jh190066-DAH

Deep Neural Network Optimization Based on Dual Inheritance Theory and Its Application

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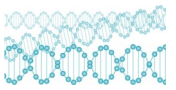
Goal: To realize an efficient automatic development framework of deep neural network (DNN) that jointly optimizes the network configurations and the parameters based on the dual inheritance theory and massively parallel computing

Background

- Existing evolution based DNN meta-parameter optimization methods are useful but not efficient. Only gene (Chromosome) is propagated to descendant generations, and other learned results are discarded
- In evolutional biology, the prominent development of the human brain is explained as the result of gene-culture coevolution

Comparison of Human Brain and DNN

- Both has a double structure of learning. The system design and individual learning
- The nature designs the brains, humans design DNN

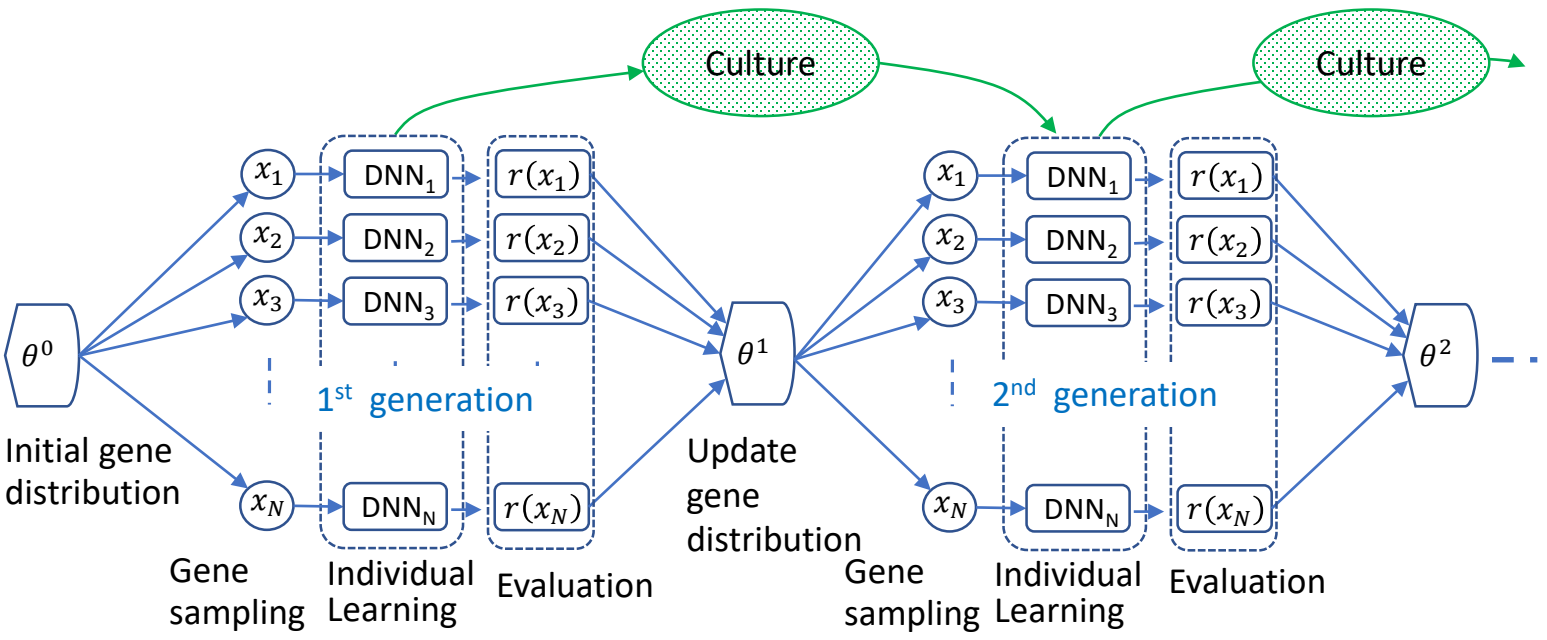


System Design
(evolution / meta-parameter tuning)

Individual learning
(Interaction with environment / back-propagation)

Proposed Dual-Inheritance Evolution Strategy

- Introduces an additional culture inheritance path to conventional evolution processes
- Uses teacher-student (TS) learning as the knowledge (culture) inheritance mechanism



Experimental Setups

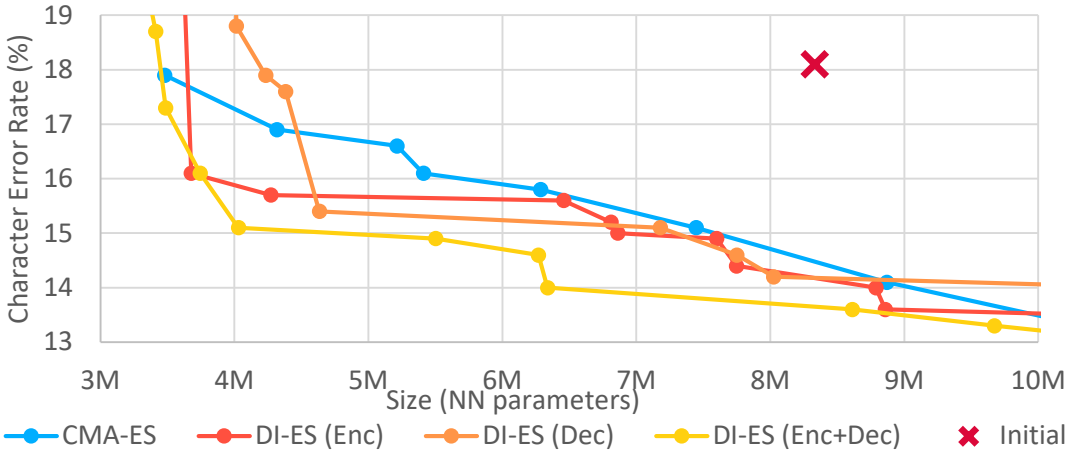
- Target optimization task is end-to-end speech recognition
- CMA-ES was used as a baseline
- Two variations of TS learnings (Enc, Dec) and their combination (Enc+Dec) were implemented. They correspond to where at the network layers the TS is performed

Gene Definition and Initialization

Type	Meta-parameters	Initial value
Learning	patience	3
	mtlalpha	0.5
Encoder	elayers	4
	eunits	320
	eprojs	320
Decoder	dlayer	1
	dunits	300
Attention	adim	320
	aconv-chans	10
	aconv-filts	100
TS learning	μ (TS weight)	0.3
	λ (End/Dec balance)	0.5
	T_T (Temperature)	20

Results

- Proposed DI-ES (Enc+Dec) gave the best performance, which combines TS learnings at the encoder and decoder of the end-to-end DNN



Publications

- 木村他、情報処理学会 音声言語情報処理研究会 (SLP)、2020
- 日野他、日本音響学会春季研究発表会、2020
- K. Hino et al., IEEE Congress on Evolution Computation 2020 (accepted)