

# Self-Supervised Learning for Time Series Classification via Redundancy Reduction and Wavelet-based Data Augmentation

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## Ablation Study

All ablation experiments follow the same setup in Section 4.2 in the main paper. We report the average classification accuracy over five runs for each dataset, as well as the average accuracy computed across all nine datasets.

**Wavelet family** Table 1 shows the effect of different wavelet families in our data augmentation. By default, the wavelet family is randomly selected from Haar or db2 for each training iteration. Therefore, when generating two augmented views of the input, the wavelets used for the two views may be the same or different.

Table 1: Impact of different wavelet families on classification performance.

Datasets	Haar	db2	Default
WISDM2	64.02	66.01	<b>66.66</b>
PAMAP2	70.57	70.36	<b>70.62</b>
USC-HAD	60.10	60.31	<b>63.68</b>
Sleep	<b>83.81</b>	83.62	83.75
Skoda	<b>98.65</b>	97.94	98.46
Opportunity	86.46	86.74	<b>86.83</b>
WISDM	84.60	84.55	<b>84.79</b>
Epilepsy	97.82	97.65	<b>97.88</b>
UCI-HAR	<b>93.36</b>	92.96	93.15
Avg	82.15	82.24	<b>82.87</b>

**Components in data augmentation** We divide our data augmentation method into three components for the ablation study: (1) wavelet-based augmentation, (2) cropping the augmented samples, and (3) cropping the representation matrix (output of the encoder, before max pooling). To assess the contribution of

each component, we conduct a series of experiments by selectively enabling or disabling them and evaluating the impact on classification performance. Note that cropping the representation matrix is applicable only when input cropping is used, since the time indices from the cropped input are required to align the features. The effect of each component on the downstream classification accuracy is shown in Table 2.

Table 2: Classification performance of our model under different combinations of the components of our augmentation methods.

Datasets	Crop(input)	Crop(input+repr)	Wavelet	Wavelet+Crop(input)	All
WISDM2	63.34	59.03	64.60	63.87	<b>66.66</b>
PAMAP2	<b>74.15</b>	70.22	71.20	71.68	70.62
USC-HAD	45.67	40.17	55.29	51.67	<b>63.68</b>
Sleep	84.49	80.48	83.04	<b>85.03</b>	83.75
Skoda	98.74	<b>98.95</b>	97.19	98.22	98.46
Opportunity	86.12	86.23	86.44	85.73	<b>86.83</b>
WISDM	83.34	80.35	82.97	84.52	<b>84.79</b>
Epilepsy	97.57	97.59	97.71	<b>97.90</b>	97.88
UCI-HAR	<b>93.74</b>	93.49	91.46	93.16	93.15
Average	80.80	78.50	81.10	81.31	<b>82.87</b>

**$\lambda$  parameter** The sensitivity of  $\lambda$  is shownd in Table 3. For the WISDM2 and USC-HAD datasets, performance drops when  $\lambda \geq 0.01$ . However, for the remaining dataset, the choice of  $\lambda$  has little effect on performance.

**Size of the projection head** The results from Barlow Twins [1] show that the classification performance increases when the output size of the projection is very large. However, our experimental result (see Table 4) shows that, with the exception of the USC-HAD dataset, the size of the projection head does not have much impact on the classification accuracy.

## References

- Zbontar, J., Jing, L., Misra, I., LeCun, Y., Deny, S.: Barlow twins: Self-supervised learning via redundancy reduction. In: ICML. pp. 12310–12320. PMLR (2021)

Table 3: Sensitivity of  $\lambda$  parameters on classification accuracy.

Datasets	0.002	0.005	0.007	0.01	0.015	0.02	0.001 (default)
WISDM2	65.10	63.24	63.75	63.48	60.36	62.26	<b>66.66</b>
PAMAP2	70.34	70.20	69.88	70.03	69.63	69.45	<b>70.62</b>
USC-HAD	61.14	58.67	58.57	58.59	58.34	57.42	<b>63.68</b>
Sleep	83.82	83.80	<b>83.83</b>	83.69	83.68	83.22	83.75
Skoda	98.43	98.48	98.53	98.49	98.72	<b>98.76</b>	98.46
Opportunity	86.44	86.57	86.31	86.12	85.84	85.76	<b>86.83</b>
WISDM	83.99	84.18	84.50	84.58	84.48	84.73	<b>84.79</b>
Epilepsy	97.69	97.69	97.70	<b>97.94</b>	97.77	97.74	97.88
UCI-HAR	<b>93.84</b>	93.80	93.80	93.78	93.84	93.65	93.15
Average	82.31	81.85	81.87	81.86	81.41	81.44	<b>82.87</b>

Table 4: Effect of the projection head output size.

Datasets	512	2048	1024 (default)
WISDM2	64.99	65.91	<b>66.66</b>
PAMAP2	69.98	70.58	<b>70.62</b>
USC-HAD	56.87	60.51	<b>63.68</b>
Sleep	83.03	<b>83.85</b>	83.75
Skoda	98.26	<b>98.56</b>	98.46
Opportunity	86.52	86.50	<b>86.83</b>
WISDM	84.71	83.90	<b>84.79</b>
Epilepsy	97.63	97.74	<b>97.88</b>
UCI-HAR	93.03	<b>93.78</b>	93.15
Avg	81.67	82.37	<b>82.87</b>