

# Supplement 1 for OPTICAL+: A Frequency-Based Deep Learning Scheme for Recognizing Brain Wave Signals

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In this supplementary text, we present the 10x10-fold cross-validation results of the individual subjects for the different methods.

Table S1: Misclassification rate (%) of different methods evaluated using GigaDB dataset. The values after the  $\pm$  sign are used to indicate the 95% confidence limits.

Subject	CSP	SBLFB	TFPO-CSP	I-DFBCSP	OPTICAL	OPTICAL+
1	<b>19.00 <math>\pm</math> 2.56</b>	37.20 $\pm$ 2.94	22.00 $\pm$ 2.86	24.33 $\pm$ 2.73	20.00 $\pm$ 2.79	20.83 $\pm$ 2.35
2	48.20 $\pm$ 3.21	<b>44.10 <math>\pm</math> 3.77</b>	48.50 $\pm$ 3.65	50.00 $\pm$ 3.61	47.67 $\pm$ 3.69	48.50 $\pm$ 2.77
3	8.70 $\pm$ 1.85	8.40 $\pm$ 2.16	6.17 $\pm$ 1.71	7.00 $\pm$ 1.78	6.00 $\pm$ 1.72	<b>4.67 <math>\pm</math> 1.29</b>
4	26.50 $\pm$ 2.84	19.40 $\pm$ 2.64	19.33 $\pm$ 2.59	<b>10.17 <math>\pm</math> 2.36</b>	22.00 $\pm$ 3.00	19.50 $\pm$ 2.80
5	<b>0.95 <math>\pm</math> 0.49</b>	1.00 $\pm$ 0.60	1.17 $\pm$ 0.57	1.00 $\pm$ 0.61	1.00 $\pm$ 0.61	1.00 $\pm$ 0.61
6	19.50 $\pm$ 2.63	17.50 $\pm$ 2.43	18.33 $\pm$ 2.41	22.67 $\pm$ 2.56	17.67 $\pm$ 2.31	<b>14.17 <math>\pm</math> 2.77</b>
7	48.42 $\pm$ 2.56	45.17 $\pm$ 2.67	49.58 $\pm$ 2.82	<b>44.44 <math>\pm</math> 2.55</b>	47.22 $\pm$ 2.36	47.78 $\pm$ 3.21
8	47.40 $\pm$ 3.09	53.90 $\pm$ 3.57	47.50 $\pm$ 3.00	58.17 $\pm$ 3.22	<b>44.33 <math>\pm</math> 3.47</b>	46.75 $\pm$ 3.18
9	44.00 $\pm$ 2.88	44.33 $\pm$ 2.96	48.19 $\pm$ 2.46	52.64 $\pm$ 2.10	43.60 $\pm$ 3.00	<b>39.58 <math>\pm</math> 2.08</b>
10	31.10 $\pm$ 3.38	36.40 $\pm$ 3.00	23.83 $\pm$ 3.37	<b>20.17 <math>\pm</math> 2.09</b>	27.00 $\pm$ 3.07	23.17 $\pm$ 2.70
11	50.00 $\pm$ 3.30	49.80 $\pm$ 3.03	49.17 $\pm$ 3.67	47.17 $\pm$ 3.34	42.67 $\pm$ 2.95	<b>41.50 <math>\pm</math> 2.48</b>
12	33.50 $\pm$ 2.91	37.40 $\pm$ 3.06	34.17 $\pm$ 2.47	40.50 $\pm$ 2.96	32.83 $\pm$ 2.67	<b>32.67 <math>\pm</math> 3.54</b>
13	19.40 $\pm$ 2.24	<b>11.50 <math>\pm</math> 2.39</b>	11.17 $\pm$ 3.20	13.50 $\pm$ 2.22	15.50 $\pm$ 2.46	17.33 $\pm$ 2.13

14	4.60 ± 1.41	5.20 ± 1.59	4.33 ± 1.54	3.53 ± 1.18	3.50 ± 1.05	<b>3.17 ± 1.07</b>
15	41.30 ± 4.55	33.20 ± 3.51	42.17 ± 2.83	43.33 ± 4.04	35.33 ± 3.36	<b>27.17 ± 3.85</b>
16	55.00 ± 2.74	51.60 ± 2.99	53.33 ± 3.50	53.00 ± 3.91	52.50 ± 3.24	<b>46.83 ± 3.51</b>
17	49.20 ± 3.37	47.20 ± 3.22	49.00 ± 3.30	44.33 ± 3.73	50.33 ± 2.82	<b>42.83 ± 3.62</b>
18	49.40 ± 2.85	<b>41.10 ± 3.37</b>	50.17 ± 3.39	52.83 ± 3.07	46.67 ± 2.49	48.17 ± 2.78
19	45.00 ± 3.17	<b>35.40 ± 3.17</b>	45.00 ± 3.68	45.50 ± 3.78	42.83 ± 2.73	39.83 ± 3.07
20	28.90 ± 3.19	48.70 ± 3.20	32.17 ± 2.91	45.50 ± 3.82	<b>27.17 ± 3.02</b>	31.67 ± 3.24
21	41.10 ± 3.37	35.20 ± 3.23	41.00 ± 2.88	<b>26.17 ± 2.34</b>	34.00 ± 3.38	26.67 ± 3.51
22	46.80 ± 3.55	43.40 ± 3.49	41.17 ± 3.75	42.83 ± 3.27	41.33 ± 3.00	<b>39.50 ± 2.72</b>
23	21.70 ± 2.91	25.40 ± 2.10	15.83 ± 2.58	<b>10.50 ± 2.46</b>	15.83 ± 2.48	14.17 ± 1.84
24	45.50 ± 2.83	49.40 ± 2.74	43.67 ± 3.77	57.50 ± 3.17	39.33 ± 3.05	<b>33.33 ± 2.33</b>
25	50.50 ± 3.97	46.90 ± 3.42	48.50 ± 2.62	45.67 ± 2.92	47.00 ± 4.23	<b>43.50 ± 2.98</b>
26	4.40 ± 1.30	3.30 ± 1.11	4.33 ± 1.05	4.17 ± 1.36	<b>3.17 ± 1.00</b>	3.83 ± 1.28
27	57.10 ± 3.12	51.00 ± 3.13	<b>42.33 ± 3.10</b>	47.67 ± 2.90	55.33 ± 2.98	49.17 ± 2.69
28	20.80 ± 2.58	21.00 ± 2.41	20.33 ± 2.21	20.00 ± 3.03	19.17 ± 1.47	<b>18.67 ± 2.47</b>
29	56.20 ± 3.24	57.70 ± 3.12	52.83 ± 3.23	<b>50.67 ± 2.81</b>	57.00 ± 3.24	54.17 ± 3.06
30	42.80 ± 3.16	40.70 ± 3.56	<b>38.50 ± 3.16</b>	42.17 ± 3.47	44.50 ± 3.11	42.17 ± 4.12
31	42.60 ± 4.13	38.20 ± 3.67	42.50 ± 3.69	37.33 ± 3.27	37.67 ± 3.27	<b>32.17 ± 2.70</b>
32	50.10 ± 3.69	51.60 ± 3.66	50.50 ± 3.46	56.50 ± 3.35	49.43 ± 3.58	<b>49.00 ± 3.53</b>
33	48.00 ± 3.10	46.20 ± 3.03	51.33 ± 3.37	50.67 ± 2.73	<b>44.33 ± 3.64</b>	47.17 ± 3.47
34	44.50 ± 3.41	45.60 ± 2.99	44.67 ± 2.78	46.67 ± 3.16	<b>42.00 ± 2.23</b>	43.50 ± 3.57
35	20.20 ± 2.21	27.70 ± 3.47	21.33 ± 2.36	20.00 ± 2.11	<b>18.17 ± 2.78</b>	20.33 ± 2.47
36	34.10 ± 3.51	44.90 ± 3.53	36.00 ± 4.10	45.33 ± 4.37	<b>30.50 ± 3.04</b>	32.00 ± 2.58
37	22.50 ± 2.78	26.00 ± 2.62	<b>23.00 ± 3.24</b>	26.50 ± 2.42	23.02 ± 2.20	24.50 ± 3.35
38	52.30 ± 3.31	51.70 ± 2.79	46.67 ± 3.76	<b>46.00 ± 2.78</b>	51.50 ± 3.61	50.50 ± 2.83
39	29.40 ± 2.60	29.80 ± 3.52	33.67 ± 3.00	38.17 ± 3.17	27.00 ± 2.76	<b>26.83 ± 2.26</b>
40	49.70 ± 3.18	53.10 ± 3.05	<b>48.67 ± 3.55</b>	55.67 ± 2.56	48.83 ± 2.73	52.00 ± 3.56
41	16.40 ± 2.56	19.60 ± 3.10	16.00 ± 2.51	9.17 ± 1.80	14.67 ± 2.62	<b>13.33 ± 2.29</b>
42	53.90 ± 2.95	51.00 ± 3.27	53.00 ± 2.58	52.00 ± 3.31	51.67 ± 3.01	<b>51.17 ± 3.12</b>
43	5.90 ± 1.67	3.60 ± 1.35	3.83 ± 1.54	4.50 ± 1.32	4.17 ± 1.24	<b>2.50 ± 1.16</b>
44	11.10 ± 1.93	10.70 ± 1.93	<b>8.67 ± 1.92</b>	9.00 ± 1.97	10.83 ± 2.25	9.33 ± 1.91
45	46.40 ± 2.73	49.40 ± 3.76	<b>44.50 ± 2.01</b>	50.17 ± 3.07	47.50 ± 3.27	47.67 ± 3.29
46	25.25 ± 2.71	24.92 ± 2.73	24.44 ± 2.39	24.86 ± 2.98	25.42 ± 2.60	<b>21.25 ± 2.91</b>

47	24.60 ± 2.68	29.10 ± 2.62	30.33 ± 3.24	26.83 ± 2.46	25.83 ± 2.93	<b>21.67 ± 2.94</b>
48	36.70 ± 3.32	19.00 ± 2.52	26.67 ± 2.16	<b>11.82 ± 1.94</b>	21.83 ± 2.89	11.83 ± 2.36
49	14.20 ± 1.98	10.40 ± 1.47	12.17 ± 2.34	<b>8.67 ± 2.35</b>	12.50 ± 1.99	15.50 ± 2.69
50	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
51	47.30 ± 2.89	47.10 ± 2.89	47.17 ± 3.30	<b>46.33 ± 3.69</b>	46.83 ± 3.19	50.33 ± 3.71
52	39.70 ± 3.41	39.50 ± 2.92	<b>34.83 ± 3.05</b>	38.67 ± 2.95	38.17 ± 3.90	36.50 ± 3.70
Average	34.07 ± 2.80	33.88 ± 2.80	32.76 ± 2.78	33.31 ± 2.71	31.81 ± 2.78	<b>30.41 ± 2.70</b>