Supplementary material of "EEGSym: Overcoming Inter-subject Variability in Motor Imagery Based BCIs with Deep Learning"

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S.I. EEGSym 8-electrode architecture details

3.i. EEGSylli o-electrode architecture details										
EEGSym stage	Block	Name	Туре	Filters	Groups	Kernel	Padding	Output shape	Connected to	
	-	SD Input	Input	-	-	-	-	384x8x1	-	
•	-	SD Expand_dims	Expand_dims	-	-	-	-	1x384x8x1	SD Input	
SD)	-	SD gather_left	Gather	-	-	-	-	1x384x3x1	SD Expand_dims	
) u	-	SD gather_central	Gather	-	-	-	-	1x384x2x1	SD Expand_dims	
risio	-	SD gather_right	Gather	-	-	-	-	1x384x3x1	SD Expand_dims	
β	-	SD concatanata laft	Concatonata					1x384x5x1	SD gather_left	
etric	-	SD concatenate_left	Concatenate	-	_	<u>-</u>	-	133043331	SD gather_central	
Symmetric division (SD)	-	SD concatenate_right	Concatenate	_	_	_	_	1x384x5x1	SD gather_right	
Syr	-	OD concatenate_right	Concatenate					1700-7071	SD gather_central	
	-	SD concatenate_sym	Concatenate	_	_	_	_	2x384x5x1	SD concatenate_left	
	-	OD Concatchate_3ym	Concatenate	_	_			2,004,0,1	SD concatenate_right	
		IB1 conv_temporal1	Conv3D	24		1x16x1	same	2x384x5x24	SD concatenate_sym	
		IB1 conv_temporal2	Conv3D	24		1x32x1	same	2x384x5x24	SD concatenate_sym	
		IB1 conv_temporal3	Conv3D	24		1x64x1	same	2x384x5x24	SD concatenate_sym	
	31		Concatenate					2x384x5x72	IB1 conv_temporal1	
	1 (E	IB1 concatenate		-	-	-	-		IB1 conv_temporal2	
	상								IB1 conv_temporal3	
	Inception block 1 (IB1)	ID4 A 1-14	A -1 -1					2x384x5x72	SD concatenate_sym	
		septi	IB1 Add1	Add	-	-	-	-	2830483872	IB1 concatenate
(\o		IB1 AvPool	AveragePooling3D	-	-	1x2x1	-	2x192x5x72	IB1 Add	
L) s		IB1 gconv_spatial	Conv3D	72	72	1x1x5	valid	2x192x1x72	IB1 AvPool	
alysi			ID4 A 440	A -1 -1					0400570	IB1 AvPool
ans		IB1 Add2	Add	-	-	-	-	2x192x5x72	IB1 gconv_spatial	
Tempospatial analysis (TA)		IB2 conv_temporal1	Conv3D	24		1x4x1	same	2x192x5x24	IB1 Add2	
eds		IB2 conv_temporal2	Conv3D	24		1x8x1	same	2x192x5x24	IB1 Add2	
odu		IB2 conv_temporal3	Conv3D	24		1x16x1	same	2x192x5x24	IB1 Add2	
Ter	(2)								IB2 conv_temporal1	
	2 (IB	IB2 concatenate	Concatenate	-	-	-	-	2x192x5x24	IB2 conv_temporal2	
	S K								IB2 conv_temporal3	
	ig u								IB1 Add2	
	Inception block 2 (IB2)	IB2 Add1	Add	-	-	-	-	2x192x5x24	IB2 concatenate	
	<u>n</u>	IB2 AvPool	AveragePooling3D	-	-	1x2x1	-	2x96x5x72	IB2 Add	
		IB2 gconv_spatial	Conv3D	72	72	1x1x5	valid	2x96x1x72	IB2 AvPool	
									IB2 AvPool	
		IB2 Add2	Add	-	-	-	-	2x96x5x72	IB2 gconv_spatial	
į									·	

EEGSym stage	Block	Name	Туре	Filters	Groups	Kernel	Padding	Output shape	Connected to
		RB1 conv_shortcut	Conv3D	36	-	1x1x1	same	2x96x5x36	IB2 Add2
		RB1 conv_temporal	Conv3D	36	-	1x16x1	same	2x96x5x36	IB2 Add2
	88 8	DD4 4 114	A 1.1					0.00.5.00	RB1 conv_shortcut
	ار ک	RB1 Add1	Add	-	-	-	-	2x96x5x36	RB1 conv_temporal
	Residual block 1 (RB1)	RB1 AvPool	AveragePooling3D	-	-	1x2x1	-	2x48x5x36	RB1 Add
	sidu	RB1 conv_spatial	Conv3D	36	-	1x1x5	valid	2x48x1x36	RB1 AvPool
	Re	RB1 Add2	Add					2x48x5x36	RB1 AvPool
		RBT Add2	Add	-	-	-	-	2x40x3x30	RB1 conv_spatial
		RB2 conv_shortcut	Conv3D	36	-	1x1x1	same	2x48x5x36	RB1 Add2
	32)	RB2 conv_temporal	Conv3D	36	-	1x8x1	same	2x48x5x36	RB1 Add2
<u> </u>	Residual block 2 (RB2)	RB2 Add1	Add					2x48x5x36	RB2 conv_shortcut
L) si	ock ?	MB2 Add I	Add	-	-	-	-	2x40x3x30	RB2 conv_temporal
alysi	al blo	RB2 AvPool	AveragePooling3D	-	-	1x2x1	-	2x24x5x36	RB2 Add
ans	sidu	RB2 conv_spatial	Conv3D	36	-	1x1x5	valid	2x24x1x36	RB2 AvPool
atial	å	RB2 Add2	Add					2x24x5x36	RB2 AvPool
edso		NB2 Add2	Add	-	-	-	-	2,24,3,3,30	RB2 conv_spatial
Tempospatial analysis (TA)	Residual block 3 (RB3)	RB3 conv_shortcut	Conv3D	18	-	1x1x1	same	2x24x5x18	RB2 Add2
<u>⊒</u>		RB3 conv_temporal	Conv3D	18	-	1x4x1	same	2x24x5x18	RB2 Add2
		RB3 Add1	Add	_	_	_		2x24x5x18	RB3 conv_shortcut
			, lad					ZAZTAOATO	RB3 conv_temporal
		RB3 AvPool	AveragePooling3D	-	-	1x2x1	-	2x12x5x18	RB3 Add
	sidu	RB3 conv_spatial	Conv3D	18	-	1x1x5	valid	2x12x1x18	RB3 AvPool
	A.	RB3 Add2	Add	_	_	_	_	2x12x5x18	RB3 AvPool
		115071442	7100						RB3 conv_spatial
	-	TA conv_temporal	Conv3D	18	-	1x4x1	same	2x12x5x18	RB3 Add2
	_	TA Add	Add	_	_	_	_	2x12x5x18	RB3 Add2
		1717100	7100					ZXTZXXXTO	TA conv_temporal
	-	TA AvPool	AveragePooling3D	-	-	1x2x1	-	2x6x5x18	TA Add
Σ	-	CM conv_temporal1	Conv3D	18	-	1x4x1	same	2x6x5x18	TA AvPool
Channel merging (CM)	_	CM Add1	Add	_	_	_	_	2x6x5x18	RB3 Add2
gin									CM conv_temporal1
ше		CM conv_temporal2	Conv3D	18	-	1x4x1	same	2x6x5x18	CM Add1
ne	-	RB3 Add1	Add	-	-	-	-	2x6x5x18	CM Add1
han									CM conv_temporal2
	-	CM gconv_spatial	Conv3D	18	9	2x1x5	valid	1x6x1x18	CM Add1
ral TM	-	TM conv_temporal	Conv3D	18	-	1x4x1	same	1x6x1x18	CM gconv_spatial
odu) Bu	-	TM Add	Add	-	-	-	-	1x6x1x18	TM conv_temporal
Temporal merging (TM)									CM gconv_spatial
<u>Ĕ</u>		TM gconv_temporal	Conv3D	36	18	1x6x1	valid	1x1x1x36	TM Add

EEGSym stage	Block	Name	Туре	Filters	Groups	Kernel	Padding	Output shape	Connected to
	_	OM conv1	Conv3D	36	-	1x1x1	same	1x1x1x36	TM gconv_temporal
	-	OM Add1	Add	-	-	-	-	1x1x1x36	TM gconv_temporal OM conv1
	-	OM conv2	Conv3D	36	-	1x1x1	same	1x1x1x36	OM Add1
Output module (OM)	-	OM Add2	Add	-	-	-	-	1x1x1x36	OM Add1 OM conv2
	-	OM conv3	Conv3D	36	-	1x1x1	same	1x1x1x36	OM Add2
	-	OM Add3	Add	-	-	-	-	1x1x1x36	OM Add2 OM conv3
Out	-	OM conv4	Conv3D	36	-	1x1x1	same	1x1x1x36	OM Add3
	-	OM Add4	Add	-	-	-	-	1x1x1x36	OM Add3 OM conv4
		OM Flatten	Flatten	-	-	-	-	36	OM Add4
		OM Softmax	Dense	-	-	-	-	2	OM Flatten

Column "Type" describes the class used to implement each operation in Tensorflow. All convolutional operations are followed by batch normalization, 'elu' activation and dropout regularization. The model has 142784 trainable parameters.

S.II. EEGSym 16-electrode architecture details

5.II. EEGSylli 16-electrode architecture details											
EEGSym stage	Block	Name	Туре	Filters	Groups	Kernel	Padding	Output shape	Connected to		
	-	SD Input	Input	-	-	-	-	384x16x1	-		
	-	SD Expand_dims	Expand_dims	-	-	-	-	1x384x16x1	SD Input		
SD)	-	SD gather_left	Gather	-	-	-	-	1x384x7x1	SD Expand_dims		
) L	-	SD gather_central	Gather	-	-	-	-	1x384x2x1	SD Expand_dims		
/isic	-	SD gather_right	Gather	-	-	-	-	1x384x7x1	SD Expand_dims		
β	-	SD concatonate left	Concatenate					1x384x9x1	SD gather_left		
etric	-	SD concatenate_left	Concatenate	-	-		-	133043331	SD gather_central		
Symmetric division (SD)	-	SD	Concatenate					1x384x9x1	SD gather_right		
Syr	-	concatenate_right	Concatenate					1,004,011	SD gather_central		
	-	SD	Concatenate	_		_	_	2x384x9x1	SD concatenate_left		
	-	concatenate_sym	Concatenate					2,004,9,1	SD concatenate_right		
		IB1 conv_temporal1	Conv3D	24		1x16x1	same	2x384x9x24	SD concatenate_sym		
	1 (IB1)	IB1 conv_temporal2	Conv3D	24		1x32x1	same	2x384x9x24	SD concatenate_sym		
		IB1 conv_temporal3	Conv3D	24		1x64x1	same	2x384x9x24	SD concatenate_sym		
			Concatenate		-	-	-	2x384x9x72	IB1 conv_temporal1		
		IB1 concatenate		-					IB1 conv_temporal2		
	oc K								IB1 conv_temporal3		
	Inception block 1 (IB1)	ld nc	ID4 A L14			_			2v204v0v72	SD concatenate_sym	
		IB1 Add1	Add	-	-	<u>-</u>	-	2x384x9x72	IB1 concatenate		
<u> </u>		IB1 AvPool	AveragePooling3D	-	-	1x2x1	-	2x192x9x72	IB1 Add		
L) s		IB1 gconv_spatial	Conv3D	72	72	1x1x9	valid	2x192x1x72	IB1 AvPool		
alysi					ID4 A LIO						0.400.0.70
ana		IB1 Add2	Add	-	-	-	-	2x192x9x72	IB1 gconv_spatial		
Tempospatial analysis (TA)		IB2 conv_temporal1	Conv3D	24		1x4x1	same	2x192x9x24	IB1 Add2		
sba		IB2 conv_temporal2	Conv3D	24		1x8x1	same	2x192x9x24	IB1 Add2		
odu		IB2 conv_temporal3	Conv3D	24		1x16x1	same	2x192x9x24	IB1 Add2		
Ter	(2								IB2 conv_temporal1		
	2 (IB	IB2 concatenate	Concatenate	-	-	-	-	2x192x9x24	IB2 conv_temporal2		
	SCK.								IB2 conv_temporal3		
	n bl								IB1 Add2		
	Inception block 2 (IB2)	IB2 Add1	Add	-	-	-	-	2x192x9x24	IB2 concatenate		
	luce	IB2 AvPool	AveragePooling3D	-	-	1x2x1	-	2x96x9x72	IB2 Add		
		IB2 gconv_spatial	Conv3D	72	72	1x1x9	valid	2x96x1x72	IB2 AvPool		
									IB2 AvPool		
		IB2 Add2	Add	-	-	-	-	2x96x9x72	IB2 gconv_spatial		
										<u> </u>	

EEGSym stage	Block	Name	Туре	Filters	Groups	Kernel	Padding	Output shape	Connected to	
:		RB1 conv_shortcut	Conv3D	36	-	1x1x1	same	2x96x9x36	IB2 Add2	
	<u></u>	RB1 conv_temporal	Conv3D	36	-	1x16x1	same	2x96x9x36	IB2 Add2	
	Residual block 1 (RB1)	RB1 Add1	Add	-	_	-	-	2x96x9x36	RB1 conv_shortcut	
	block	RB1 AvPool	AveragePooling3D			1x2x1		2x48x9x36	RB1 conv_temporal RB1 Add	
	dual	RB1 conv_spatial	Conv3D	36		1x1x9	valid	2x48x1x36	RB1 AvPool	
	Resid	KB1 conv_spatial	CONVOD	30		17179	valiu	2,40,11,30	RB1 AvPool	
	ш	RB1 Add2	Add	-	-	-	-	2x48x9x36	RB1 conv_spatial	
•		RB2 conv_shortcut	Conv3D	36	-	1x1x1	same	2x48x9x36	RB1 Add2	
	5	RB2 conv_temporal	Conv3D	36	-	1x8x1	same	2x48x9x36	RB1 Add2	
€	(RB								RB2 conv_shortcut	
T) s	Қ 2	RB2 Add1	Add	-	-	-	-	2x48x9x36	RB2 conv_temporal	
lysis	Residual block 2 (RB2)	RB2 AvPool	AveragePooling3D	-	-	1x2x1	-	2x24x9x36	RB2 Add	
ana	idua	RB2 conv_spatial	Conv3D	36	_	1x1x9	valid	2x24x1x36	RB2 AvPool	
tial (Res					-	-	2x24x9x36	RB2 AvPool	
spai		RB2 Add2	Add	-	-				RB2 conv_spatial	
Tempospatial analysis (TA)	sidual block 3 (RB3)	RB3 conv_shortcut	Conv3D	18	-	1x1x1	same	2x24x9x18	RB2 Add2	
Теп		RB3 conv_temporal	Conv3D	18	-	1x4x1	same	2x24x9x18	RB2 Add2	
		8 R	DD0 4 114	A 1.1					0.04.0.40	RB3 conv_shortcut
		RB3 Add1	Add	-	-	-	-	2x24x9x18	RB3 conv_temporal	
		RB3 AvPool	AveragePooling3D	-	-	1x2x1	-	2x12x9x18	RB3 Add	
	sidu	RB3 conv_spatial	Conv3D	18	-	1x1x9	valid	2x12x1x18	RB3 AvPool	
	Ϋ́ Be	RB3 Add2	Add					2v12v0v10	RB3 AvPool	
_		RB3 Add2	Add		-	-	-	2x12x9x18	RB3 conv_spatial	
	-	TA conv_temporal	Conv3D	18	-	1x4x1	same	2x12x9x18	RB3 Add2	
		TA Add	Add					2x12x9x18	RB3 Add2	
_		TA Add	Add	-	-	-	-	2	TA conv_temporal	
	-	TA AvPool	AveragePooling3D	-	-	1x2x1	-	2x6x9x18	TA Add	
Σ	-	CM conv_temporal1	Conv3D	18	-	1x4x1	same	2x6x9x18	TA AvPool	
Channel merging (CM)	_	CM Add1	Add	_		_	_	2x6x9x18	RB3 Add2	
ginç		CIVI Add I	Add					2,0,3,10	CM conv_temporal1	
mer		CM conv_temporal2	Conv3D	18	-	1x4x1	same	2x6x9x18	CM Add1	
nel	_	RB3 Add1	Add	_	_	_	_	2x6x9x18	CM Add1	
Jan									CM conv_temporal2	
	-	CM gconv_spatial	Conv3D	18	9	2x1x9	valid	1x6x1x18	CM Add1	
_ TMֻ	-	TM conv_temporal	Conv3D	18	-	1x4x1	same	1x6x1x18	CM gconv_spatial	
por) gι	_	TM Add	Add	_	_	-	-	1x6x1x18	TM conv_temporal	
Temporal merging (TM)									CM gconv_spatial	
<u></u>		TM gconv_temporal	Conv3D	36	18	1x6x1	valid	1x1x1x36	TM Add	

EEGSym stage	Block	Name	Туре	Filters	Groups	Kernel	Padding	Output shape	Connected to
	_	OM conv1	Conv3D	36	-	1x1x1	same	1x1x1x36	TM gconv_temporal
	-	OM Add1	Add	-	-	-	-	1x1x1x36	TM gconv_temporal OM conv1
	-	OM conv2	Conv3D	36	-	1x1x1	same	1x1x1x36	OM Add1
Output module (OM)	-	OM Add2	Add	-	-	-	-	1x1x1x36	OM Add1 OM conv2
	-	OM conv3	Conv3D	36	-	1x1x1	same	1x1x1x36	OM Add2
	-	OM Add3	Add	-	-	-	-	1x1x1x36	OM Add2 OM conv3
Out	-	OM conv4	Conv3D	36	-	1x1x1	same	1x1x1x36	OM Add3
	-	OM Add4	Add	-	-	-	-	1x1x1x36	OM Add3 OM conv4
		OM Flatten	Flatten	-	-	-	-	36	OM Add4
		OM Softmax	Dense	-	-	-	-	2	OM Flatten

Column "Type" describes the class used to implement each operation in Tensorflow. All convolutional operations are followed by batch normalization, 'elu' activation and dropout regularization. The model has 160496 trainable parameters.