Weekly Report

Wangwon Lee, 2019/03/09

This week

- **1D- CNN fine tuning**
  - Previous work
  - Kernel size
  - Channel size
  - Integrate previous result
  - Dropout rate
  - Kernel size like VGG
  - Summary

Next week

- **Audio Classification**
  - To investigate 1D model more specific
  - 1D, 2D CNN visualization

Interesting and new finding

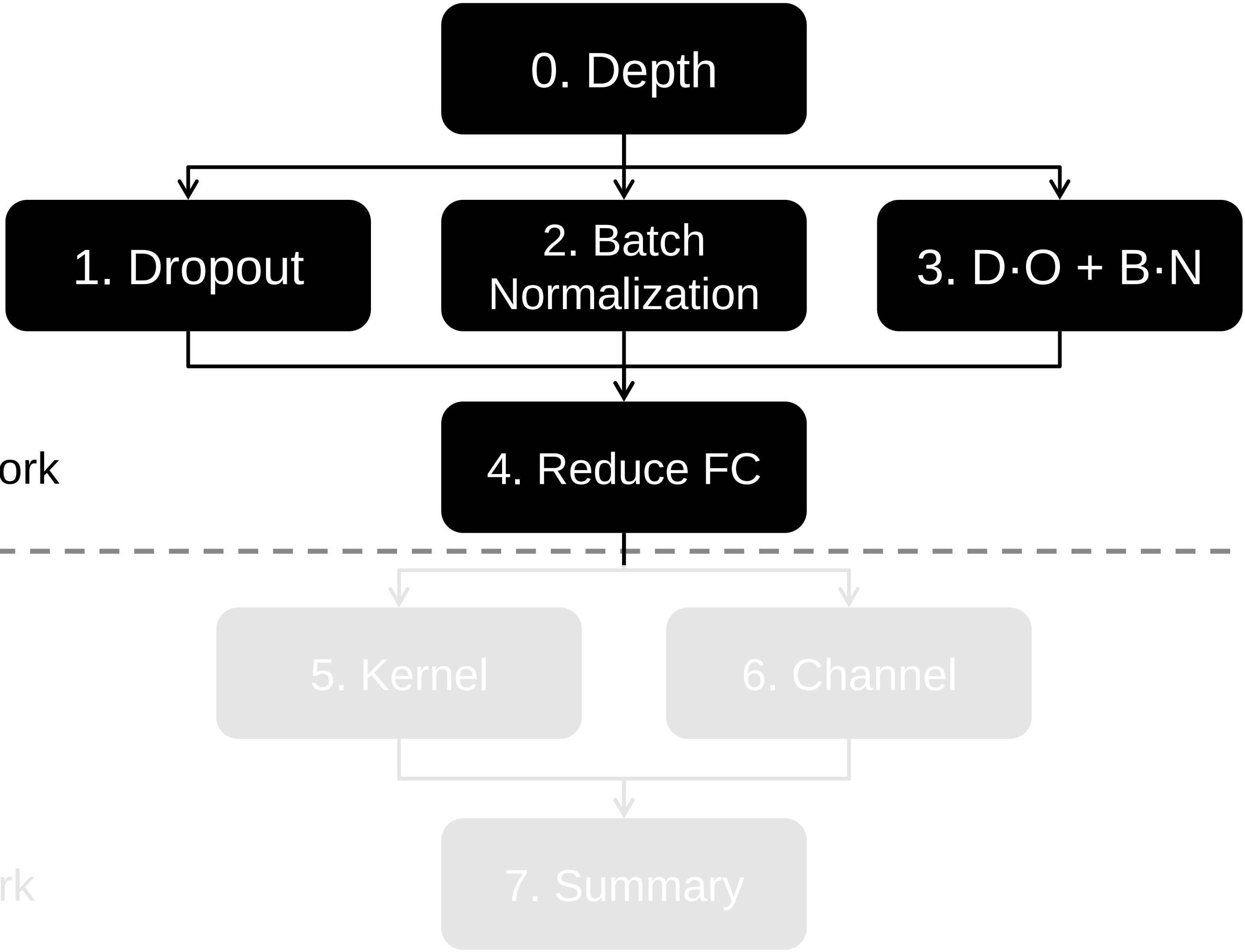
- Fine Tuning

The aim of this month / Discussion

- **The aim of this month:** To study the brain and GLM, To investigate about CNN.

Audio Classification

- Fine tuning task in 1D-CNN



0. Depth

1. Dropout

2. Batch Normalization

3. D·O + B·N

4. Reduce FC

Previous Work

5. Kernel

6. Channel

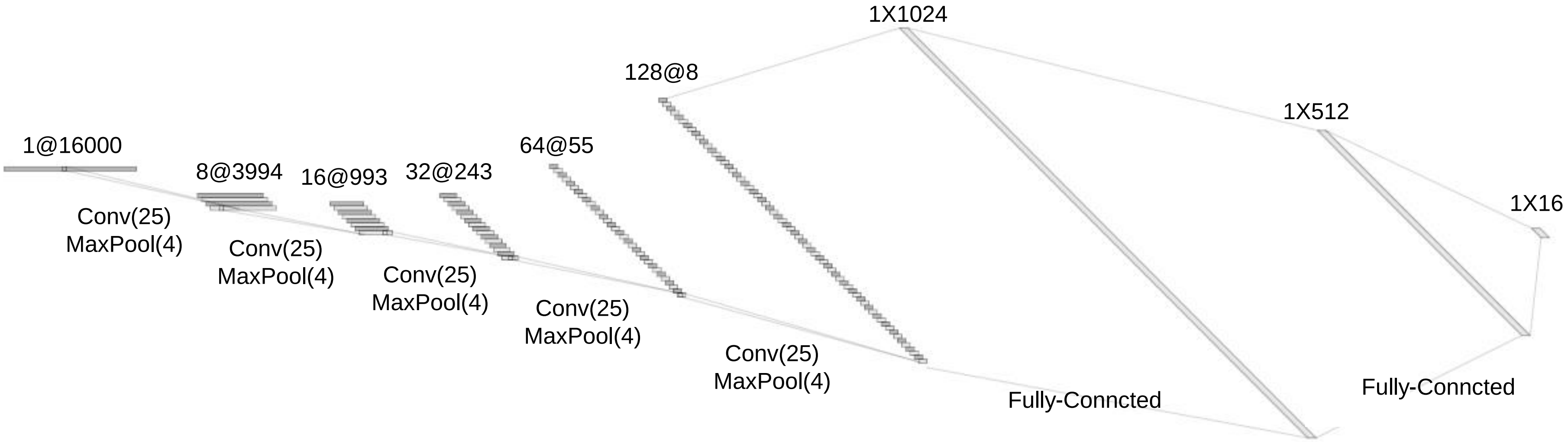
7. Summary

Current Work

Audio Classification

- For example, ‘5Conv, 2FC’ 1D model’s detail.
- It just flatten 2D model. (5X5 filter->1X25 filter, 2X2 stride->1X4 stride)

- Input: 16000X1 low waveform.
- Output:1x16 labeled one hot vector. ('zero', …, 'eight', …, 'house', 'dog')
- Loss: cross entropy loss
- Obtimizer: Adam

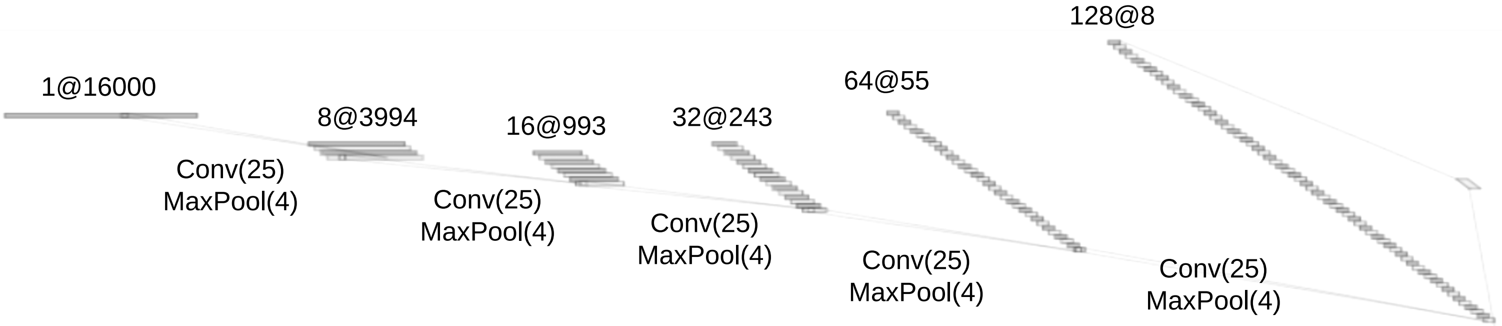


[Baseline Architecture]

Audio Classification

- 4th, I think that FC has a lot of problem (FC = Fully Connected)
- So I retry the model without FC layer (Now I call this model “only conv”)
- FC exists only between the last Conv layer and the output layer (for classfication)

Architecture (i = 0,1,2…)	1D No-DO	1D DO(0.5)	1D BN	1D DO+BN
1 CONV(25, 8*2^i)	0.4621	0.4889	0.4289	0.4490
2 CONV(25, 8*2^i)	0.5321	0.6449	0.5836	0.6885
3 CONV(25, 8*2^i)	0.7747	0.8239	0.7890	0.8538
4 CONV(25, 8*2^i)	0.8866	0.9215	0.8804	0.9238
5 CONV(25, 8*2^i)	0.8870	0.9277	0.9288	0.9375



[“Only Conv” Architecture]

Audio Classification

- Compared to the best accuracy, It is increased. (0.9240 → 0.9375)
- Compared to the number of parameter, It is greatly decreased. (~90.8%)
- It's a great achievement beyond what I expected.

base model

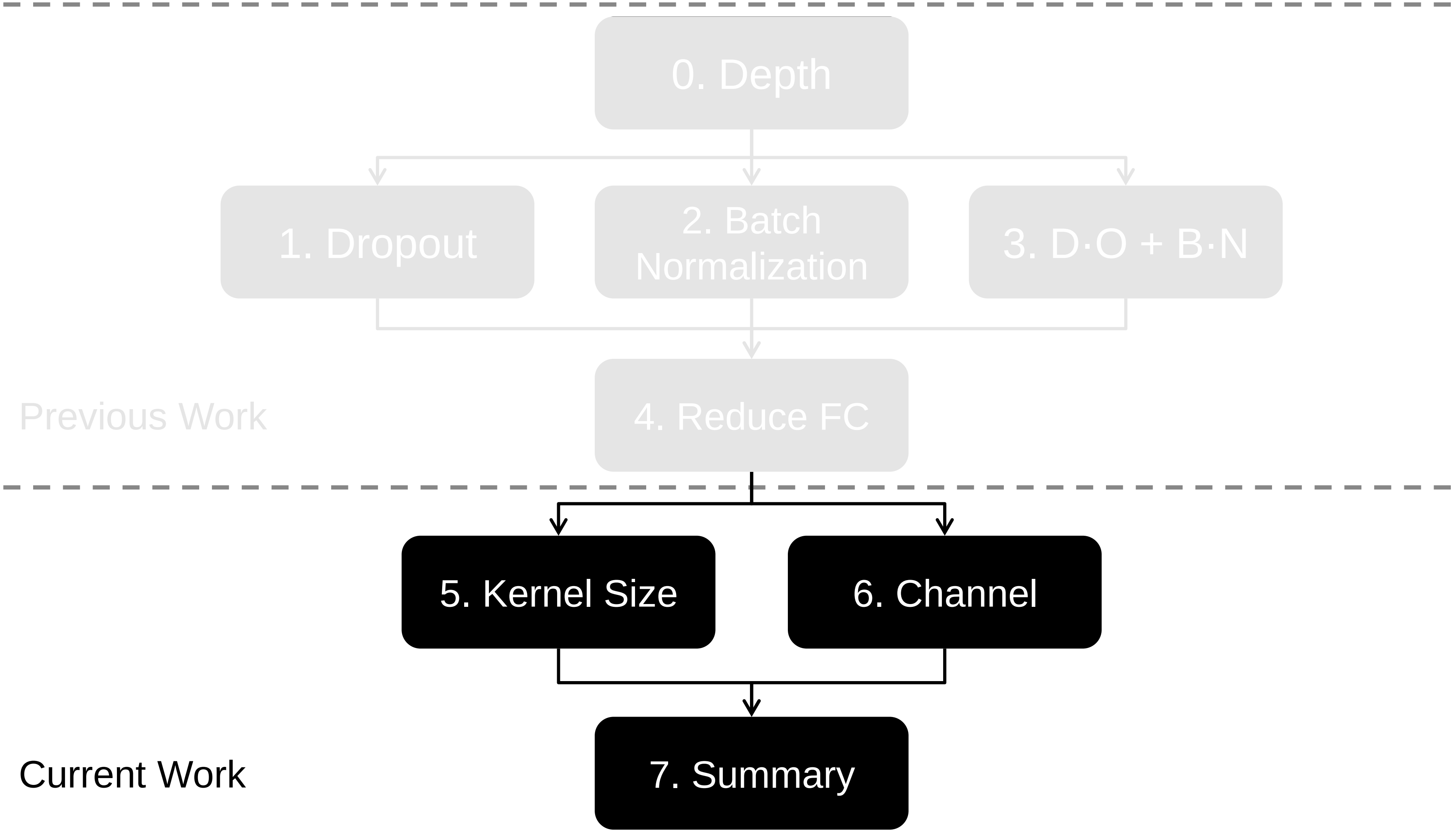
Architecture (i = 0,1,2…)	1D DO(0.5) [baseline]	1D BN	1D DO+BN	Params
…				
4 Conv(25, $8*2^i$), 4 Pool(4), 1 FC	0.8945	0.8841	0.8970	3,689,424
4 Conv(25, $8*2^i$), 4 Pool(4), 2 FC	0.9038	0.8814	0.9061	4,206,032
5 Conv(25, $8*2^i$), 5 Pool(4), 1 FC	0.9047	0.9026	0.9169	1,338,448
5 Conv(25, $8*2^i$), 5 Pool(4), 2 FC	0.9090	0.9072	0.9240	1,855,056

Only Conv model

Architecture (i = 0,1,2…)	1D DO(0.5)	1D BN	1D DO+BN	Params
…				
4 CONV(25, $8*2^i$)	0.9215	0.8804	0.9238	123,856
5 CONV(25, $8*2^i$)	0.9277	0.9288	0.9375	288,848

Audio Classification

- Fine tuning task in 1D-CNN



Audio Classification

- Change kernel size 25 -> 5
- If we reduce the kernel size, we can make the model deeper.
- Pooling size is also reduced.

Architecture (i = 0,1,2…)	DO(0.5)	BN	DO+BN	Params
1 Conv(5, 8*2^{i}), 1 Pool(3, 3)	0.2818	0.2735	0.3171	682,576
2 Conv(5, 8*2^{i}), 2 Pool(3, 3)	0.4671	0.4665	0.4974	455,424
3 Conv(5, 8*2^{i}), 3 Pool(3, 3)	0.6295	0.6004	0.6725	306,016
4 Conv(5, 8*2^{i}), 4 Pool(3, 3)	0.7556	0.6644	0.7807	214,560
5 Conv(5, 8*2^{i}), 5 Pool(3, 3)	0.8492	0.7674	0.8737	186,272
6 Conv(5, 8*2^{i}), 6 Pool(3, 3)	0.9180	0.8860	0.9192	301,728
7 Conv(5, 8*2^{i}), 7 Pool(3, 3)	0.9196	0.9167	0.9445	925,856
8 Conv(5, 8*2^{i}), 8 Pool(3, 3)	0.9132	0.9238	0.9310	3,517,600

Audio Classification

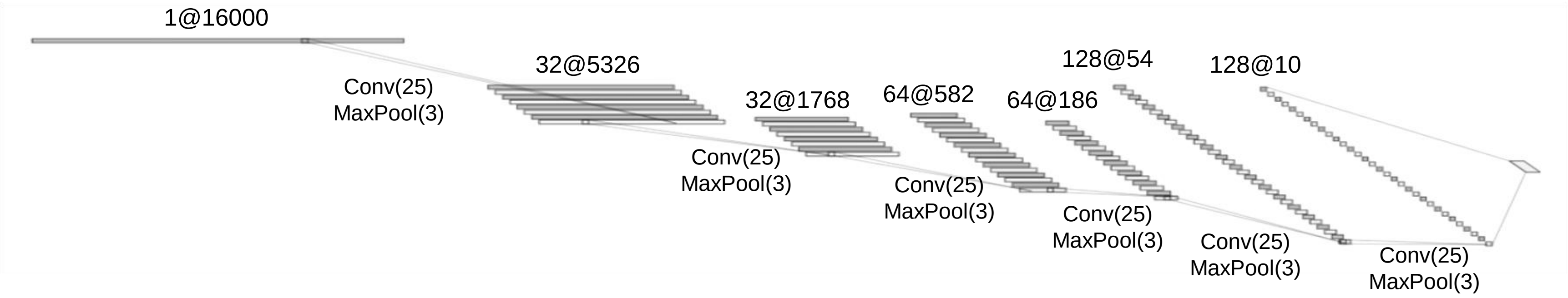
- Summarising this straight. This is current SOTA(State Of The Art) in my research.
- Accuracy is more increased. (0.9375 -> 0.9445)

	Architecture (i = 0,1,2…)	1D DO(0.5)	1D BN	1D DO+BN	Params
	baseline				
base model	5 Conv(25, $8*2^i$), 5 Pool(4), 2 FC	0.9090	0.9072	0.9240	1,855,056
	Accuracy and Number of parameters				
Only Conv	4 CONV(25, $8*2^i$)	0.9215	0.8804	0.9238	123,856
	Only Accuracy				
Only Conv	5 CONV(25, $8*2^i$)	0.9277	0.9288	0.9375	288,848
	And, here is new challenger				
Only Conv kernel 5	7 Conv(5, $8*2^i$), 7 Pool(3, 3)	0.9196	0.9167	0.9445	925,856

Audio Classification

- Change channel size
- Start channel size: 32

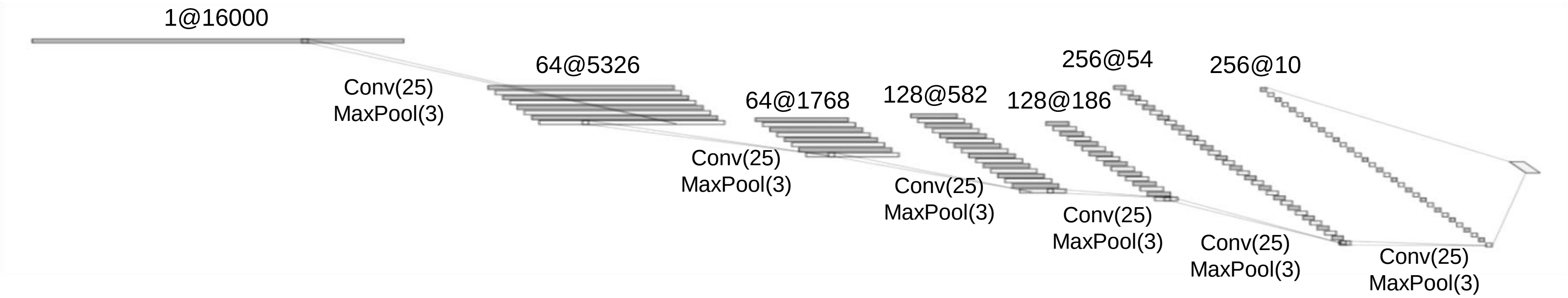
Architecture	DO(0.5)	BN	DO+BN	Params
1 Conv(25), 1 Pool(3, 3)	0.4874	0.4548	0.4453	2,727,824
2 Conv(25), 2 Pool(3, 3)	0.5948	0.5913	0.6399	931,824
3 Conv(25), 3 Pool(3, 3)	0.7886	0.7053	0.7782	673,968
4 Conv(25), 4 Pool(3, 3)	0.8953	0.8810	0.8987	371,056
5 Conv(25), 5 Pool(3, 3)	0.9375	0.9279	0.9387	496,368
6 Conv(25), 6 Pool(3, 3)	0.9364	0.9479	0.9479	816,240



Audio Classification

- Change channel size
- Start channel size: 64

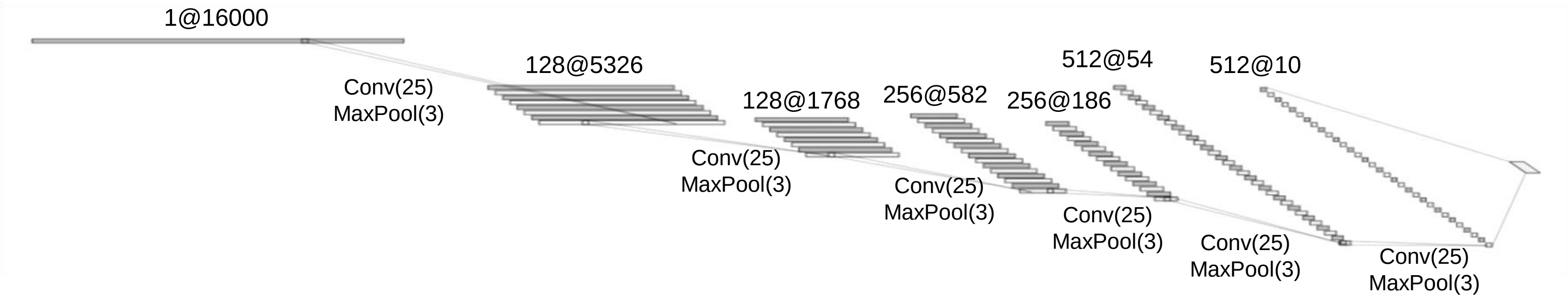
Architecture	DO(0.5)	BN	DO+BN	Params
1 Conv(25), 1 Pool(3, 3)	0.4962	0.3601	0.4469	6,137,360
2 Conv(25), 2 Pool(3, 3)	0.6486	0.5398	0.6361	2,141,136
3 Conv(25), 3 Pool(3, 3)	0.7958	0.6139	0.7965	1,650,512
4 Conv(25), 4 Pool(3, 3)	0.8945	0.8619	0.9030	1,148,112
5 Conv(25), 5 Pool(3, 3)	0.9408	0.9408	0.9466	1,788,368
6 Conv(25), 6 Pool(3, 3)	0.9412	0.9547	0.9543	3,224,784



Audio Classification

- Change channel size
- Start channel size: 128

Architecture	DO(0.5)	BN	DO+BN	Params
1 Conv(25), 1 Pool(3, 3)	0.5148	0.4417	0.4673	10,911,248
2 Conv(25), 2 Pool(3, 3)	0.6536	0.6108	0.6928	4,034,448
3 Conv(25), 3 Pool(3, 3)	0.8133	0.7502	0.7691	3,617,424
4 Conv(25), 4 Pool(3, 3)	0.9024	0.8611	0.9171	3,634,576
5 Conv(25), 5 Pool(3, 3)	0.9398	0.9412	0.9462	6,593,424
6 Conv(25), 6 Pool(3, 3)	0.9391	0.9526	0.9601	12,788,112



Audio Classification

- Summarising this straight. This is current SOTA(State Of The Art) in my research.
- Accuracy is more increased. (0.9445 -> 0.9601)
- The number of params is ……

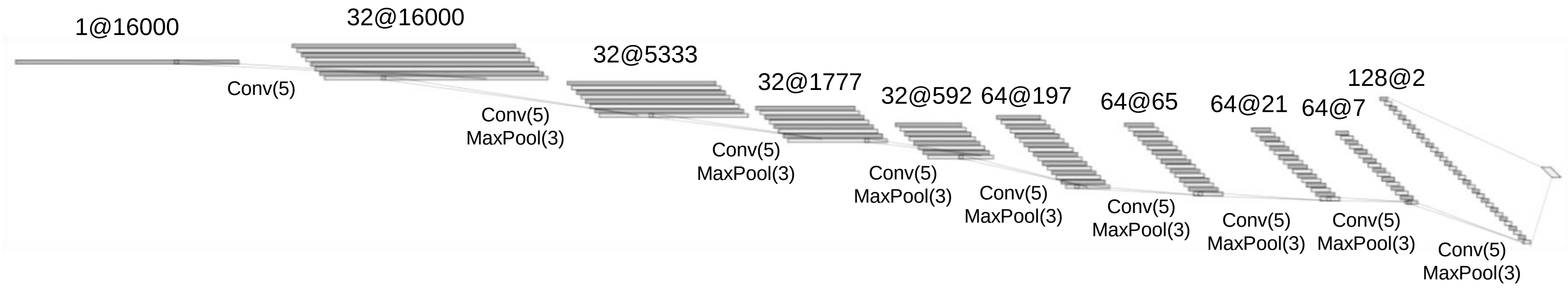
	Architecture (i = 0,1,2…)	1D DO(0.5)	1D BN	1D DO+BN	Params
	baseline				
base model	5 Conv(25, $8*2^i$), 5 Pool(4), 2 FC	0.9090	0.9072	0.9240	1,855,056
	Accuracy and Number of parameters				
Only Conv	4 CONV(25, $8*2^i$)	0.9215	0.8804	0.9238	123,856
	Only Accuracy				
Only Conv	7 Conv(5, $8*2^i$), 7 Pool(3, 3)	0.9196	0.9167	0.9445	925,856
	And, here is new challenger				
Only Conv channel 128	6 Conv(25), 6 Pool(3, 3)	0.9391	0.9526	0.9601	12,788,112

Audio Classification

- Finally, I made custom model to integrate previous result.

- First, In the case of a “DO, BN, DO+BN”, I tried everything
  -> because the results were different each time.
- Second, In the case of a channel, I tried everything
  -> because the number of channels and the accuracy are inversely proportional.
- Third, In the case of Kernel size, I tried reducing the size
  -> because reducing the kernel size could make the model deeper.
  -> pooling size is also reduced. 4 -> 3

- So, the architecture below is an example of one of them



Audio Classification

- I didn't try early because the results were probably not good.
- Start channel size: 32
- The performance was close to 0.95 with less than 100,000 parameters.

Architecture	DO(0.5)	BN	DO+BN	Params
1 CONV(5, 32)	X	X	X	X
2 CONV(5, 32)	X	X	X	X
3 CONV(5, 32)	0.5169	0.5119	0.5676	920,336
4 CONV(5, 32)	0.6656	0.6253	0.7376	318,768
5 CONV(5, 64)	0.7605	0.7065	0.8039	227,696
6 CONV(5, 64)	0.8893	0.8278	0.8826	113,072
7 CONV(5, 64)	0.9373	0.9011	0.9293	88,560
8 CONV(5, 64)	0.9477	0.9285	0.9391	94,768
9 CONV(5, 128)	0.9379	0.9268	0.9424	132,784

Audio Classification

- I didn’t try early because the results were probably not good.
- Start channel size: 64
- I think this is the most appropriate between the number of parameters and accuracy.

Architecture	DO(0.5)	BN	DO+BN	Params
1 CONV(5, 64)	X	X	X	X
2 CONV(5, 64)	X	X	X	X
3 CONV(5, 64)	0.5844	0.4893	0.5726	1,861,520
4 CONV(5, 64)	0.7128	0.6291	0.7333	668,752
5 CONV(5, 128)	0.7732	0.7022	0.8073	507,344
6 CONV(5, 128)	0.8901	0.8233	0.8818	319,312
7 CONV(5, 128)	0.9400	0.9061	0.9302	311,504
8 CONV(5, 128)	0.9560	0.9508	0.9458	365,136
9 CONV(5, 256)	0.9537	0.9464	0.9470	523,600

Audio Classification

- I didn’t try early because the results were probably not good.
- Start channel size: 128
- Accuracy is high, but the number of parameter is too large.

Architecture	DO(0.5)	BN	DO+BN	Params
1 CONV(5, 128)	X	X	X	X
2 CONV(5, 128)	X	X	X	X
3 CONV(5, 128)	0.5718	0.4521	0.5720	3,804,944
4 CONV(5, 128)	0.6766	0.6183	0.7371	1,460,368
5 CONV(5, 256)	0.7701	0.7067	0.7985	1,219,472
6 CONV(5, 256)	0.8802	0.8588	0.8762	1,007,248
7 CONV(5, 256)	0.9387	0.9236	0.9443	1,155,472
8 CONV(5, 256)	0.9543	0.9562	0.9562	1,426,576
9 CONV(5, 512)	0.9396	0.9632	0.9674	2,071,184

Audio Classification

- Summarising this straight. This is current SOTA(State Of The Art) in my research.
- Accuracy is more increased. (0.9601 -> 0.9674)
- The number of params is decreased. (123,856 -> 94,768 And 0.9238 -> 0.9477)

	Architecture (i = 0,1,2…)	1D DO(0.5)	1D BN	1D DO+BN	Params
	baseline				
base model	5 Conv(25, $8*2^{i}$), 5 Pool(4), 2 FC	0.9090	0.9072	0.9240	1,855,056
	Accuracy and Number of parameters				
Only Conv	4 CONV(25, $8*2^{i}$)	0.9215	0.8804	0.9238	123,856
	Only Accuracy				
Only Conv channel 128	6 Conv(25), 6 Pool(3, 3)	0.9391	0.9526	0.9601	12,788,112
	And, here is new challenger				
Custom channel 32	8 CONV(5, 64)	0.9477	0.9285	0.9391	94,768
Custom channel 64	8 CONV(5, 128)	0.9560	0.9508	0.9458	365,136
Custom channel 128	9 CONV(5, 512)	0.9396	0.9632	0.9674	2,071,184

Audio Classification

- Summarising this straight. This is current SOTA(State Of The Art) in my research.

	Architecture (i = 0,1,2…)	1D DO(0.5)	1D BN	1D DO+BN	Params
	baseline				
base model	5 Conv(25, $8*2^{i}$), 5 Pool(4), 2 FC	0.9090	0.9072	0.9240	1,855,056
	Accuracy and Number of parameters				
Custom channel 32	8 CONV(5, 64)	0.9477	0.9285	0.9391	94,768
Custom channel 64	8 CONV(5, 128)	0.9560	0.9508	0.9458	365,136
	Only Accuracy				
Custom channel 128	9 CONV(5, 512)	0.9396	0.9632	0.9674	2,071,184

Audio Classification

- Summarising this straight. This is current SOTA(State Of The Art) in my research.

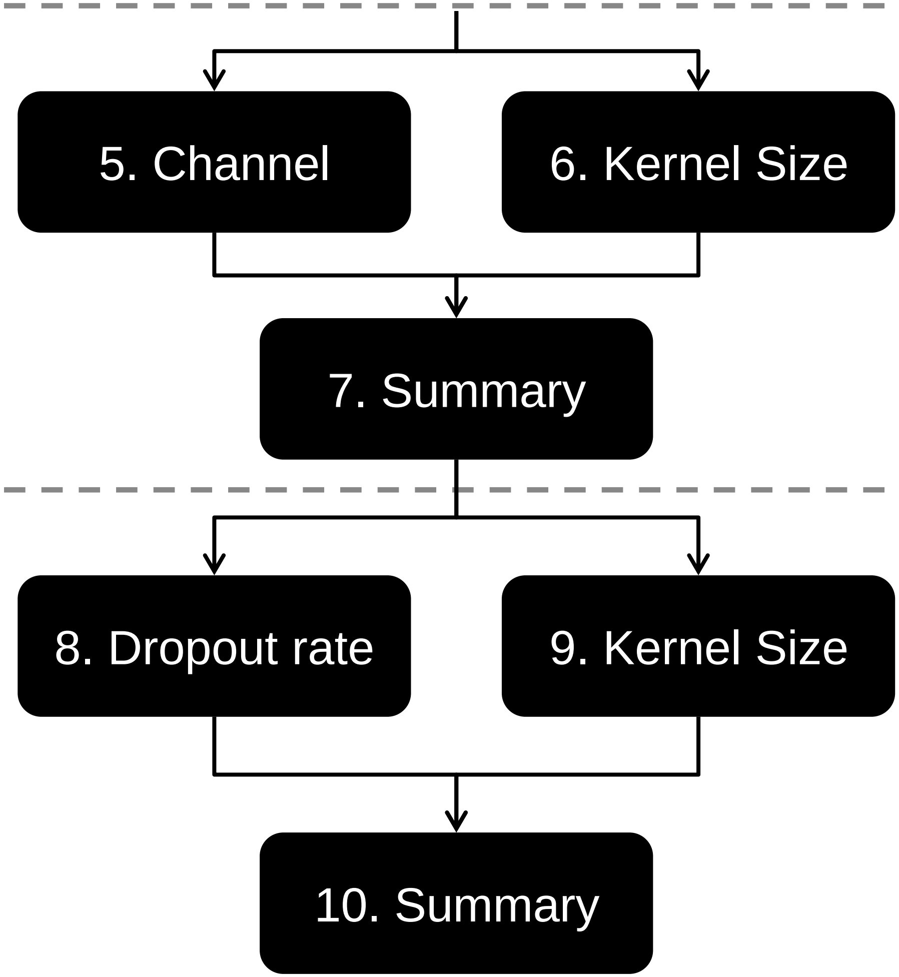
	Architecture (i = 0,1,2…)	1D DO(0.5)	1D BN	1D DO+BN	Params
	baseline				
base model	5 Conv([illegible] 2^i [illegible]) + 2 FC	[illegible]	[illegible]	[illegible]	1,855,056
	Accuracy and Number of parameters				
Custom channel 32	8 CONV(5, 64)	0.9477	0.9285	0.9391	94,768
Custom channel [illegible]	[illegible] CONV(5, [illegible])	[illegible]	[illegible]	[illegible]	[illegible]
	Only Accuracy				
Custom channel 128	9 CONV(5, 512)	0.9396	0.9632	0.9628	2,071,184

The previous goal was here…

Frankly, a lot of experiment are more…

Audio Classification

- Fine tuning task in 1D-CNN



Previous goal

Added Work

Audio Classification

- I tune the dropout’s rate
- The accuracy was close to 0.96

Architecture	DO(0.25)	DO(0.25)+BN	DO(0.75)	DO(0.75)+BN
1 CONV(5, 64)	0.3180	0.2069	0.3194	0.3049
2 CONV(5, 64)	0.4372	0.2760	0.4619	0.4617
3 CONV(5, 64)	0.5448	0.5639	0.6430	0.6426
4 CONV(5, 64)	0.6125	0.6625	0.7796	0.7934
5 CONV(5, 128)	0.7240	0.7653	0.8351	0.8320
6 CONV(5, 128)	0.8534	0.8633	0.9153	0.8812
7 CONV(5, 128)	0.9219	0.9269	0.9472	0.9321
8 CONV(5, 128)	0.9458	0.9512	0.9589	0.9497
9 CONV(5, 256)	0.9292	0.9578	0.9553	0.9585

Audio Classification

- Summarising this straight. This is current SOTA(State Of The Art) in my research.
- The performance is increased. (0.9560 -> 0.9589)
- But… I’m not sure it is really better…

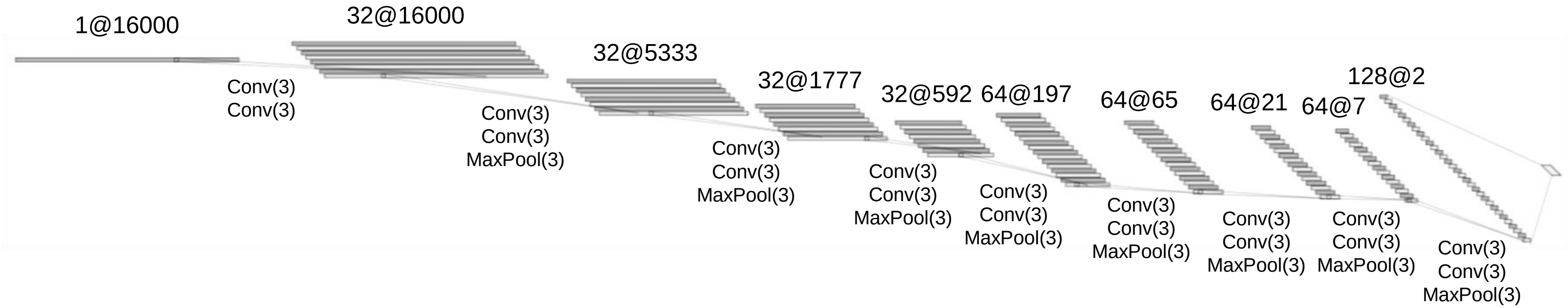
	Architecture (i = 0,1,2…)	1D DO(0.5)	1D BN	1D DO+BN	Params
	baseline				
base model	5 Conv(25, $8*2^{i}$), 5 Pool(4), 2 FC	0.9090	0.9072	0.9240	1,855,056
	Accuracy and Number of parameters				
Custom channel 32	8 CONV(5, 64)	0.9477	0.9285	0.9391	94,768
Custom channel 64	8 CONV(5, 128)	0.9560	0.9508	0.9458	365,136
	Only Accuracy				
Custom channel 128	9 CONV(5, 512)	0.9396	0.9632	0.9674	2,071,184
	And, here is new challenger				
Custom channel 64 DO(0.75)	8 CONV(5, 128)	0.9589	X	0.9497	363,600

Audio Classification

- Change kernel size 1X5 (one layer) -> 1X3 and 1X3 (two layer)

--- From VGG paper… ---
such layers have a 7 × 7 effective receptive field.
So what have we gained by using, for instance, a stack of three 3×3 conv layers instead of a single 7×7 layer?
First, we incorporate three non-linear rectification layers instead of a single one, which makes the decision function more discriminative.

- According to the VGG paper, it is better to replace a large-sized kernel with a combination of 3X3 kernels.
- So, I tried.



Audio Classification

- I tried VGG style
- The accuracy exceeded 0.96.

Architecture	1D DO(0.5)	1D BN	1D DO+BN	Params
2 CONV(3, 64), 1 Pool	0.3877	0.3674	0.3171	16,396,624
4 CONV(3, 64) , 2 Pool	0.4752	0.3668	0.3389	5,498,320
6 CONV(3, 64) ,3 Pool	0.5626	0.4933	0.4984	1,881,680
8 CONV(3, 64) , 4 Pool	0.6719	0.6521	0.6544	692,944
10 CONV(3, 128) , 5 Pool	0.7666	0.7047	0.7344	564,176
12 CONV(3, 128) , 6 Pool	0.9018	0.8349	0.7502	392,400
14 CONV(3, 128) , 7 Pool	0.9427	0.9286	0.8044	400,848
16 CONV(3, 128) , 8 Pool	0.9630	0.9423	0.9136	470,736
18 CONV(3, 256) , 9 Pool	0.9350	0.9493	0.9418	760,016

Audio Classification

- Summarising this straight. This is current SOTA(State Of The Art) in my research.
- The performance was increased. (0.9589 -> 0.9630)
- But, Params was also increased. (363,600 -> 470,736)

	Architecture (i = 0,1,2…)	1D DO(0.5)	1D BN	1D DO+BN	Params
	baseline				
base model	5 Conv(25, $8*2^{i}$), 5 Pool(4), 2 FC	0.9090	0.9072	0.9240	1,855,056
	Accuracy and Number of parameters				
Custom channel 32	8 CONV(5, 64)	0.9477	0.9285	0.9391	94,768
Custom channel 64 DO(0.75)	8 CONV(5, 128)	0.9589	X	0.9497	363,600
	Only Accuracy				
Custom channel 128	9 CONV(5, 512)	0.9396	0.9632	0.9674	2,071,184
	And, here is new challenger				
Custom VGG style	16 CONV(3, 128) , 8 Pool	0.9630	0.9423	0.9136	470,736

Audio Classification

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- But, Params was also increased. (363,600 -> 470,736)

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	baseline				
base model	5 Conv(25, 8*2^i), 5 Pool(4), 2 FC	0.9090	0.9072	0.9240	1,855,056
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	Only Accuracy				
Custom channel 128	9 CONV(5, 512)	0.9396	0.9632	0.9674	2,071,184
	And, here is new challenger				
Custom VGG style	16 CONV(3, 128) , 8 Pool	0.9630	0.9423	0.9136	470,736

Frankly, a lot of experiment are more

But, because it didn’t improve more,
I don't talk about some more…

Audio Classification

- Finally, This is current SOTA(State Of The Art) in my research.

	Architecture (i = 0,1,2…)	1D DO(0.5)	1D BN	1D DO+BN	Params
	baseline				
base model	5 Conv(25, $8*2^i$), 5 Pool(4), 2 FC	0.9090	0.9072	0.9240	1,855,056
	Accuracy and Number of parameters				
Custom channel 32	8 CONV(5, 64)	0.9477	0.9285	0.9391	94,768
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Custom VGG style	16 CONV(3, 128) , 8 Pool	0.9630	0.9423	0.9136	470,736
	Only Accuracy				
Custom channel 128	9 CONV(5, 512)	0.9396	0.9632	0.9674	2,071,184

Any Question?

Thank you