Operation and Topology Aware Differentiable Architecture Search

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This work investigates DARTS search space and shows that:

- Good cells can be discovered with *shallow search networks*.
- *Separable convolution* is the best operation in the search space.
- 3x3 kernel size is better than 5x5.
- Cell configuration also affects the accuracy.
- Skip connection bias problem can be solved faster than existing efforts.

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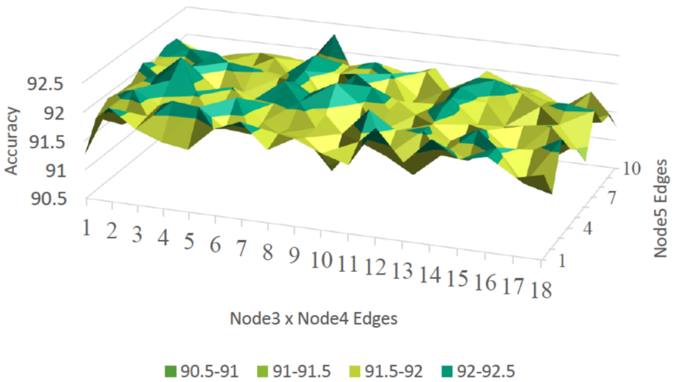
Search Space	Operations
SS1	sep-3x3, dil-3x3
SS2	sep-5x5, dil-5x5
SS3	sep-3x3, sep-5x5
SS4	dil-3x3, dil-5x5
SS5	sep-3x3, dil-5x5
SS6	sep-5x5, dil-3x3
SS7	sep-3x3, sep-5x5, dil-3x3
SS8	sep-3x3, sep-5x5, dil-5x5

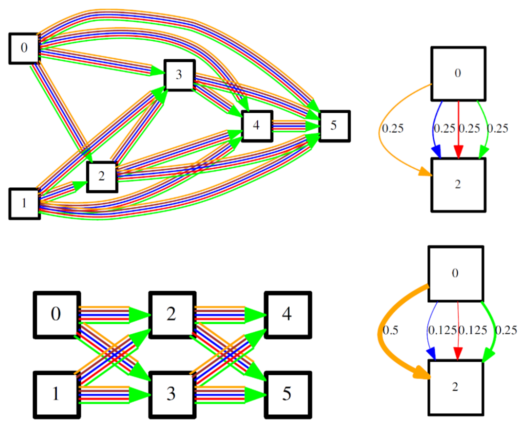
Searching in sub spaces reveals that searching deeper is only slightly better, separable convolution yields better cells than dilated and 3x3 kernel is stronger than 5x5 .



180 cell toplogies, each give different accuracy.

Method	Skip Connections: Normal	Skip Connections: Reduction	Shallow Network Accuracy	Parameters (M)	Search Cost (GPU Hours)
DARTS	14	19	90.25	0.11	36
DARTS + Data Subset	4	14	91.27	0.15	6
DARTS + Epoch Update	5	11	91.33	0.16	4.6
DARTS + Data Subset + Epoch Update	5	8	92.15	0.2	0.85

Simultaneous skip reduction and speed up mechanism.



DARTS (top) versus eDARTS search cell.

Architecture	Test Err. (%) C10	Test Err. (%) C100	Params (M)	Search Cost (GPU-days)
DenseNet-BC [24]	3.46	17.18	25.6	-
NASNet-A + cutout [7]	2.65	-	3.3	1800
AmoebaNet-A + cutout [8]	3.34	-	3.2	3150
AmoebaNet-B + cutout [8]	2.55	-	2.8	3150
Hierarchical evolution [9]	3.75	-	15.7	300
PNAS [37]	3.41	-	3.2	225
ENAS + cutout [27]	2.89	-	4.6	0.5
DARTS (first order) + cutout [10]	3.00	17.76†	3.3	1.5
DARTS (second order) + cutout [10]	2.76	17.54†	3.3	4
SNAS + mild constraint + cutout [38]	2.98	-	2.9	1.5
SNAS + moderate constraint + cutout [38]	2.85	-	2.8	1.5
SNAS + aggressive constraint + cutout [38]	3.10	-	2.3	1.5
ProxylessNAS + cutout [39]	2.08	-	5.7	4
PC-DARTS + cutout [12]	2.57	-	3.6	0.1
Fair DARTS [28]	2.54	-	2.8	0.3
P-DARTS CIFAR10 + cutout [11]	2.50	16.55	3.4	0.3
P-DARTS CIFAR100 + cutout [11]	2.62	15.92	3.6	0.3
eDARTS CIFAR10 + cutout	2.53	17.00	3.1	**0.015‡**
eDARTS CIFAR100 + cutout	2.72	16.83	3.5	0.016

eDARTS searches with fixed path and added weight to better operations. 6X faster than PC-DARTS.