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TibetanGoTinyNet: a lightweight U-Net style network for zero learning of Tibetan Go

Key words: Zero learning; Tibetan Go; U-Net; Self-attention mechanism; Capsule network; Monte–Carlo tree search

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Motivation

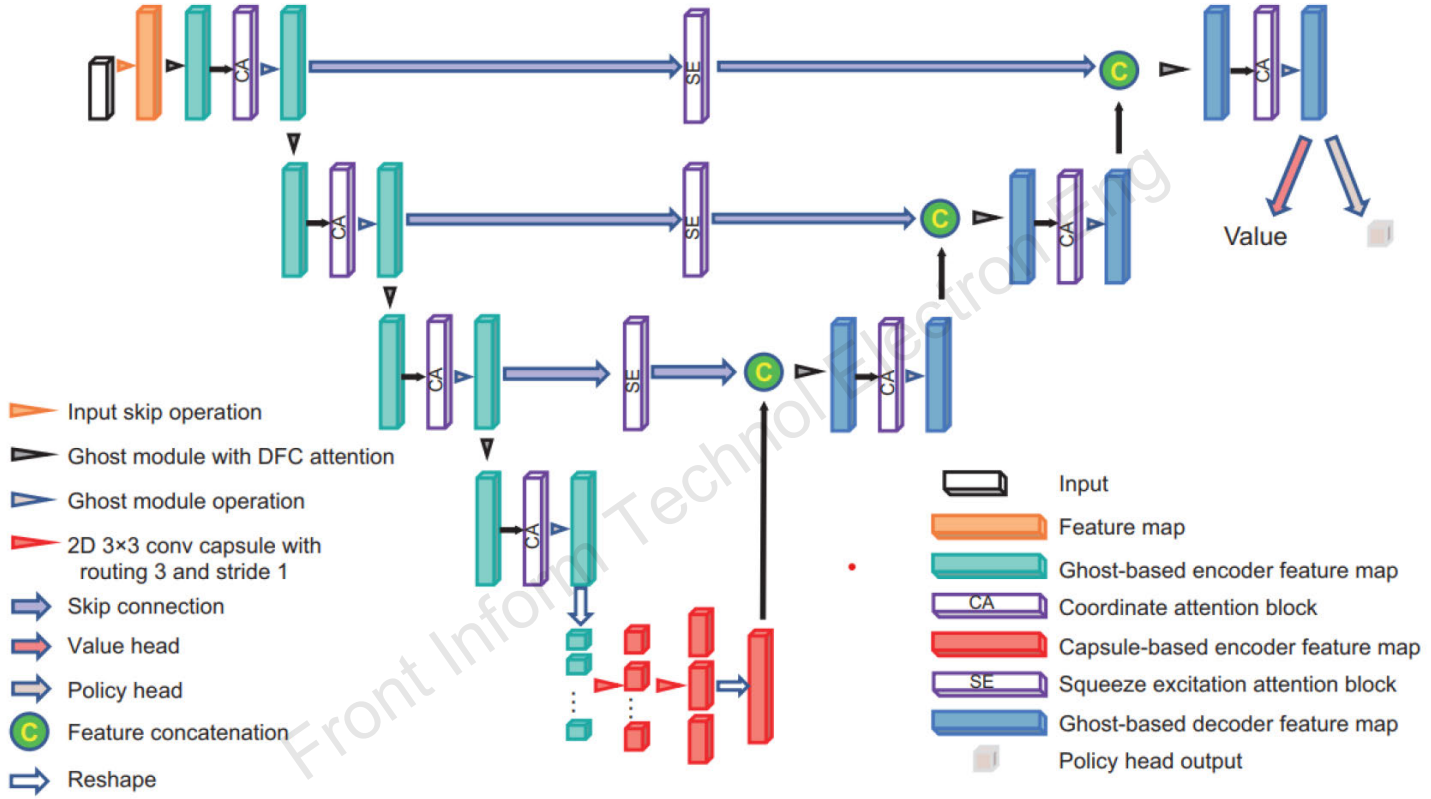
- The programs of games developed by large companies applied mostly immense neural network models, and it is challenging for general research institutions and researchers to afford the large cost of computing resources for zero learning of games mostly.

- Lightweight networks have been studied and applied in many fields, such as object detection and medical image processing. However, few people have studied these lightweight networks in computer games. It is an essential and challenging task to investigate lightweight networks in the field of computer games drawing on related technologies in the field of deep learning.

Main idea

- GhostNetV2 is used as the backbone of encoder and decoder. GhostNetV2 bottleneck contains CA and DFC modules to deal with the drawback of the convolution operation which can model only local information within a window.
- To overcome the shortcomings of traditional convolution in spatial information, and to better extract features while controlling network parameters and maintaining the lightweight characteristics of the network, we use only the capsule network layer in the extraction of the highest level.
- Different from the mostly used output design in general U-Net style networks, our proposed network has dual outputs. Channel attention mechanism SE in skip connection is used to increase the weight of some of the important channels.

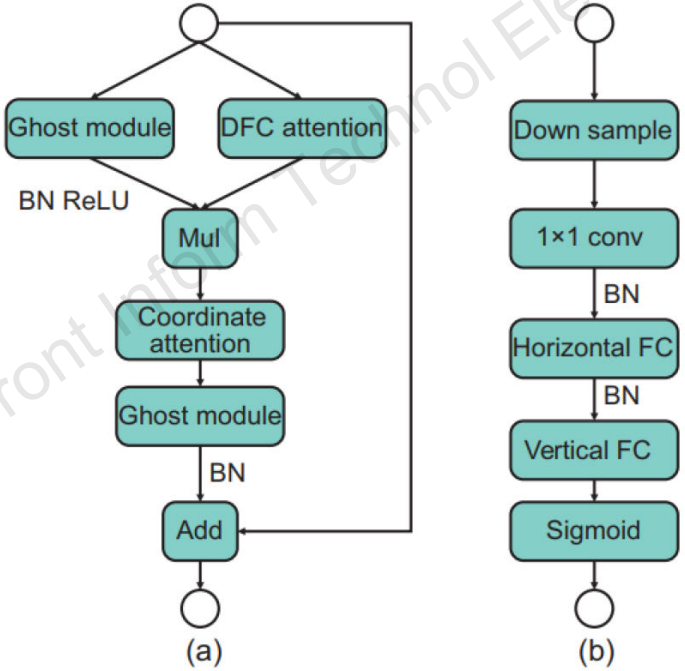
Framework



TibetanGoTinyNet architecture. The network is a U-Net style network with a structure divided into five parts: pre-feature extraction, encoder, capsule encoder, decoder, and policy–value dual output headings.

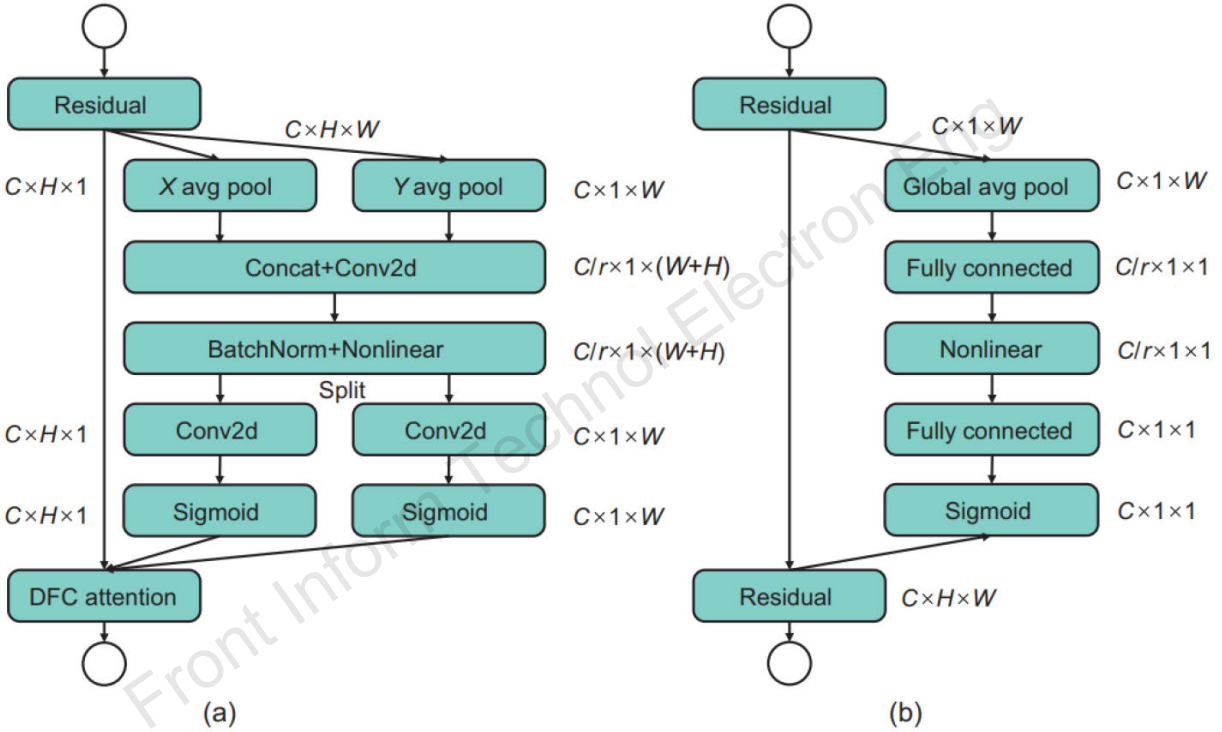
Method

The input extraction block is an extraction block employing an input_skipextract structure to extract the input channels from 36 to 72, followed by four GhostNetV2 bottleneck structures for various levels of feature encoding.



Structures of the GhostNetV2 bottleneck that contains the coordinate attention and the structure of the DFC attention module

Method



To make it better guide the network in terms of spatial location, two types of attention mechanism modules are used. One is coordinate attention block (a), and the other is squeeze excitation channel attention block (b).

Results

Table 1 Part of the winning rate data of the TibetanGoTinyNet model playing 100 games against the final version of other models every 10 epochs starting from 0

Model	Number of parameters	Winning rate (%)								
		Checkpoint=10	30	50	70	90	110	130	150	160
Res-UNet	1.226M	52	28	40	42	54	60	43	78	68
Res-UNet Attention	1.242M	44	27	44	49	46	69	60	75	72
Ghost-UNet	0.672M	34	32	32	28	31	62	54	76	78
Ghost Capsule-UNet	0.765M	28	27	20	34	43	52	52	64	62

The number of parameters of TibetanGoTinyNet is 0.772M

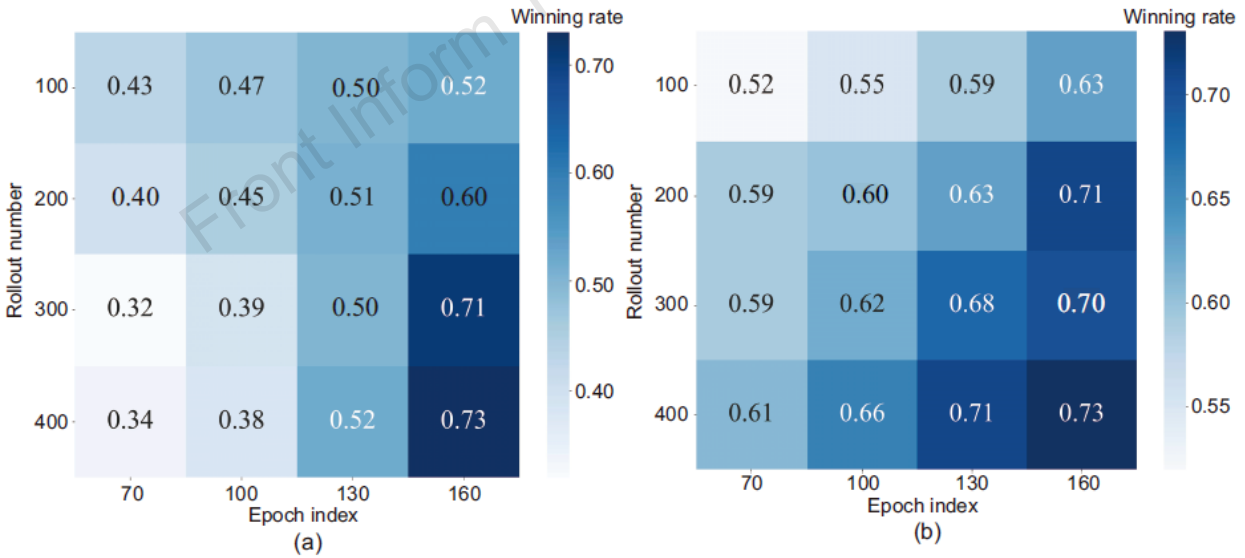


Fig. 8 Winning rates of models with (a) and without (b) the coordinate attention module

Conclusions

In this work, we studied the zero learning model of Tibetan Go under completely limited computing resources. TibetanGoTinyNet is a novel lightweight U-Net style and a scale-invariant two-headed output network that uses attention mechanisms and capsule networks. TibetanGoTinyNet has achieved good winning rate compared with other models, and is of high effectiveness in dealing with the spatial position information on board games and migrating different size game board.

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