theta) \tag{1}$$

2. Dynamic Parameter Prediction:

$$\hat{a} =_{a \in \Omega} p(a|I; \theta_s, \theta_d(q)) \tag{2}$$

The Model



VGG-Net pretrained on Image Net

second last layer is dynamically predicted.

The Model

1. The parameter prediction network:
2. GRU cells followed by a fully-connected layer, which produces the candidate weights

$$\boldsymbol{p} = \boldsymbol{W}_p \boldsymbol{h}_T \tag{3}$$

3. In the classification network, the dynamic layer

$$\boldsymbol{f^o} = \boldsymbol{W}_d(q)\boldsymbol{f_i} + b \tag{4}$$

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Hashing

1. Instead of predicting entire $\boldsymbol{W}_d$, construct $\boldsymbol{W}_d(q)$ based on a small number of candidate weights
2. random weight sharing technique based on hashing
3. a single parameter in the candidate weight vector $\boldsymbol{p}$ is shared by multiple elements of $\boldsymbol{W}_d(q)$
4. a predefined hash function that converts the 2D location in $\boldsymbol{W}_d(q)$ to the 1D index in $\boldsymbol{p}$
5. $$w_{mn}^d = p_{\psi(m,n)} . \eta(m, n) \tag{5}$$
6. $\psi m, n$ maps a key (m, n) to a natural number in $\{1, \cdots, K\}$
7. $\eta(m, n)$ also a hash function: $\mathbb{N} \times \mathbb{N} \rightarrow \{-1, 1\}$

Results

	Open-Ended				Multiple-Choice			
	All	Y/N	Num	Others	All	Y/N	Num	Others
Question [1]	48.09	75.66	36.70	27.14	53.68	75.71	37.05	38.64
Image [1]	28.13	64.01	00.42	03.77	30.53	69.87	00.45	03.76
Q+I [1]	52.64	75.55	33.67	37.37	58.97	75.59	34.35	50.33
LSTM Q [1]	48.76	78.20	35.68	26.59	54.75	78.22	36.82	38.78
LSTM Q+I [1]	53.74	78.94	35.24	36.42	57.17	78.95	35.80	43.41
CONCAT	54.70	77.09	36.62	39.67	59.92	77.10	37.48	50.31
RAND-GRU	55.46	79.58	36.20	39.23	61.18	79.64	38.07	50.63
CNN-FIXED	56.74	80.48	37.20	40.90	61.95	80.56	38.32	51.40
DPPnet	**57.22**	**80.71**	**37.24**	**41.69**	**62.48**	**80.79**	**38.94**	**52.16**