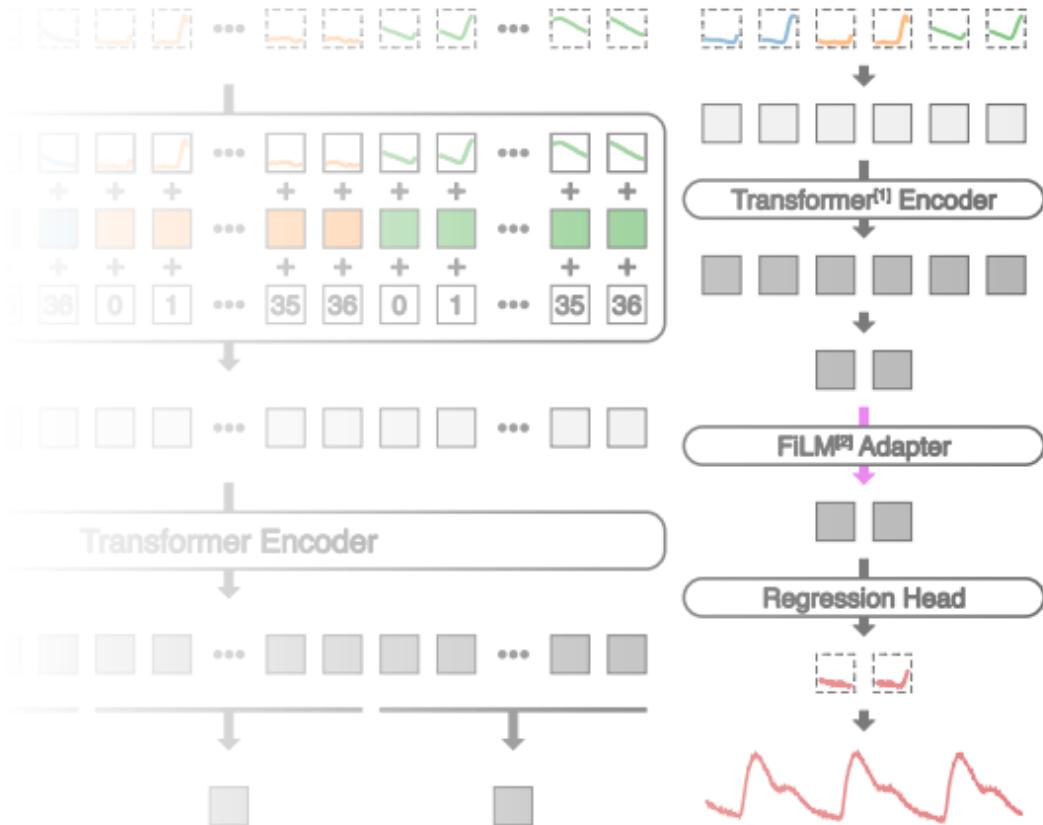


dimension	channel
100	ch1: Finger 808nm BFI
256	ch2: Finger 808nm PPG ch3: Wrist 808nm BFI

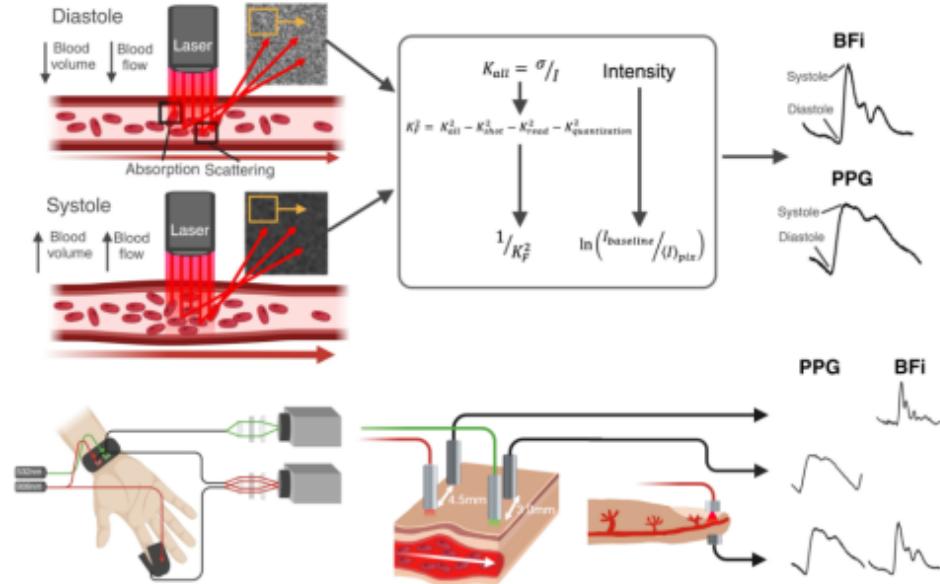
Transformer-Based Cuffless Blood Pressure Estimation

Driven by Speckle Contrast
Optical Spectroscopy (SCOS)

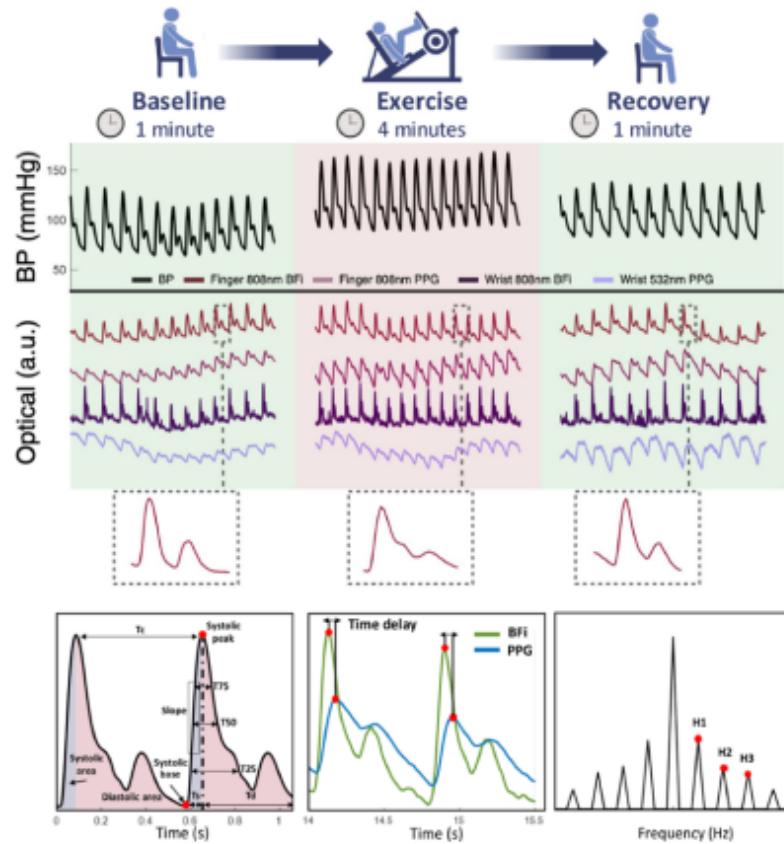
Tianrui Qi
Dec 12, 2025



Background



Garrett, A. et al. Biomed. Opt. Express 16, 3004–3016 (2025).



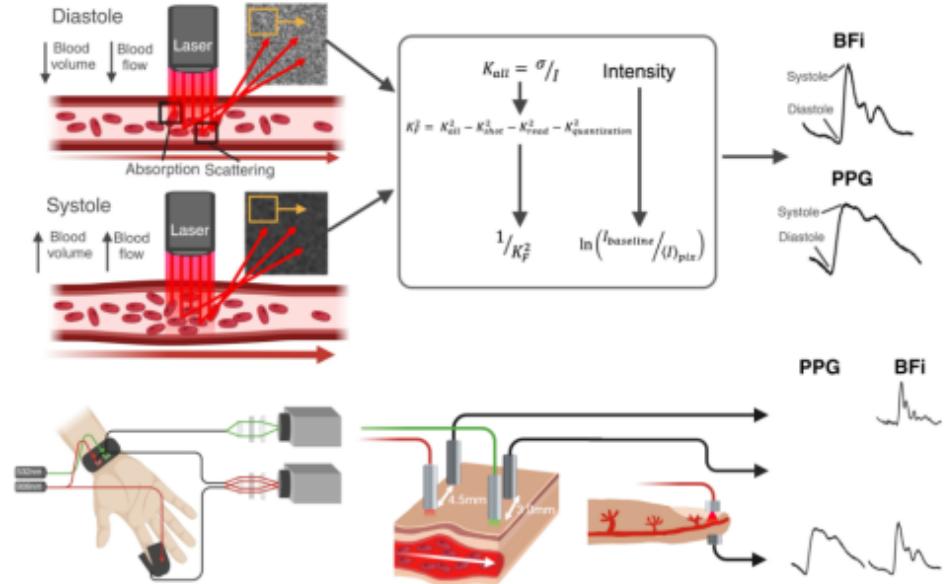
Garrett, A. et al. Biomed. Opt. Express 16, 3004–3016 (2025).



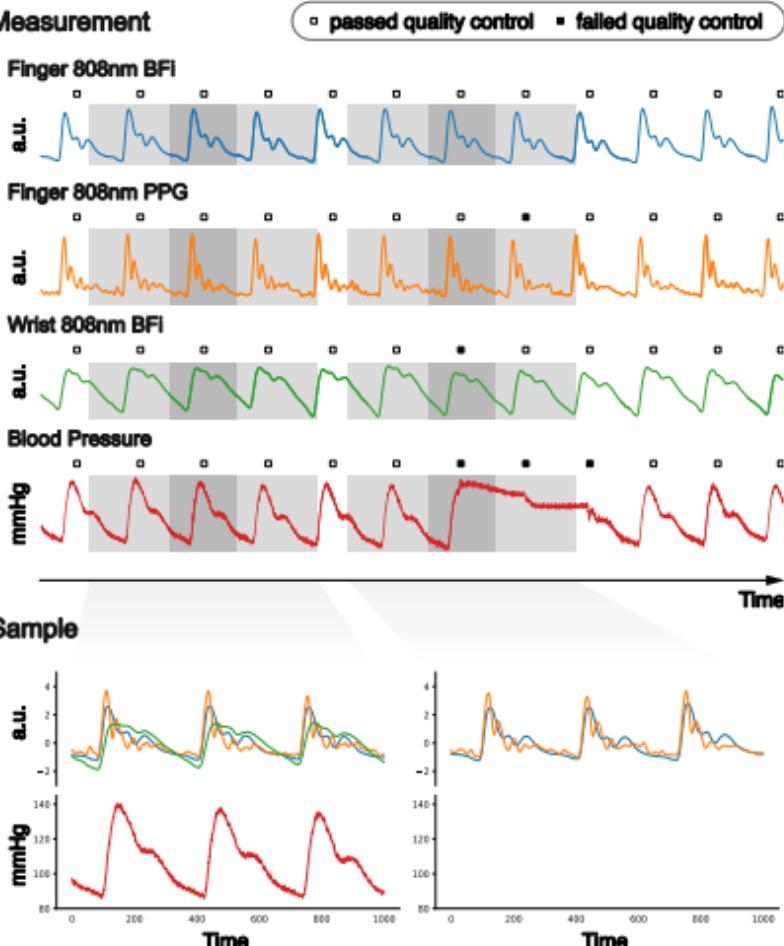
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Data: Preparation



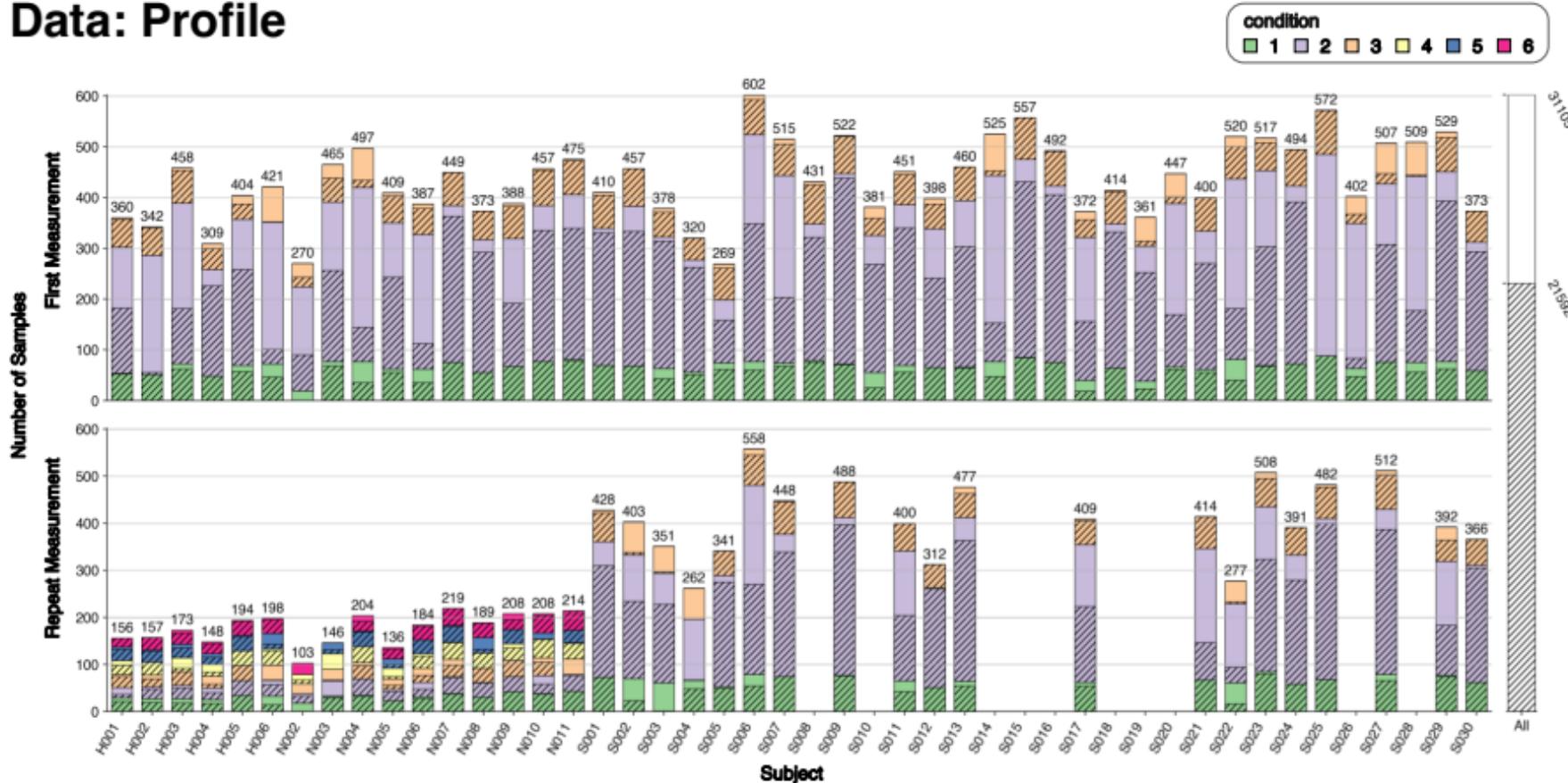
Measurement



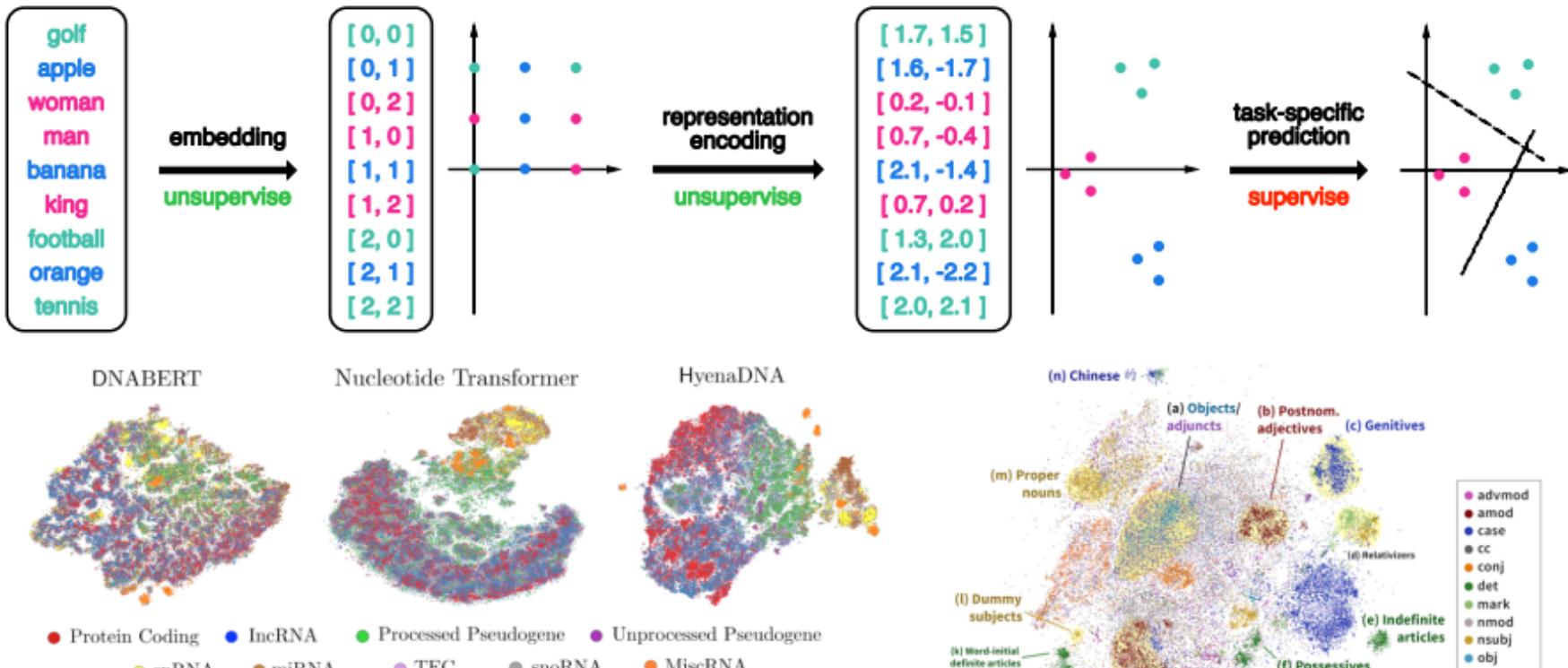
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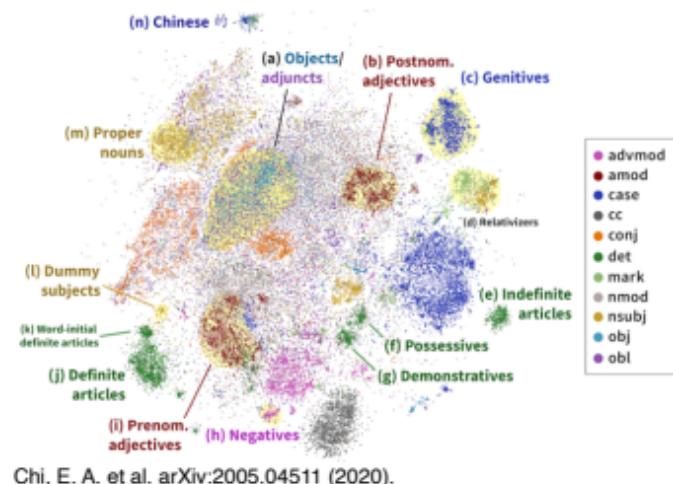
Data: Profile



Model: Representation Learning



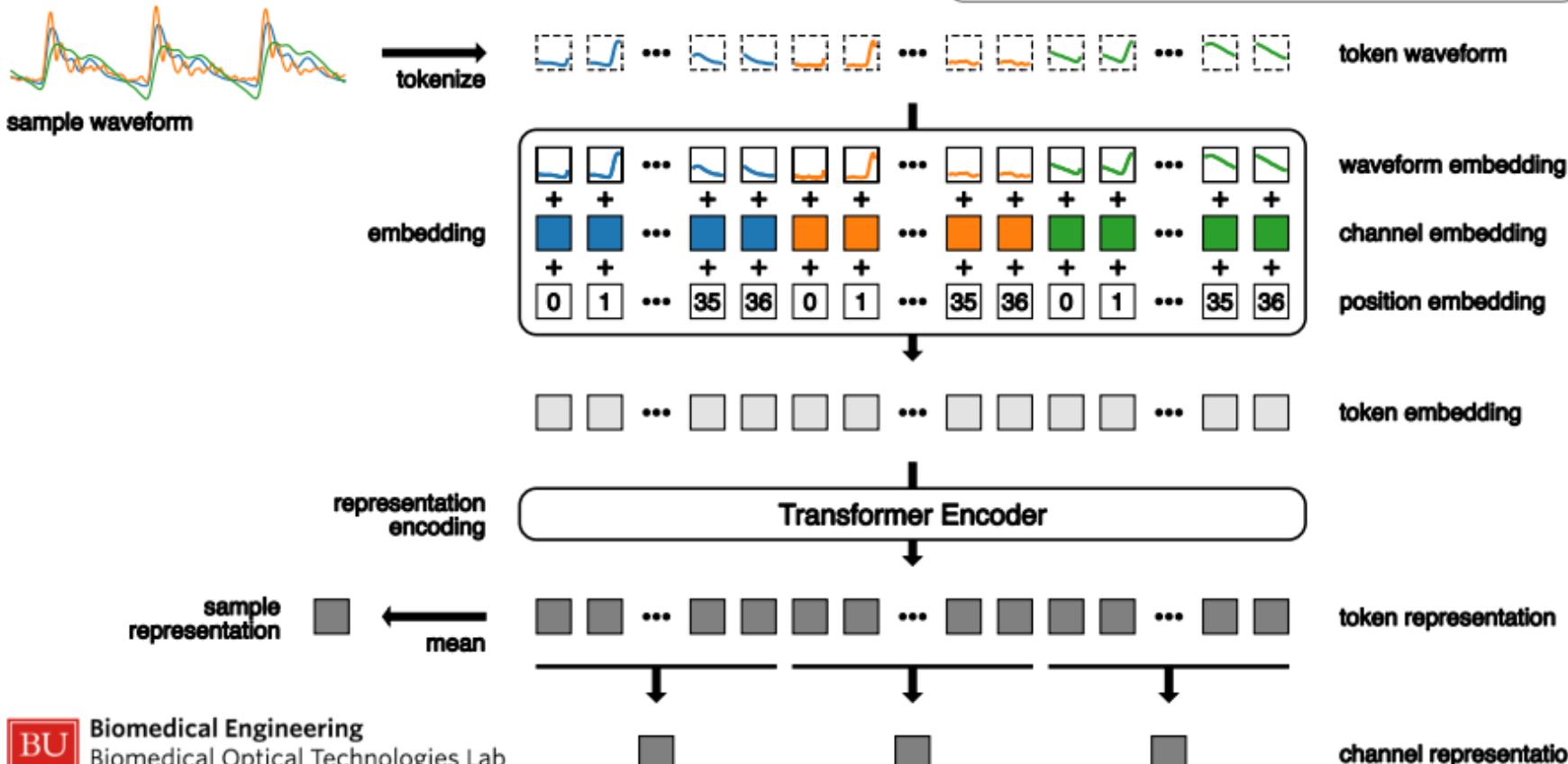
Nguyen, E. et al. arXiv:2306.15794 (2023).



Model: Backbone Architecture

Yang, C. et al. BIOT: Cross-data biosignal learning in the wild. arXiv:2305.10351 (2023).

dimension	channel
100	ch1: Finger 808nm BFI
256	ch2: Finger 808nm PPG
	ch3: Wrist 808nm BFI



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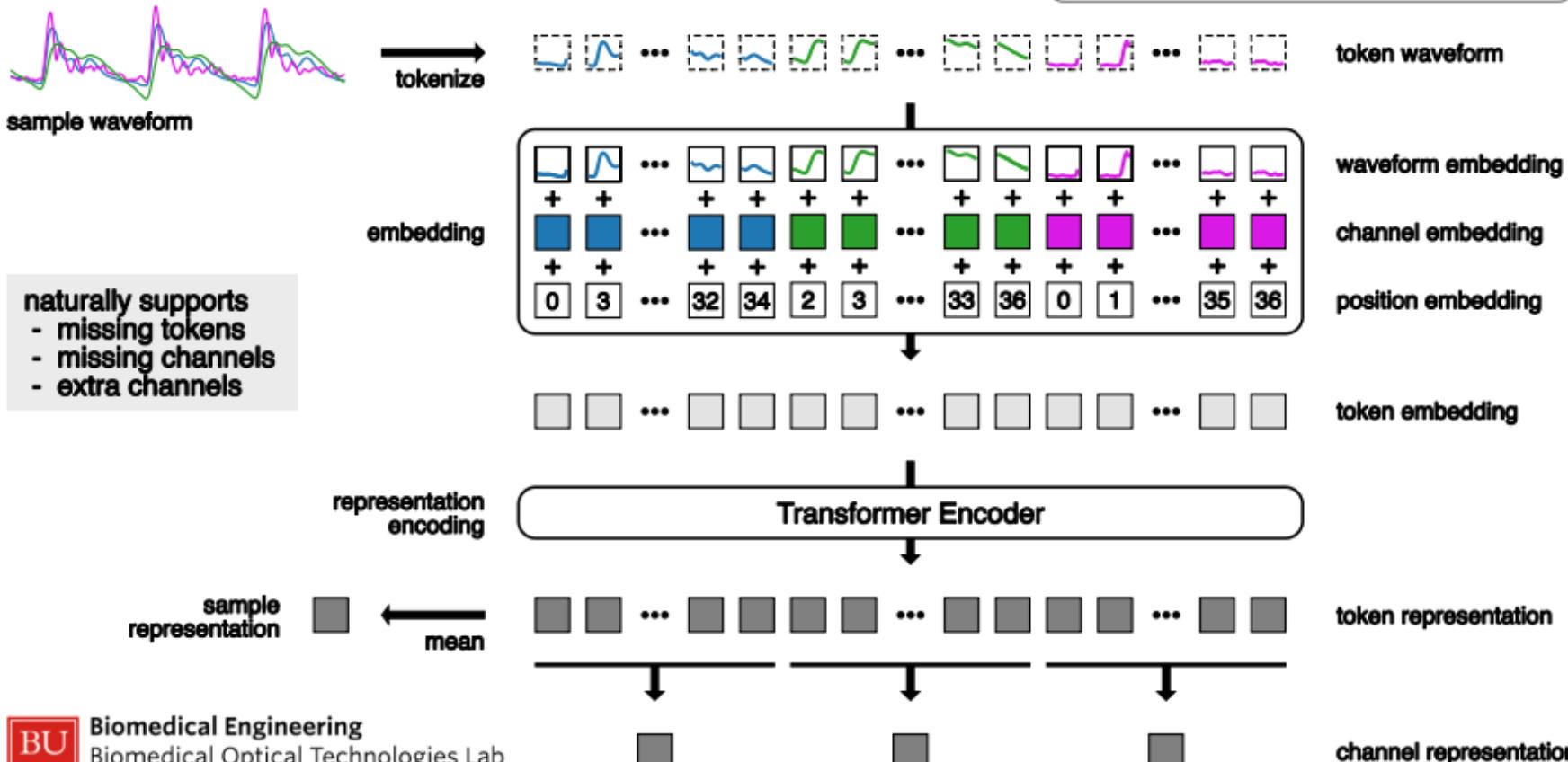
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channel representation

Model: Input Flexibility

Yang, C. et al. BIOT: Cross-data biosignal learning in the wild. arXiv:2305.10351 (2023).

dimension	channel
100	ch1: Finger 808nm BFI
256	ch2: missing ch3: Wrist 808nm BFI ch4: extra



Model: Stage 1

[1] Vaswani, A. et al. Attention Is All You Need. arXiv:1706.03762 (2017).

↑ trainable → fixed

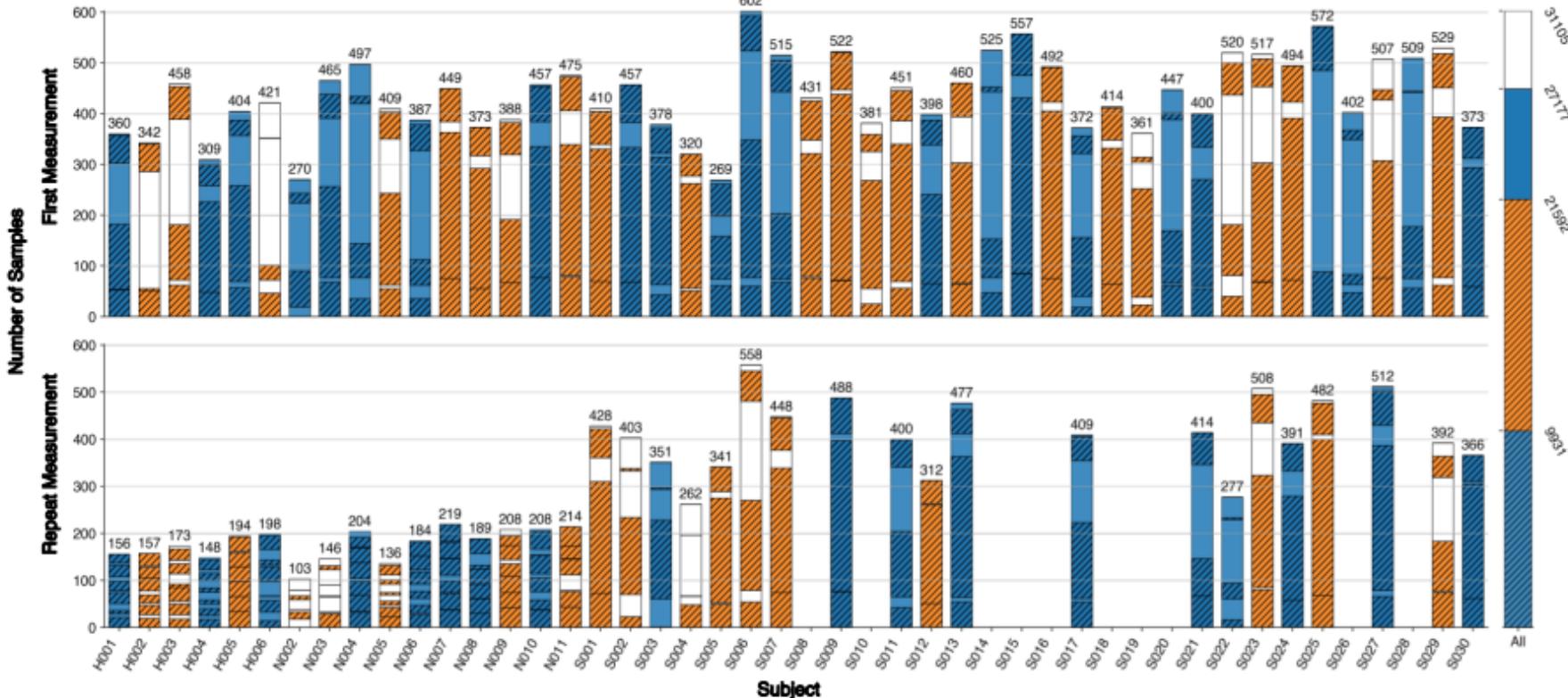


Data: Stage 1 Split

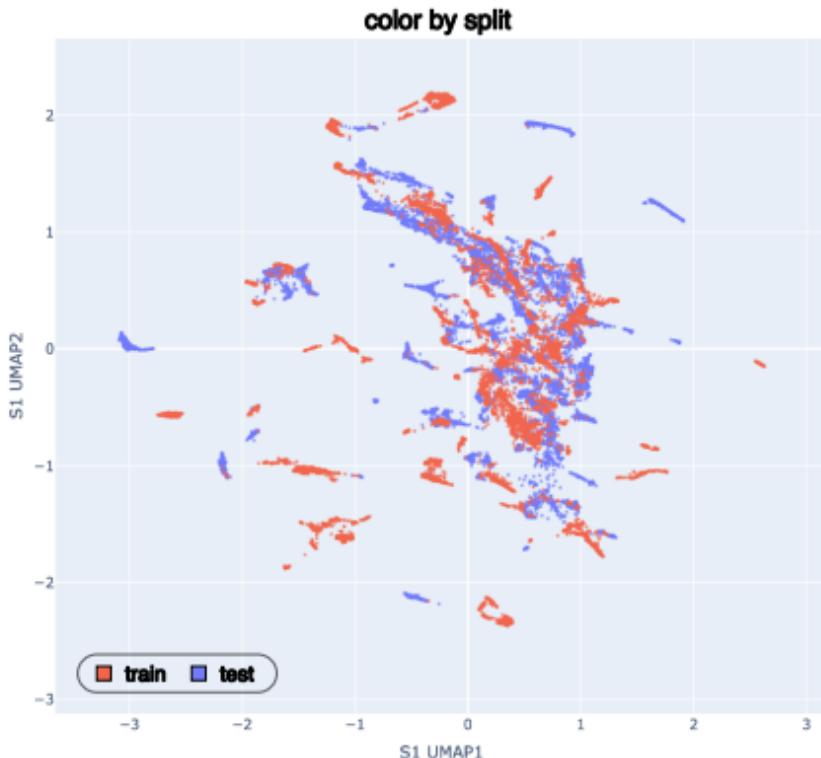
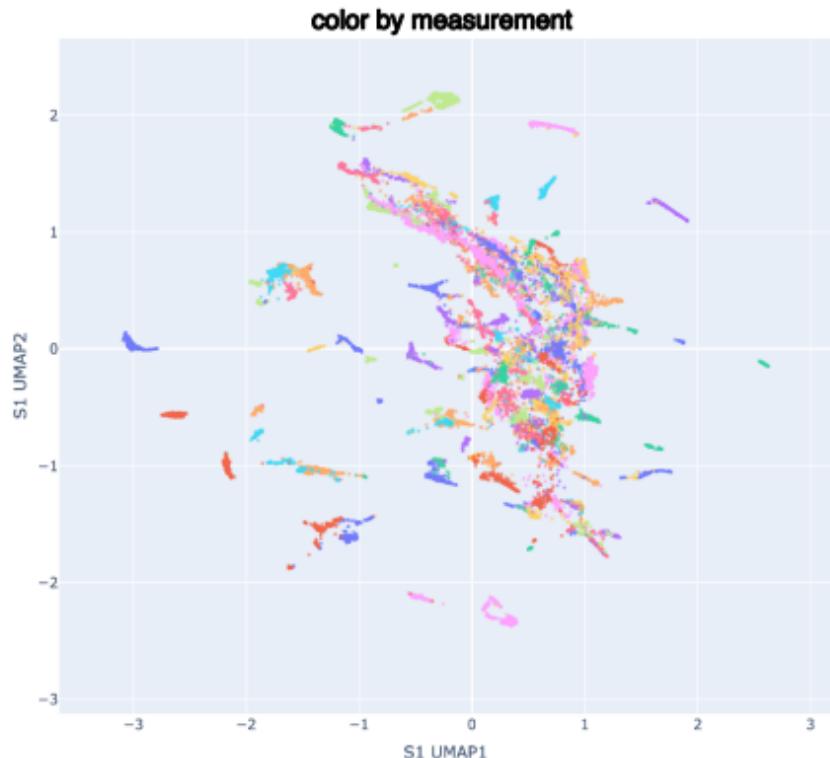
In implementation, we use (at least one optical ch passed QC), which adds ~1k more training samples.
For simplicity, the figure below displays (BP & at least one optical ch passed QC).

Wang, Y. et al. How to evaluate your medical time series classification? arXiv 2410.03057 (2024).

split
train test



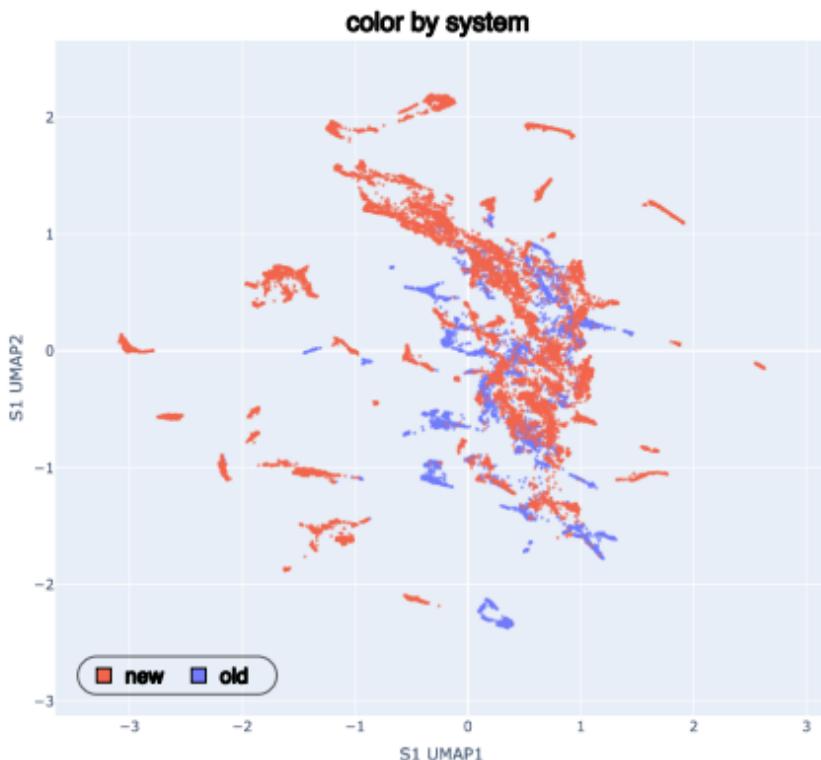
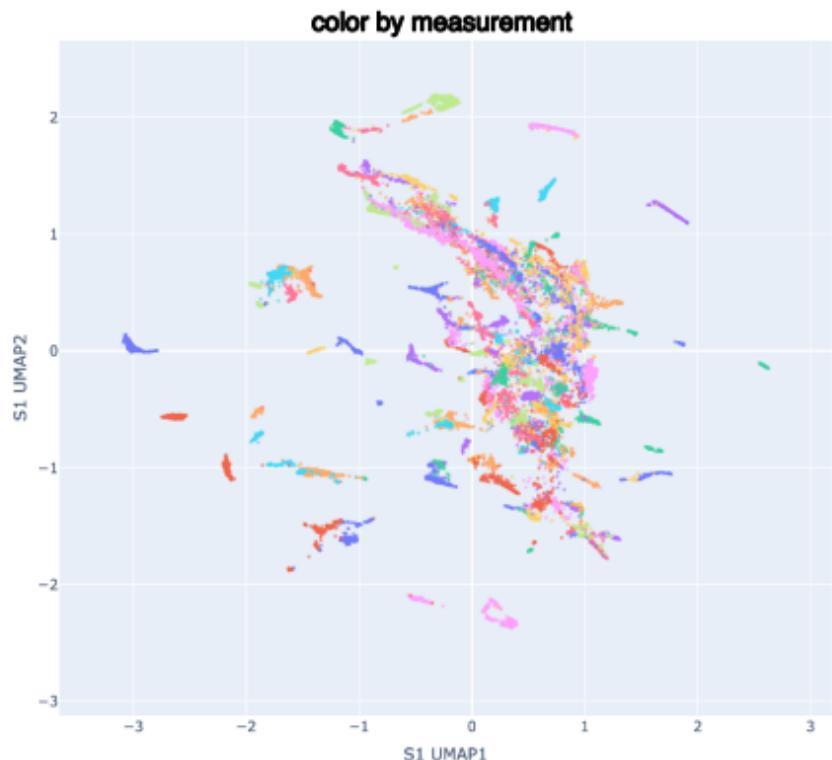
Result: Stage 1 Representation generalizes well across train and test splits



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Result: Stage 1 No clear separation between samples from old and new system

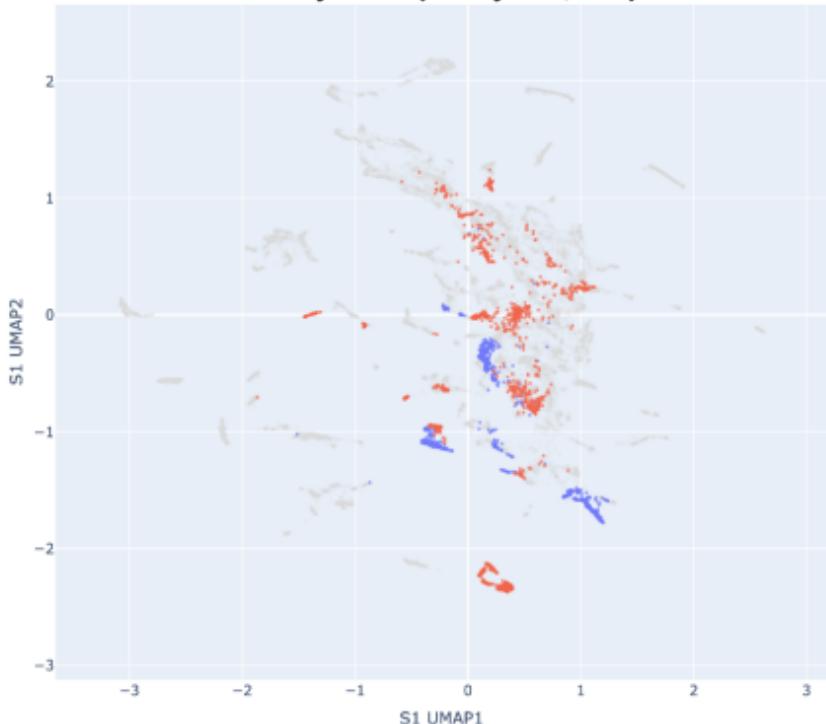


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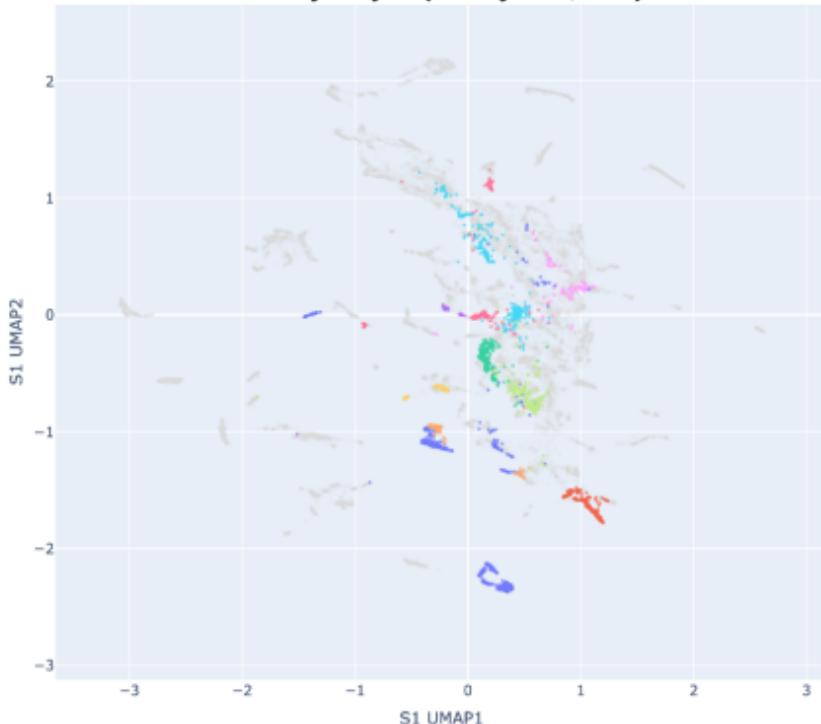
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Result: Stage 1 With current number of subjects, health-related clustering is inconclusive

color by health (new system, train)



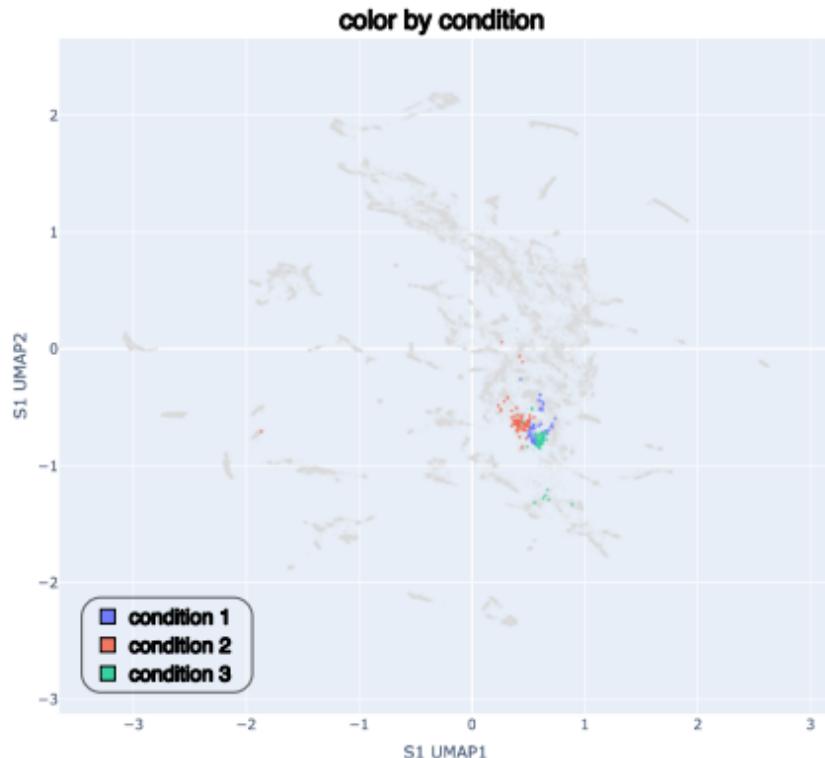
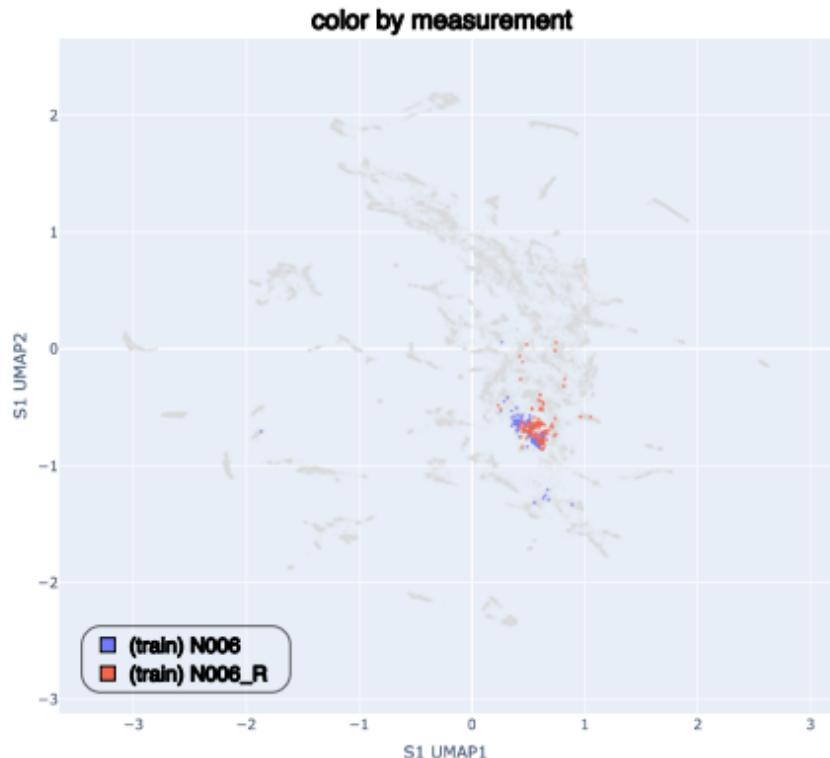
color by subject (new system, train)



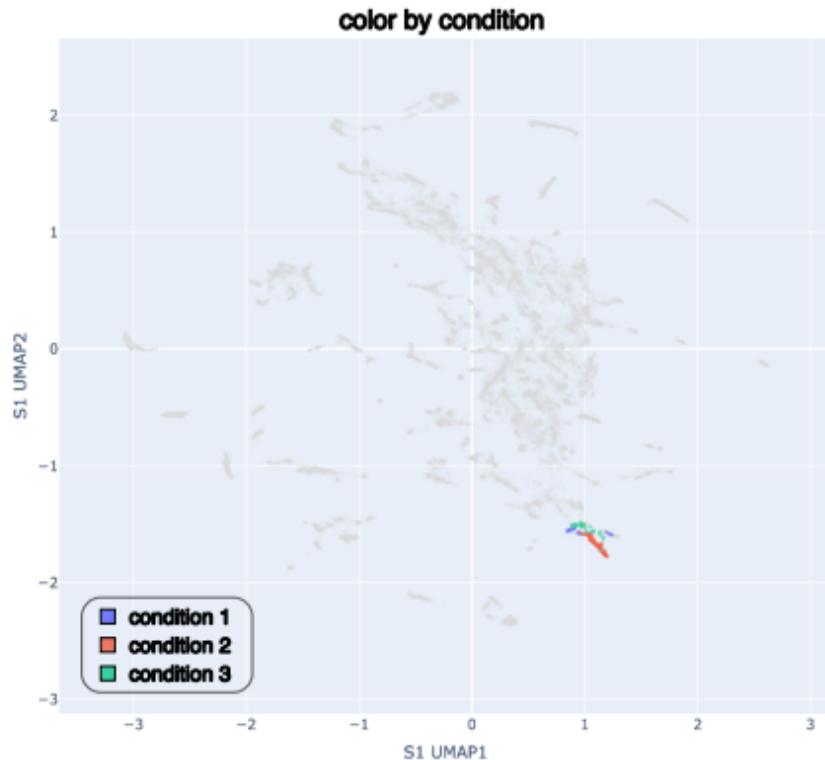
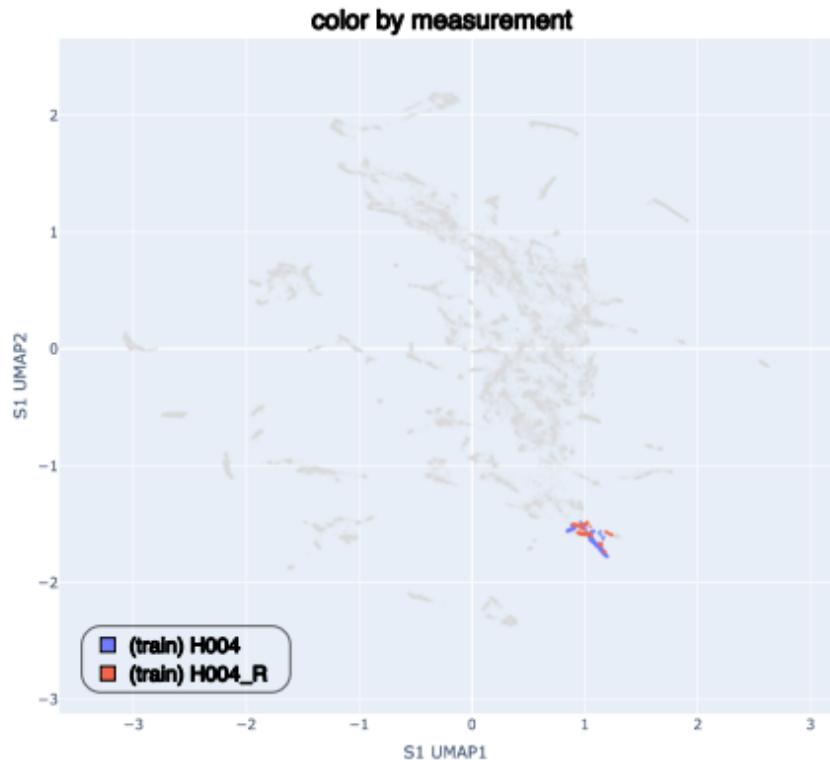
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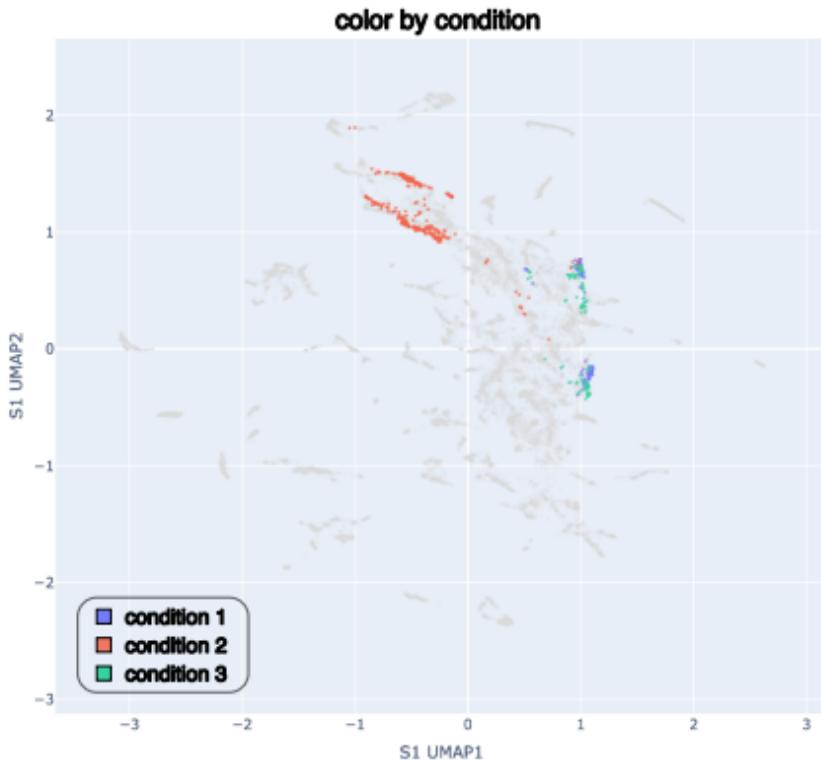
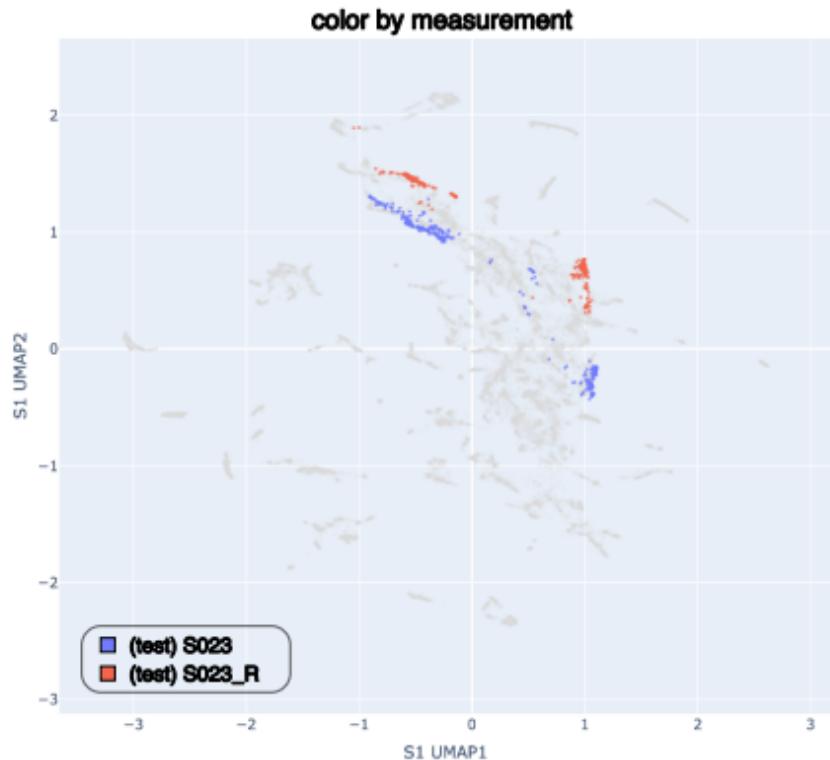
Result: Stage 1 Samples from same subject and condition cluster together



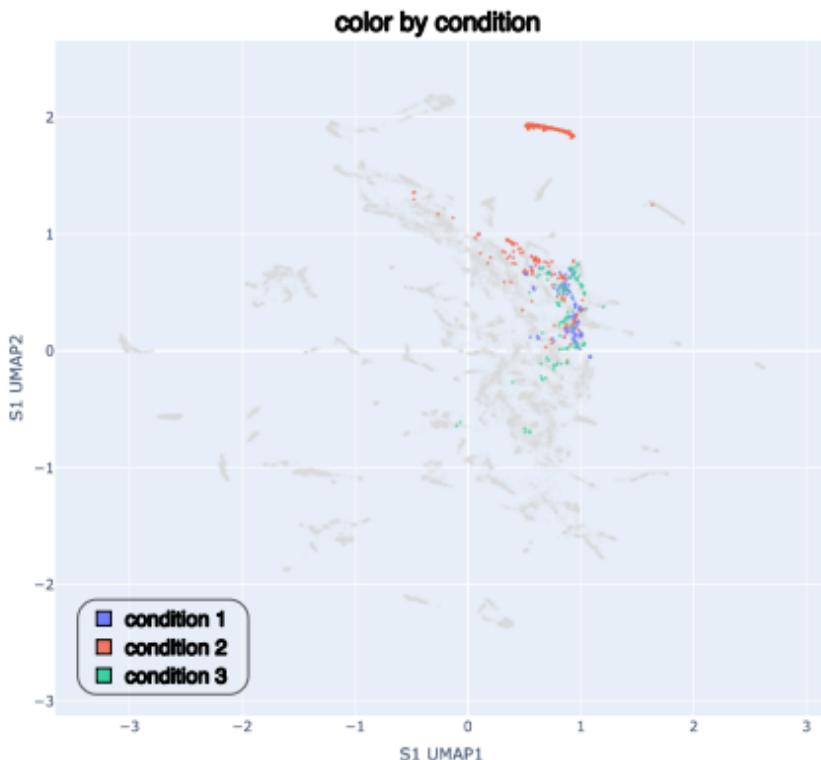
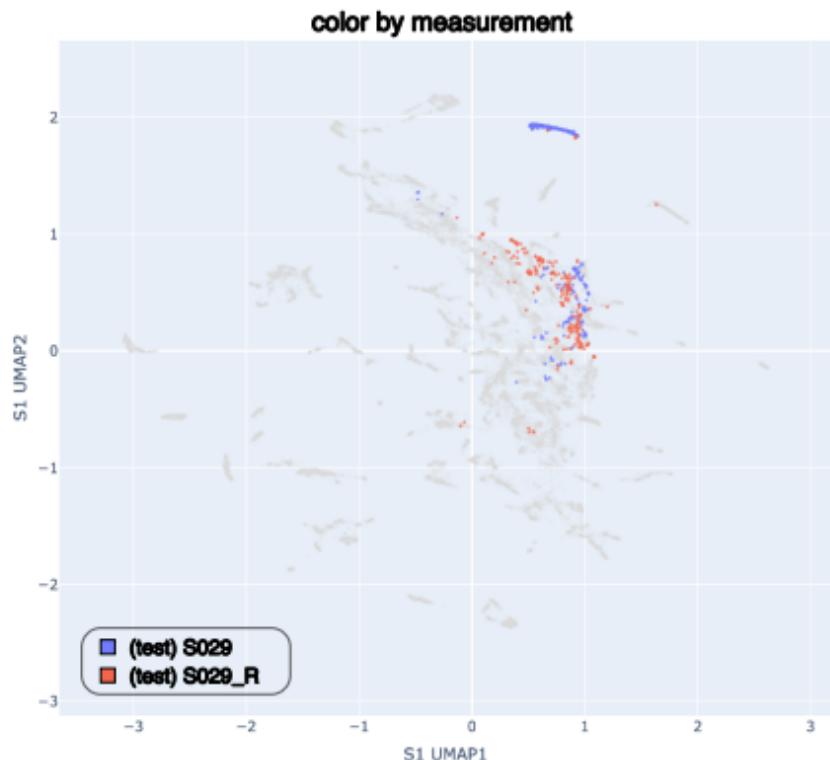
Result: Stage 1 Samples from same subject and condition cluster together



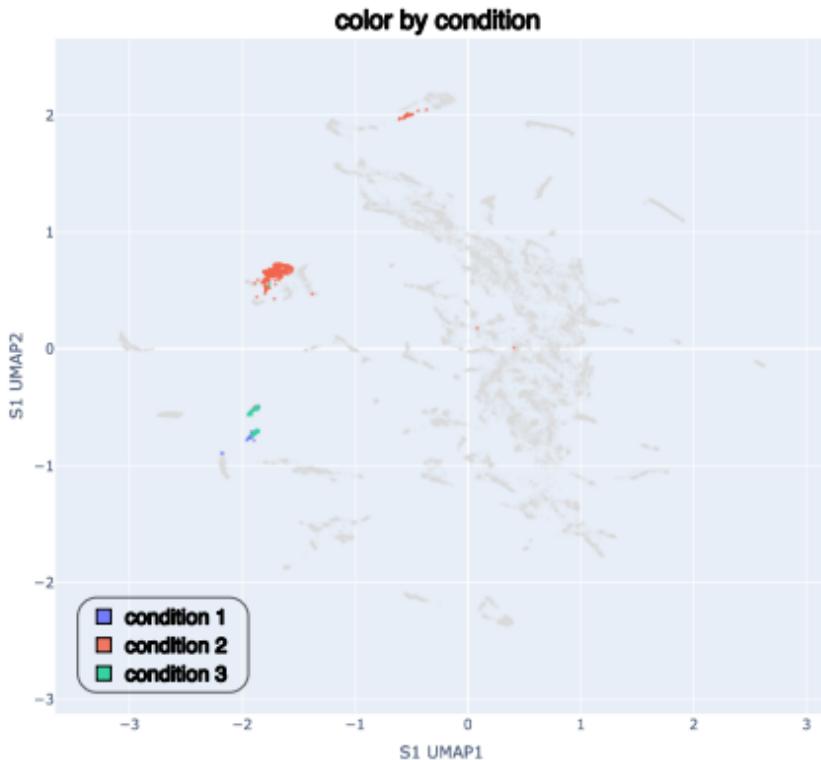
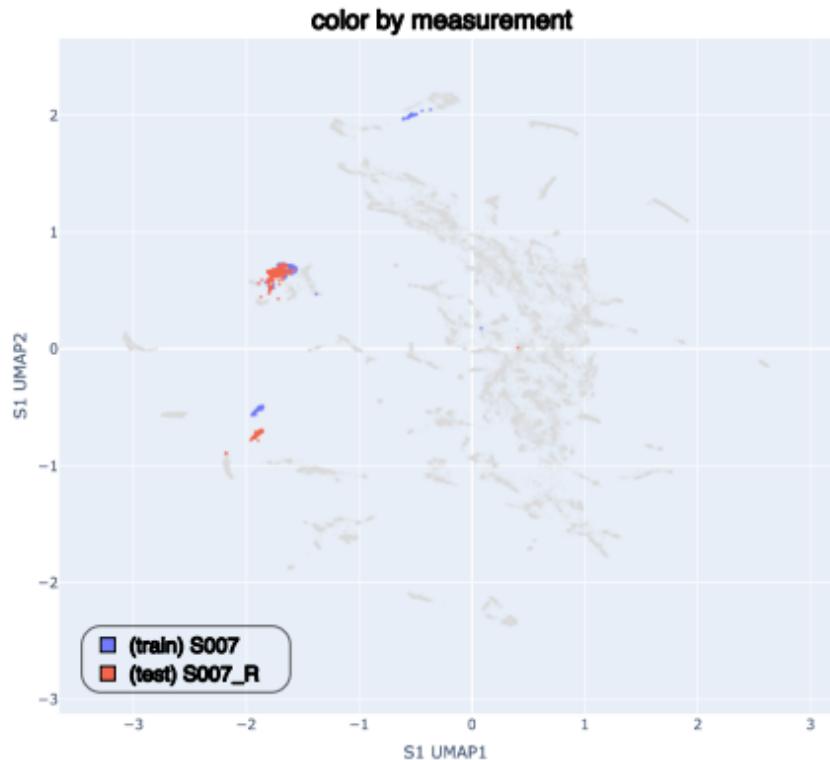
Result: Stage 1 Samples from same subject and condition cluster together



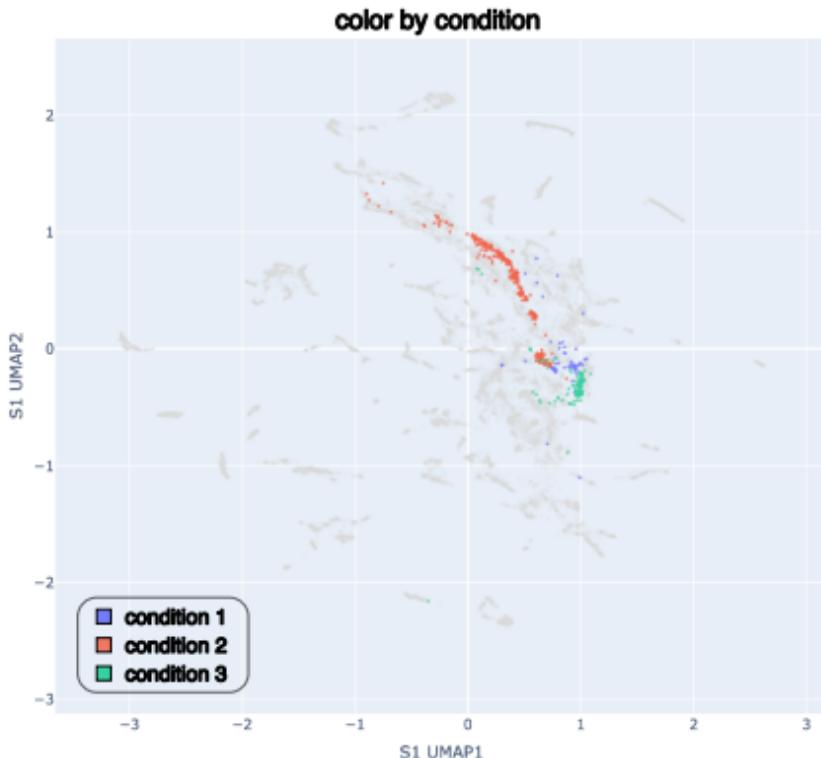
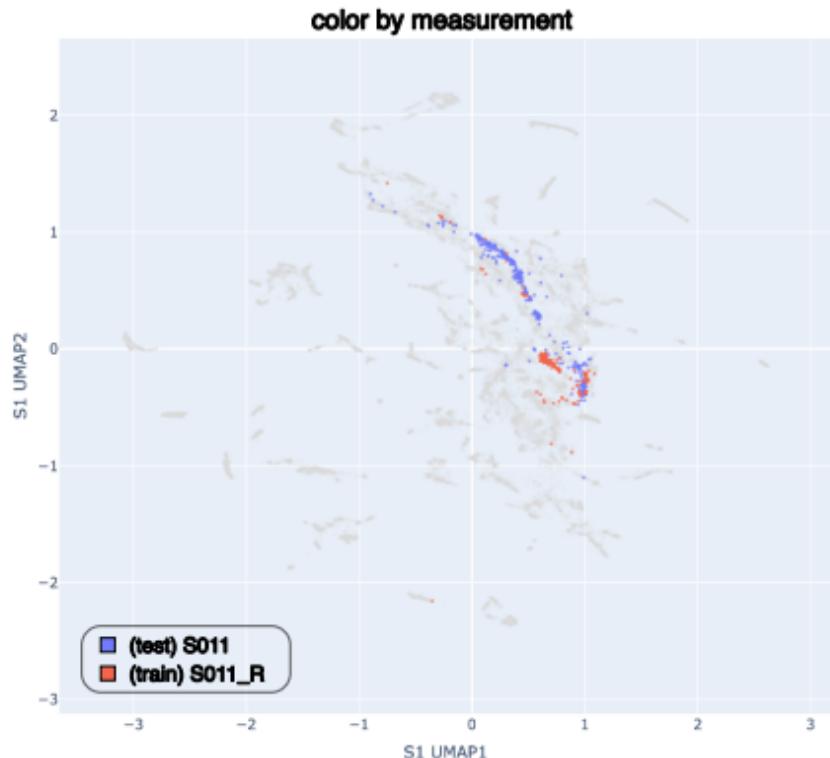
Result: Stage 1 Samples from same subject and condition cluster together



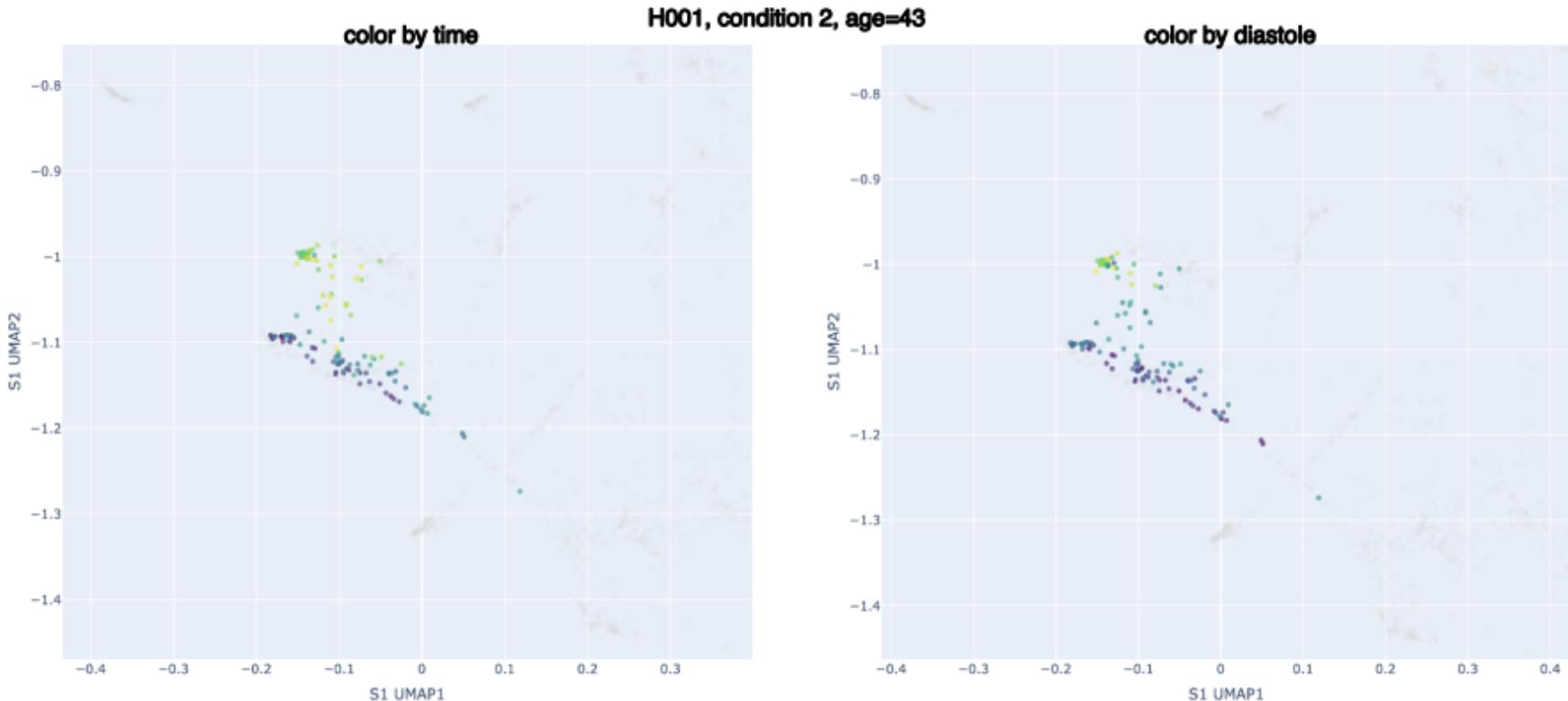
Result: Stage 1 Samples from same subject and condition cluster together



Result: Stage 1 Samples from same subject and condition cluster together



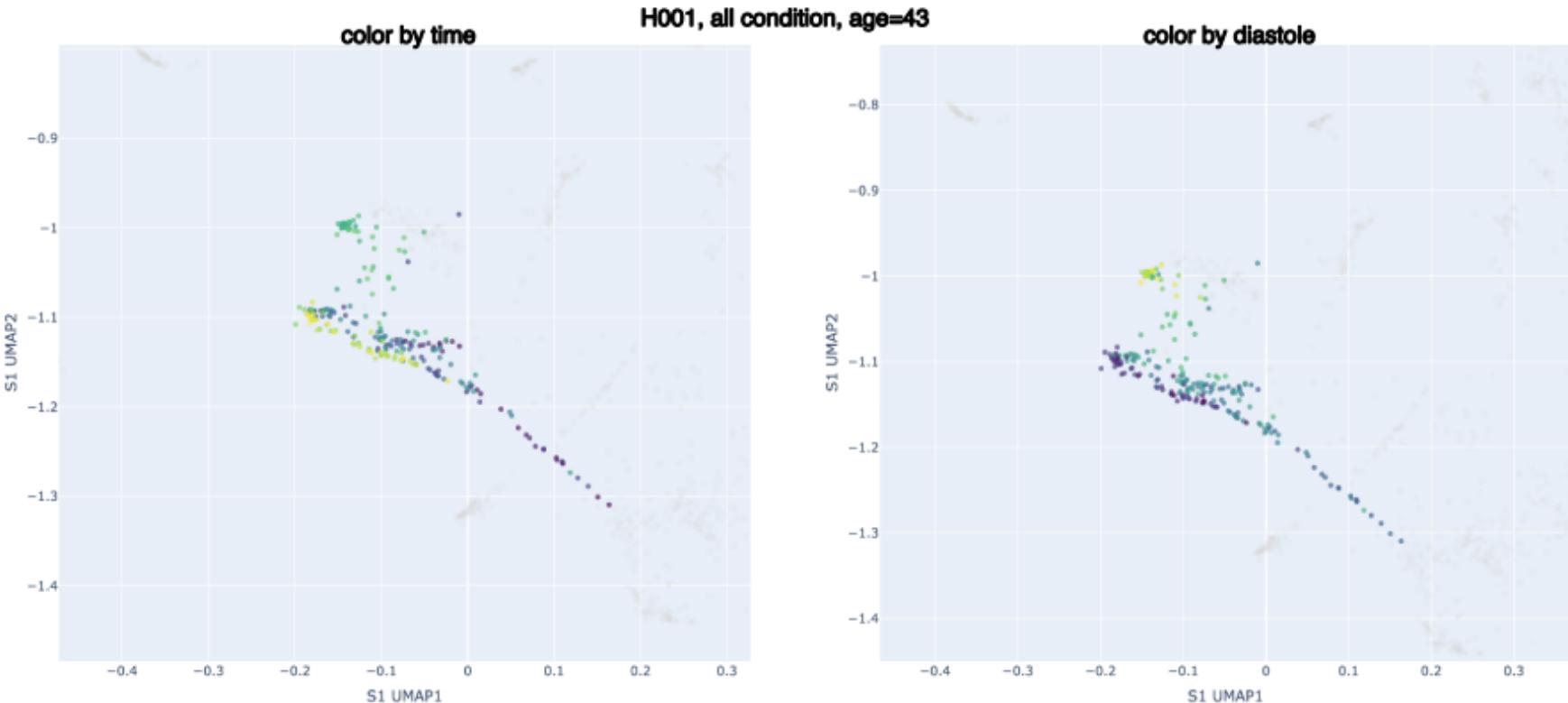
Result: Stage 1



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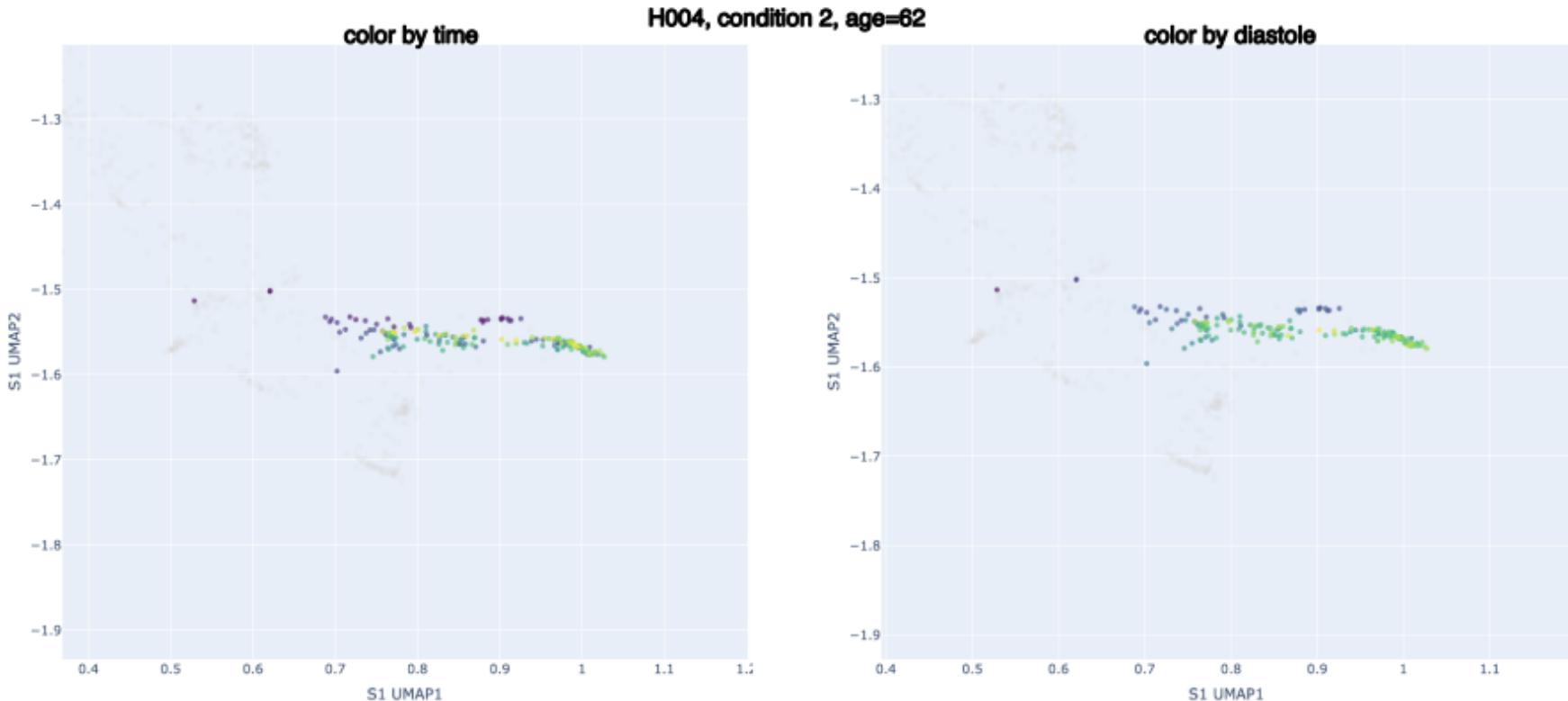
Result: Stage 1



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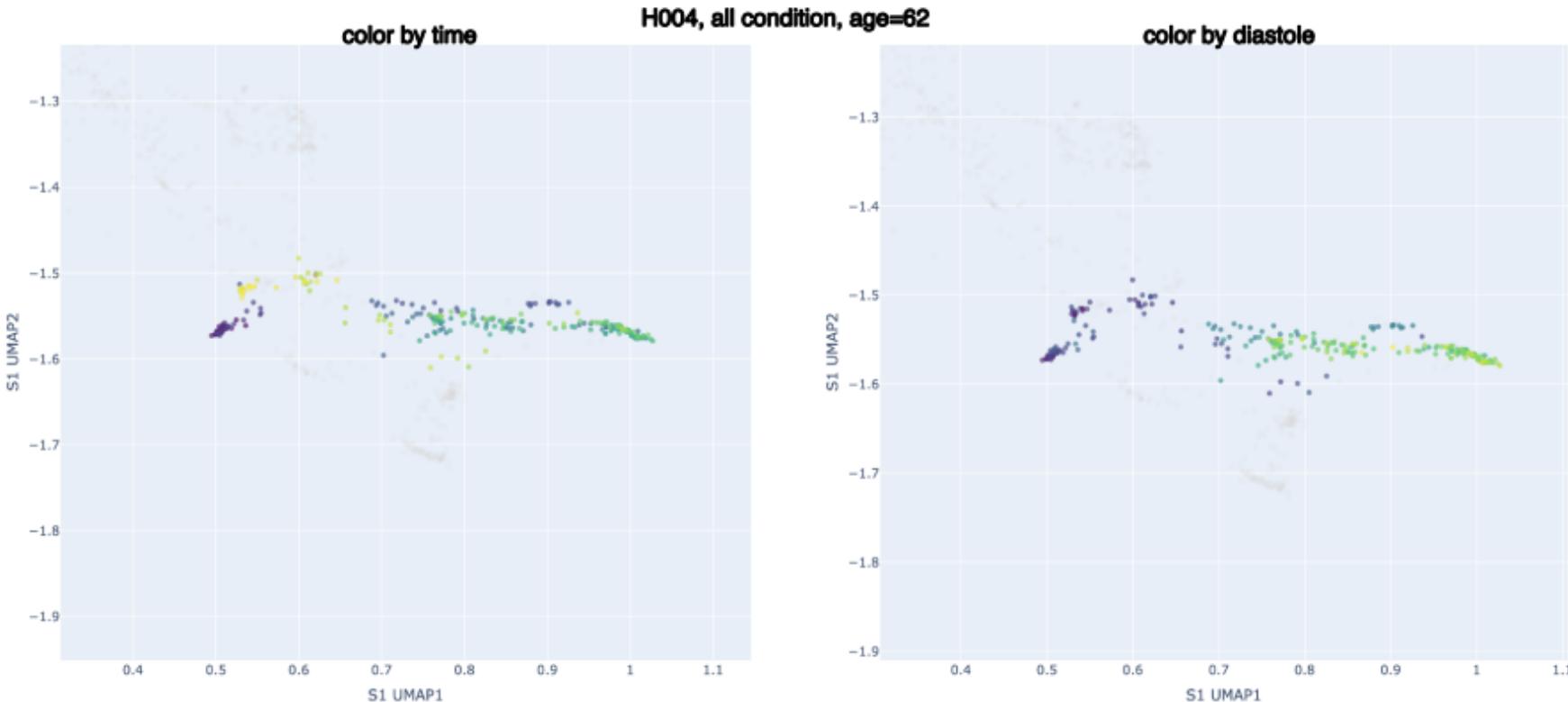
Result: Stage 1



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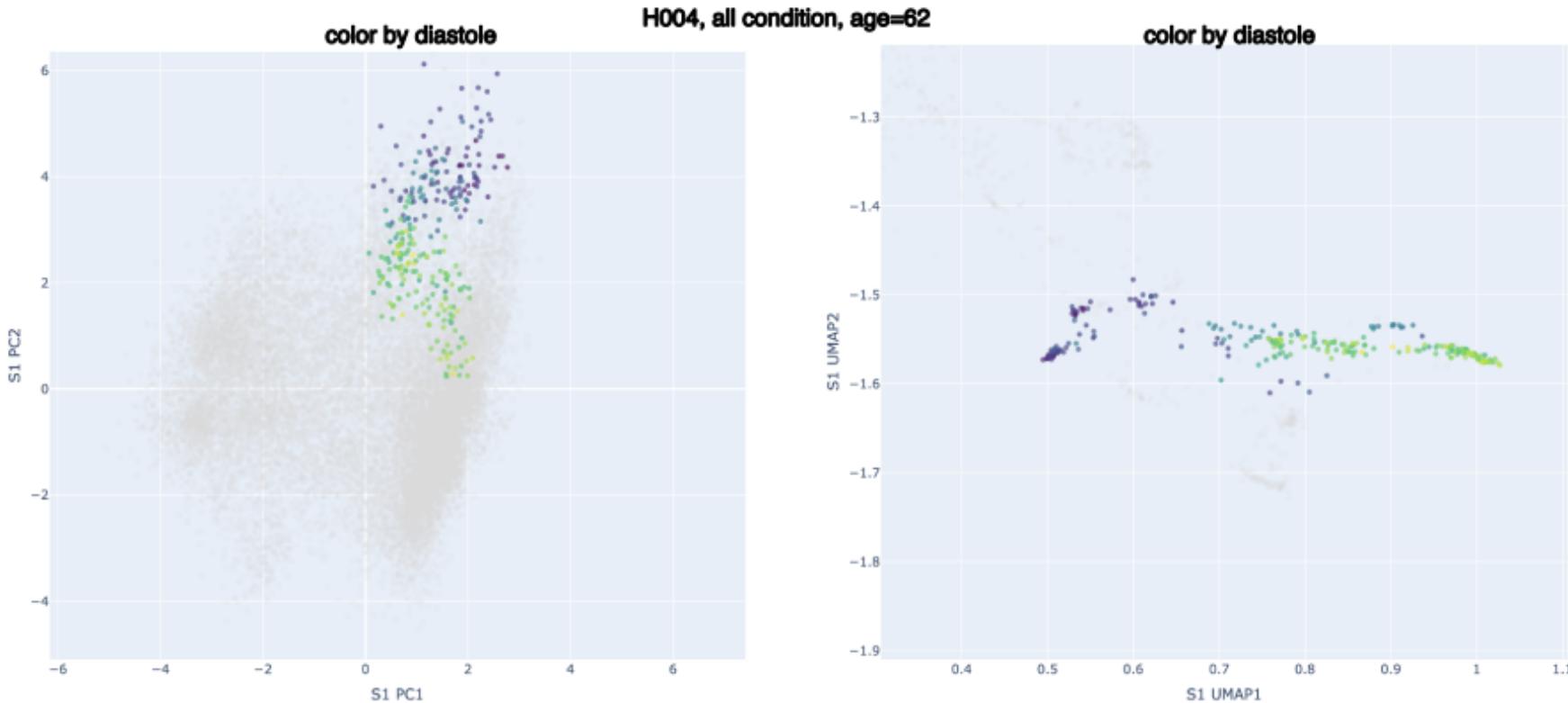
Result: Stage 1 Smple with similar BP from different condition group together



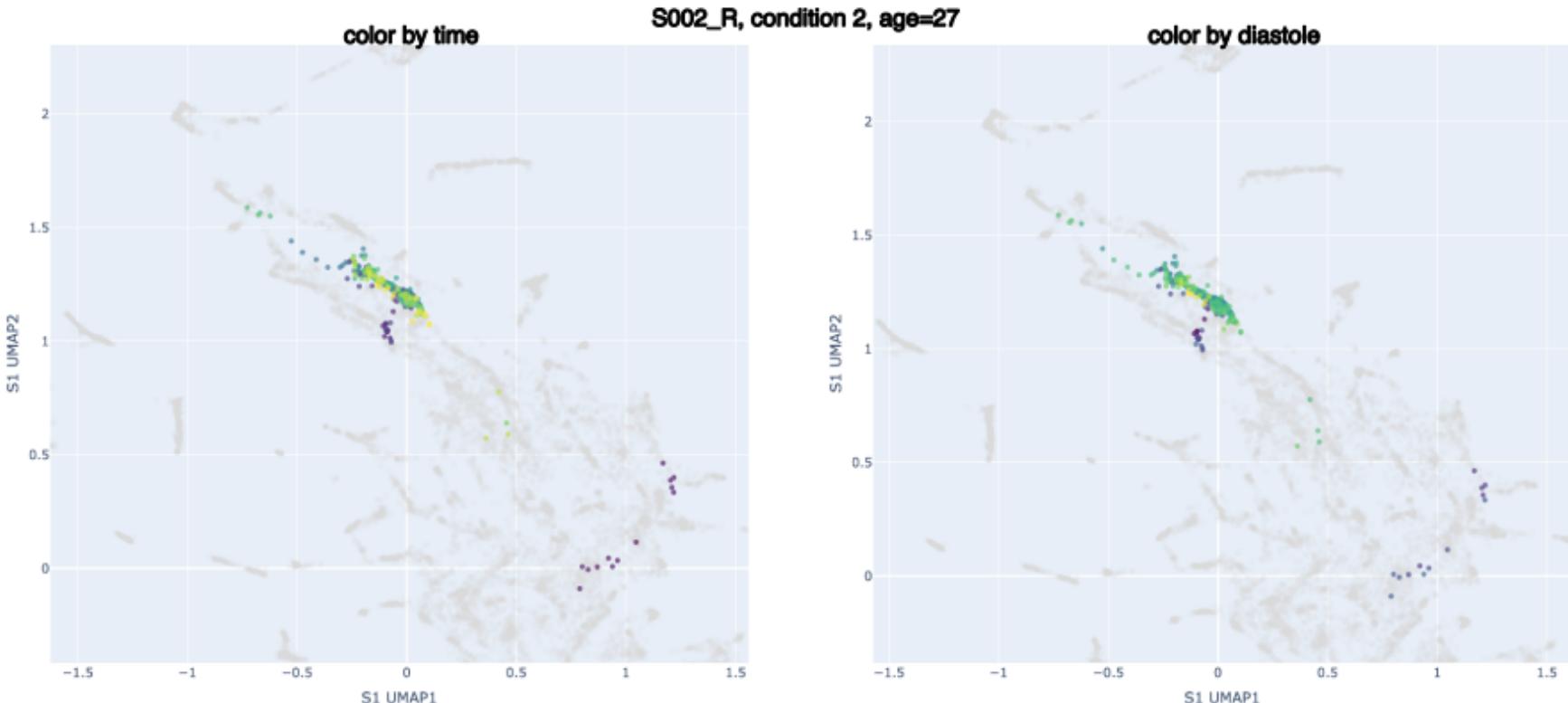
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Result: Stage 1



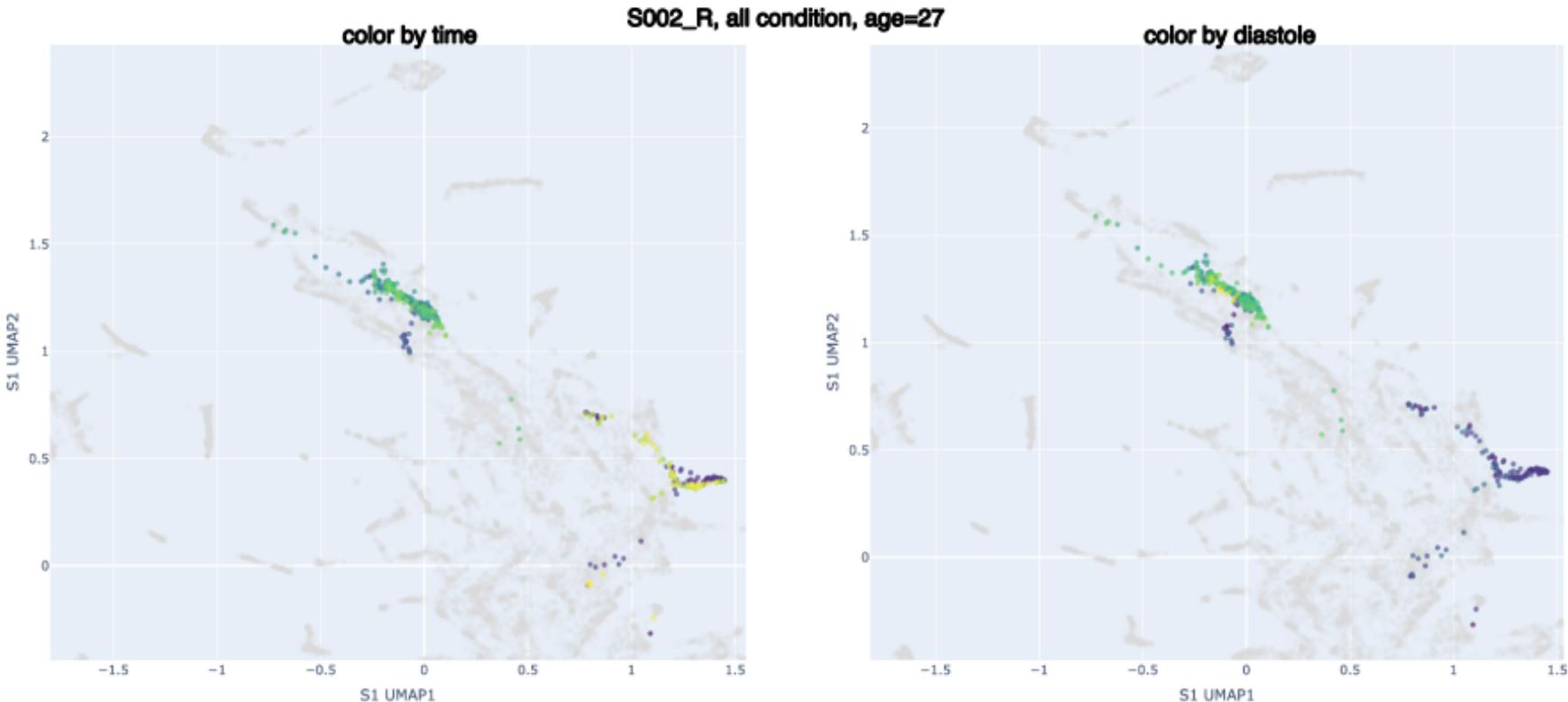
Result: Stage 1



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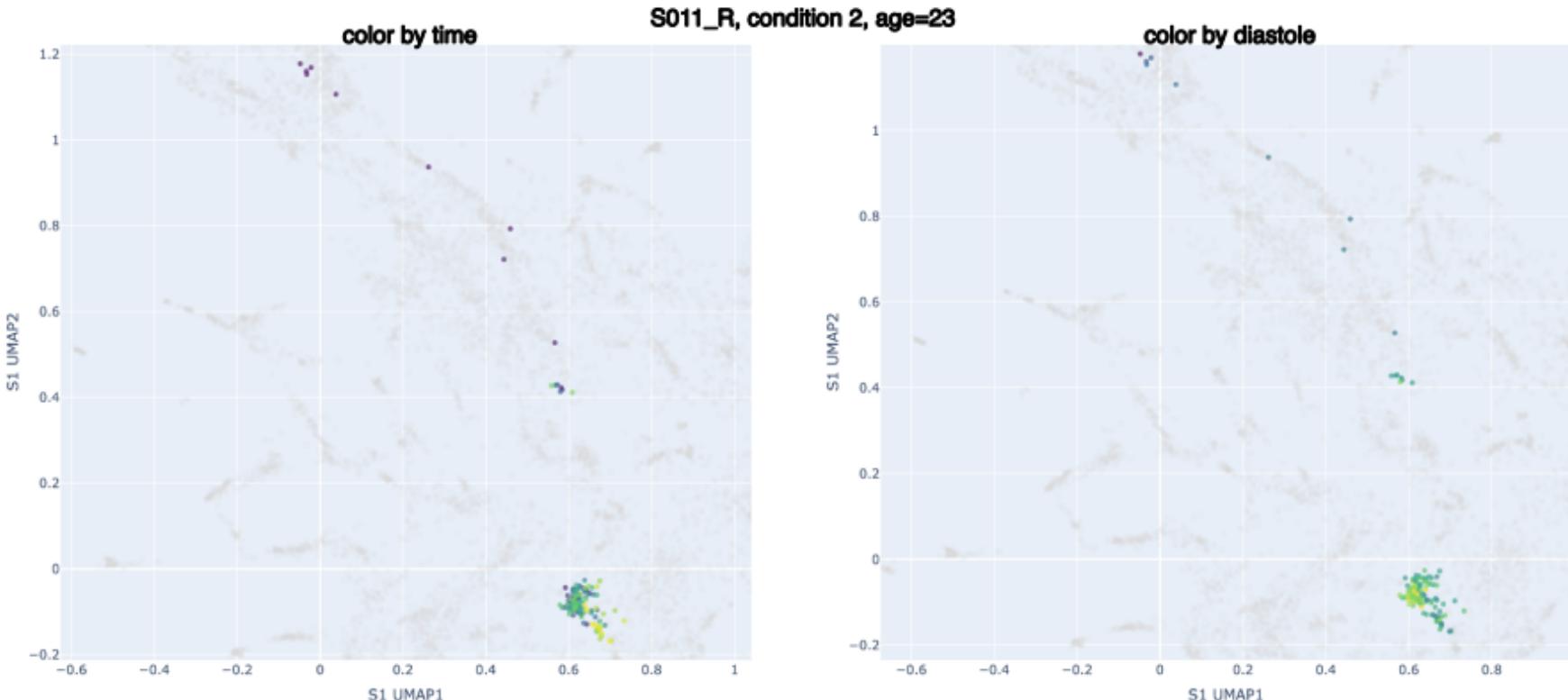
Result: Stage 1 Smple with similar BP from different condition group together



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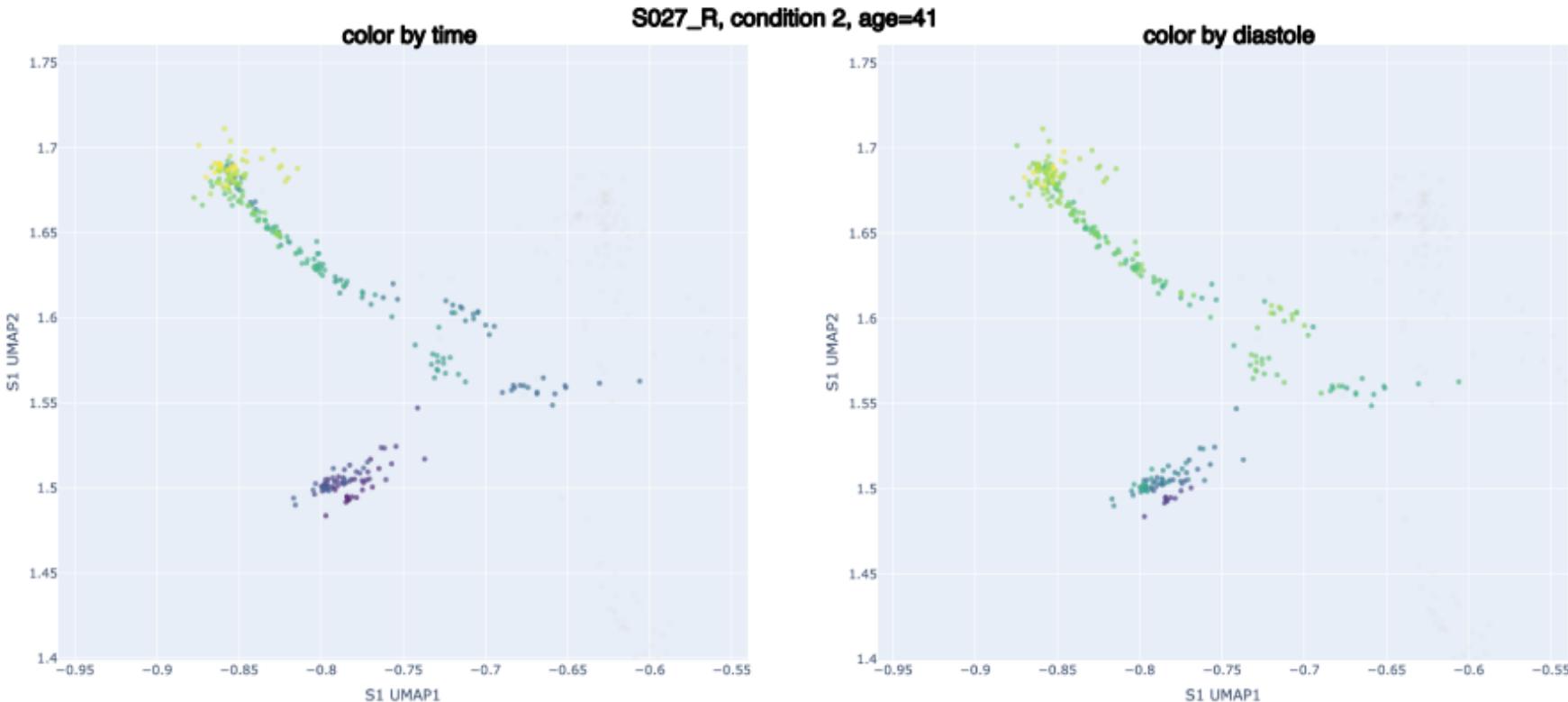
Result: Stage 1



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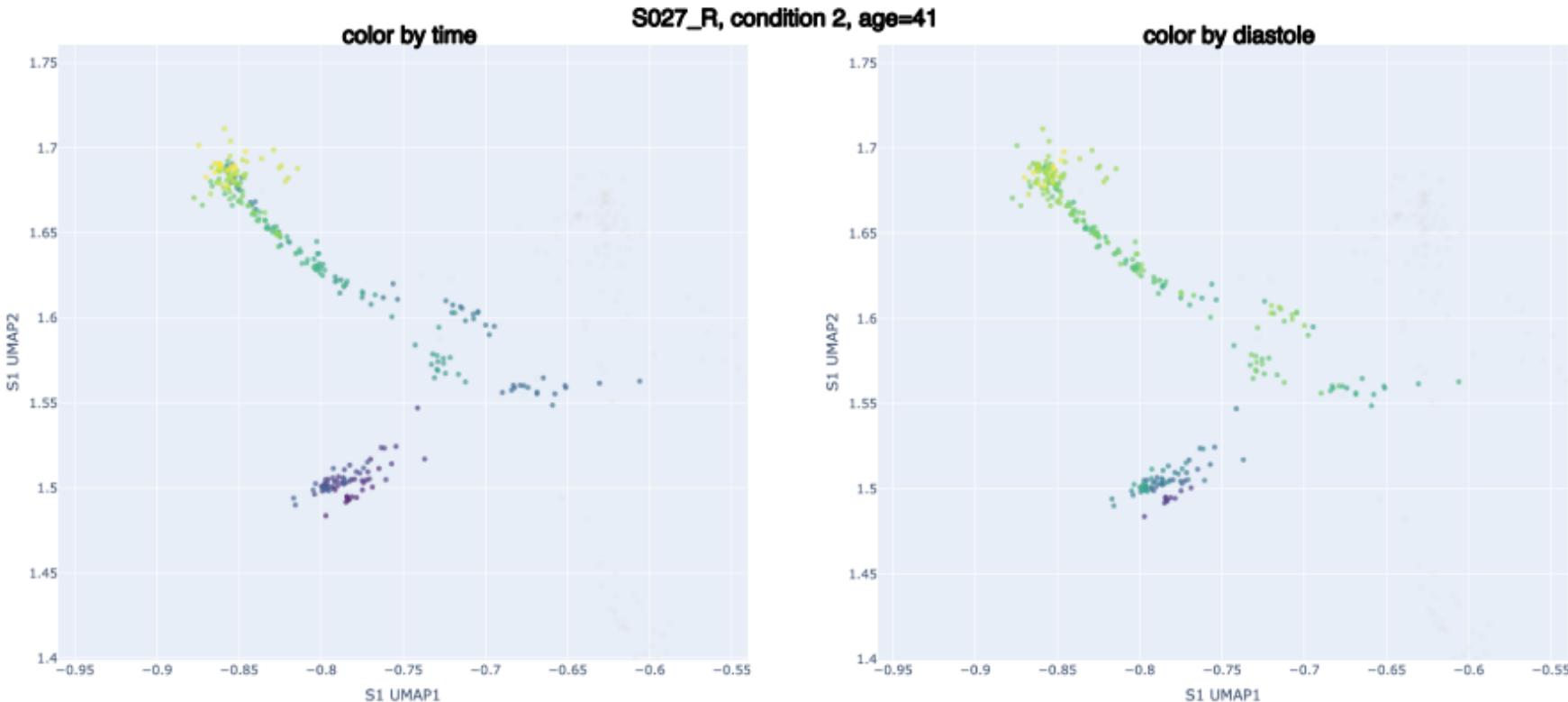
Result: Stage 1



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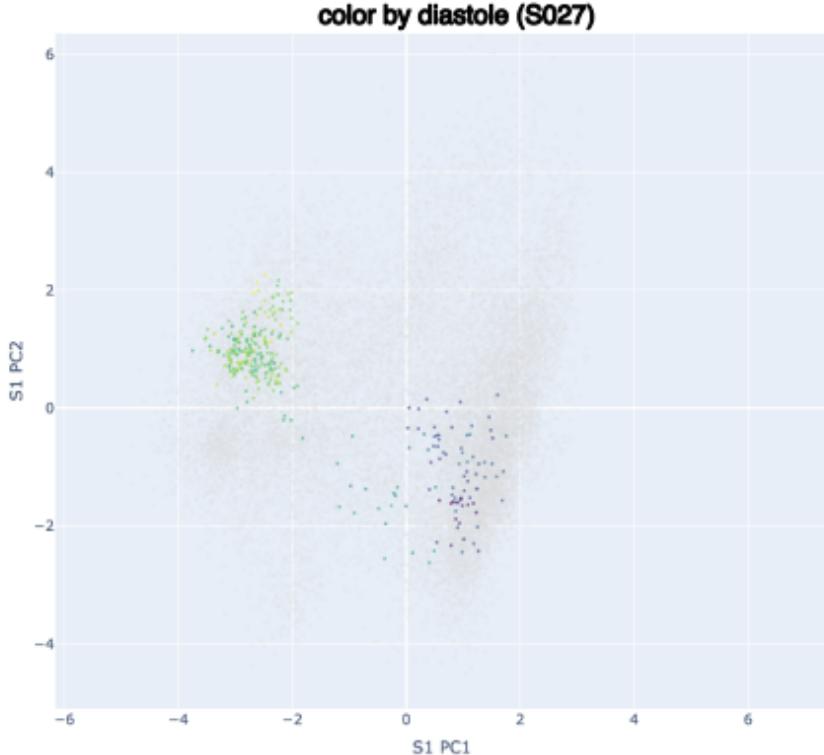
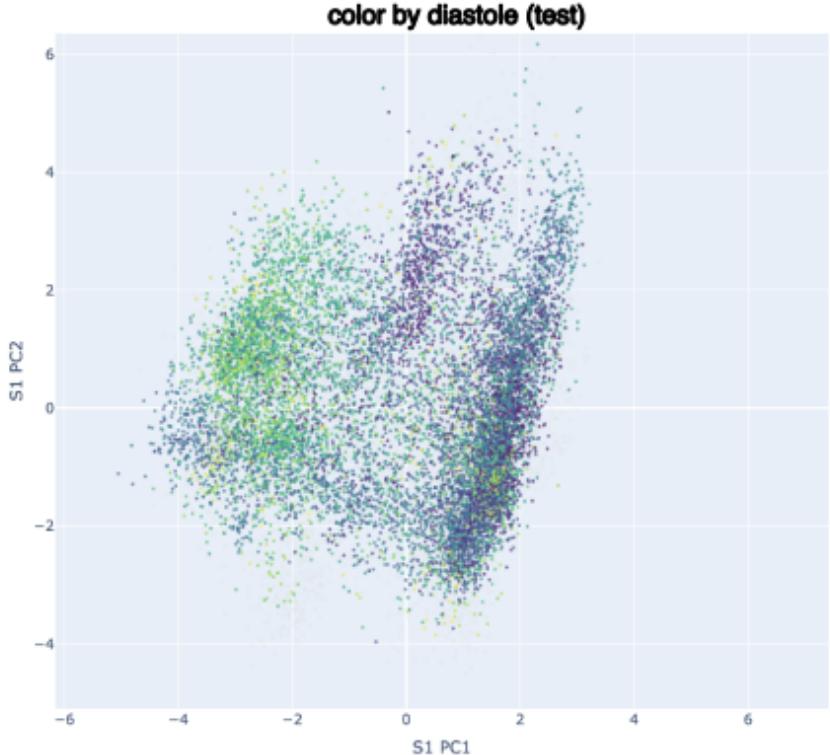
Result: Stage 1



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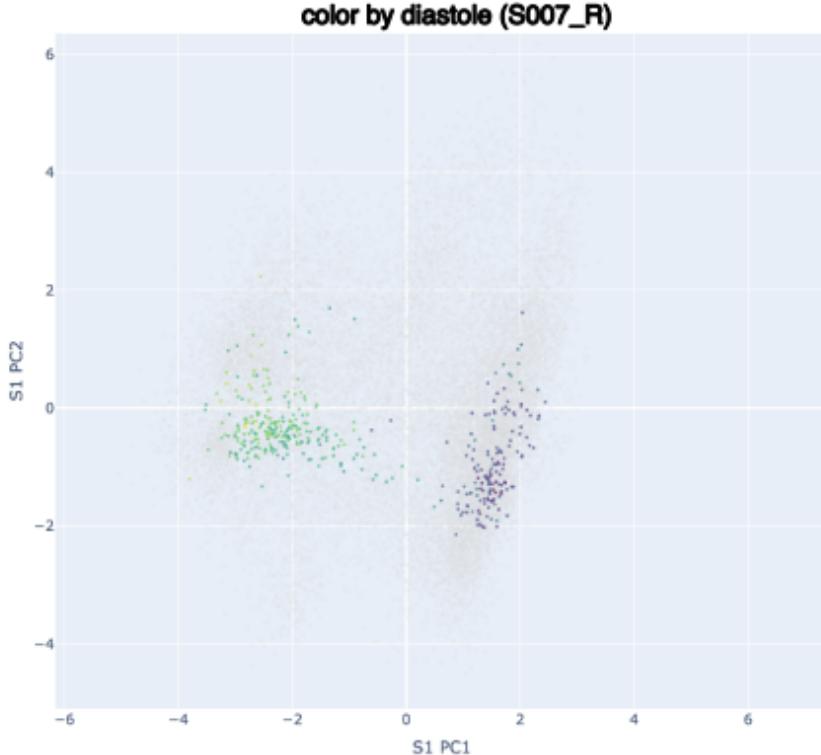
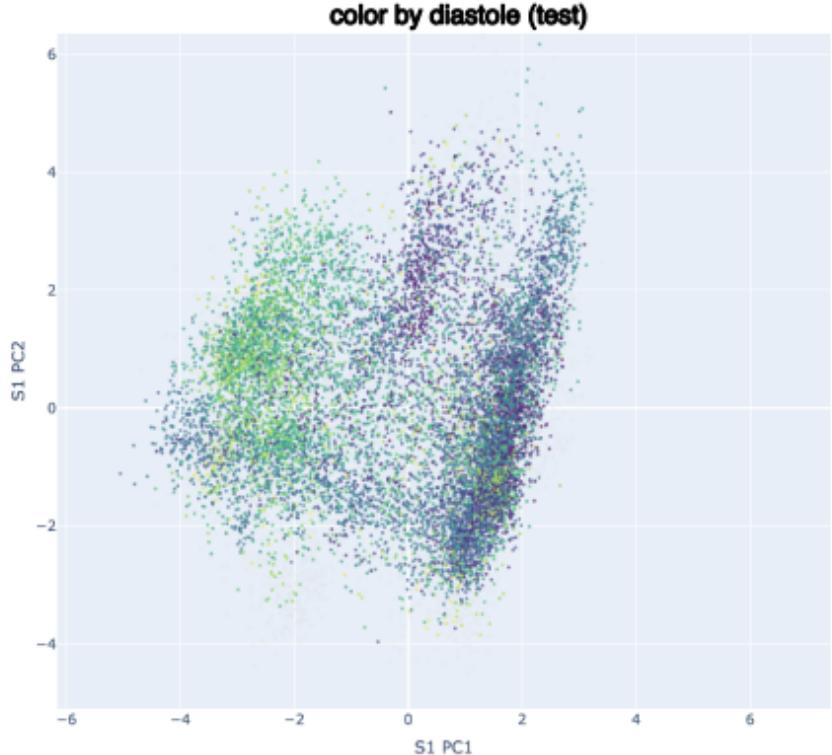
Result: Stage 1 First two PC exhibit trend relate to blood pressure



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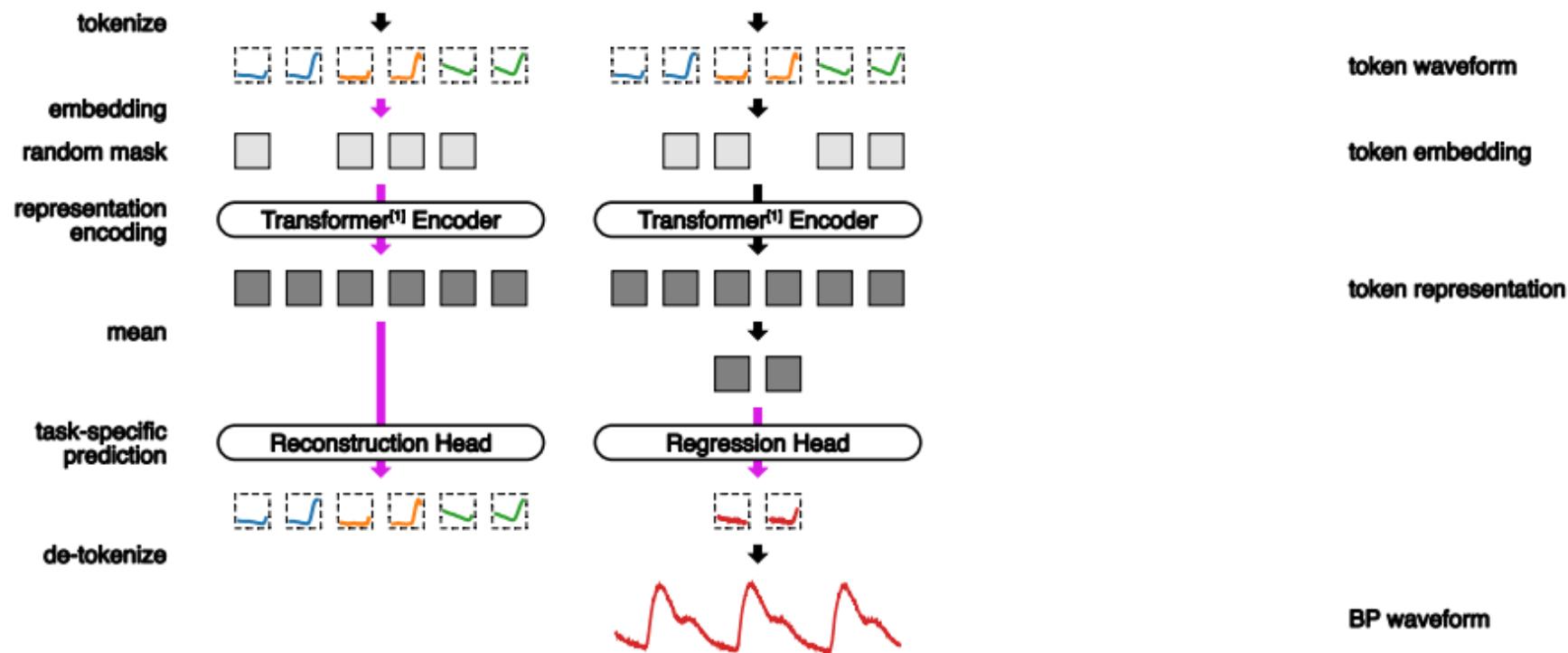
Result: Stage 1 First two PC exhibit trend relate to blood pressure



Model: Stage 2

[1] Vaswani, A. et al. Attention Is All You Need. arXiv:1706.03762 (2017).

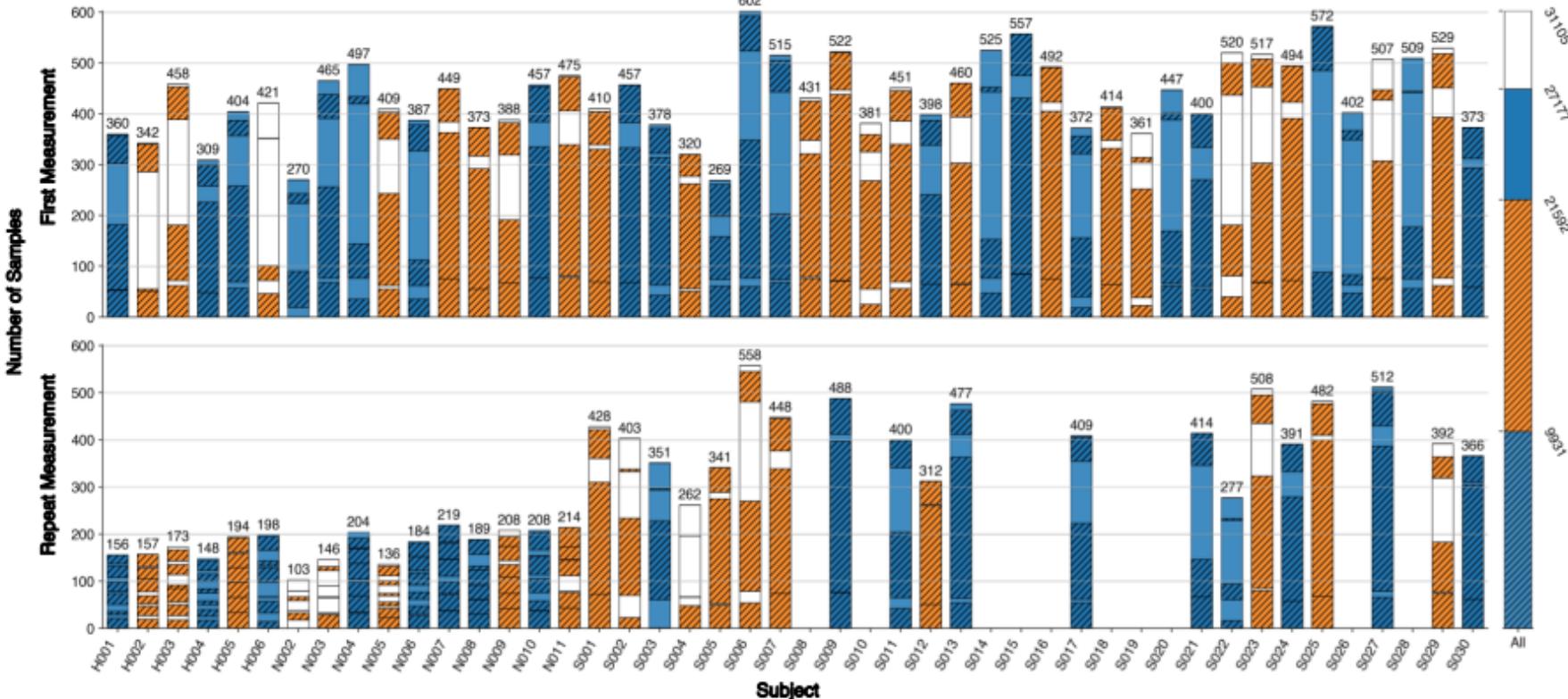
↑ trainable → fixed



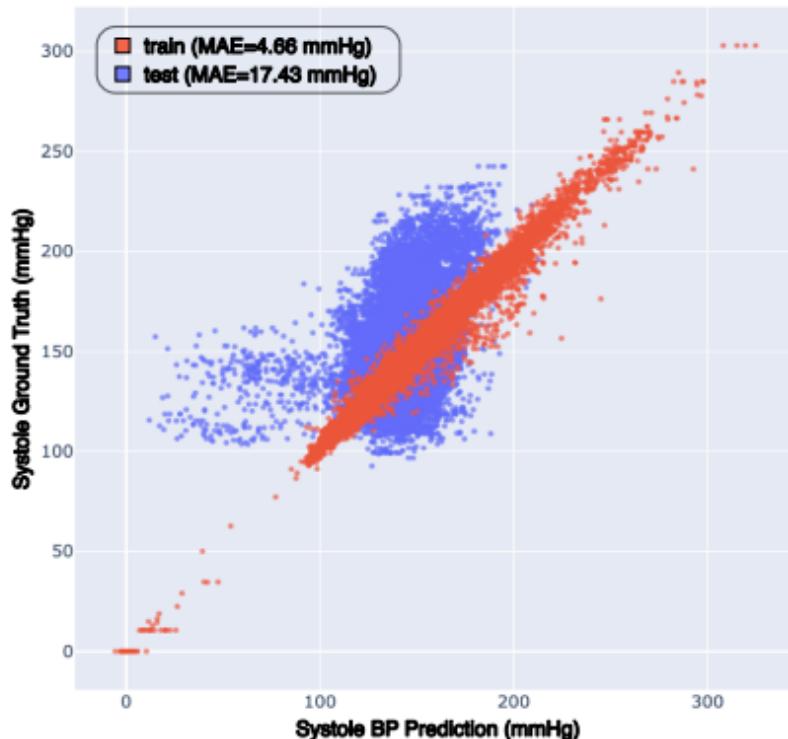
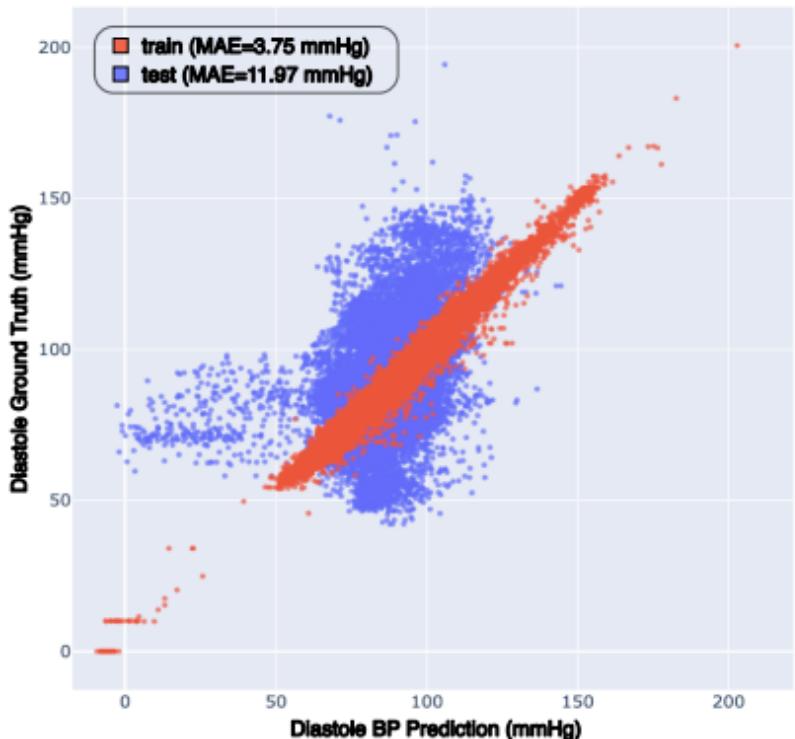
Data: Stage 2 Split

Wang, Y. et al. How to evaluate your medical time series classification? arXiv 2410.03057 (2024).

split
train test



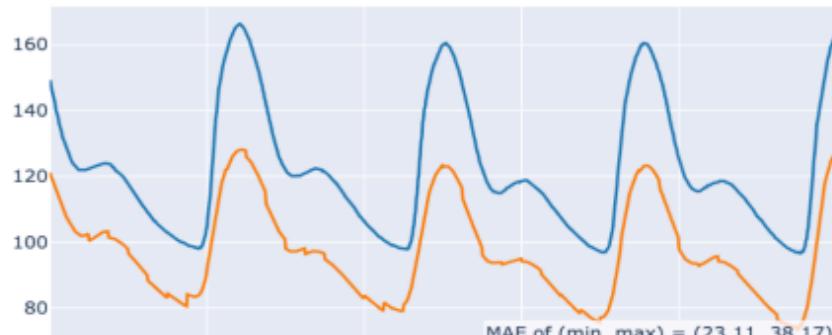
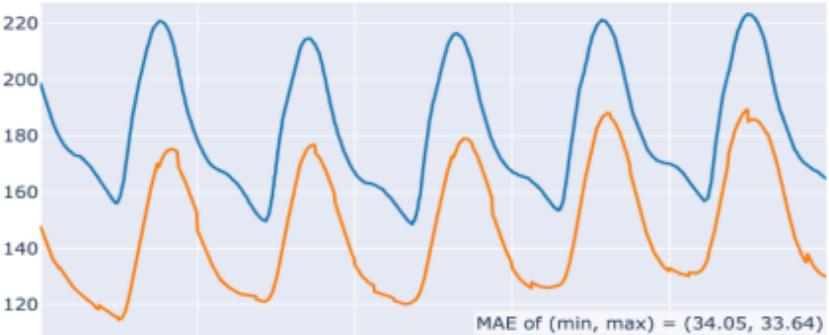
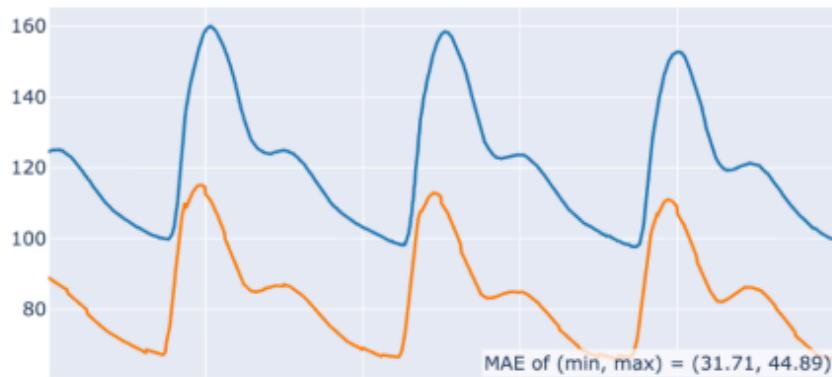
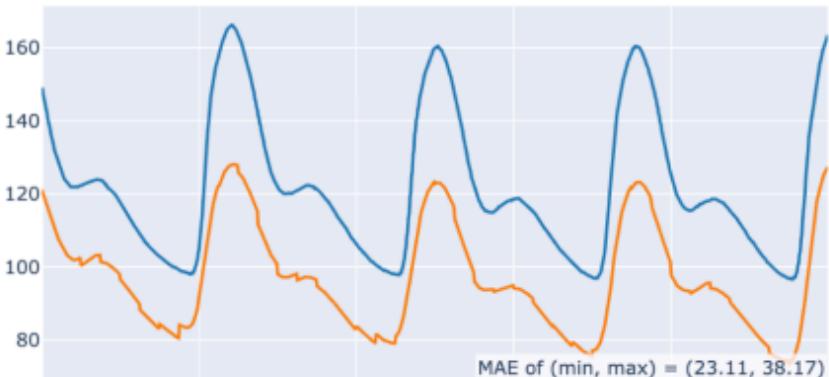
Result: Stage 2 Systolic and diastolic prediction does not generalize to test set



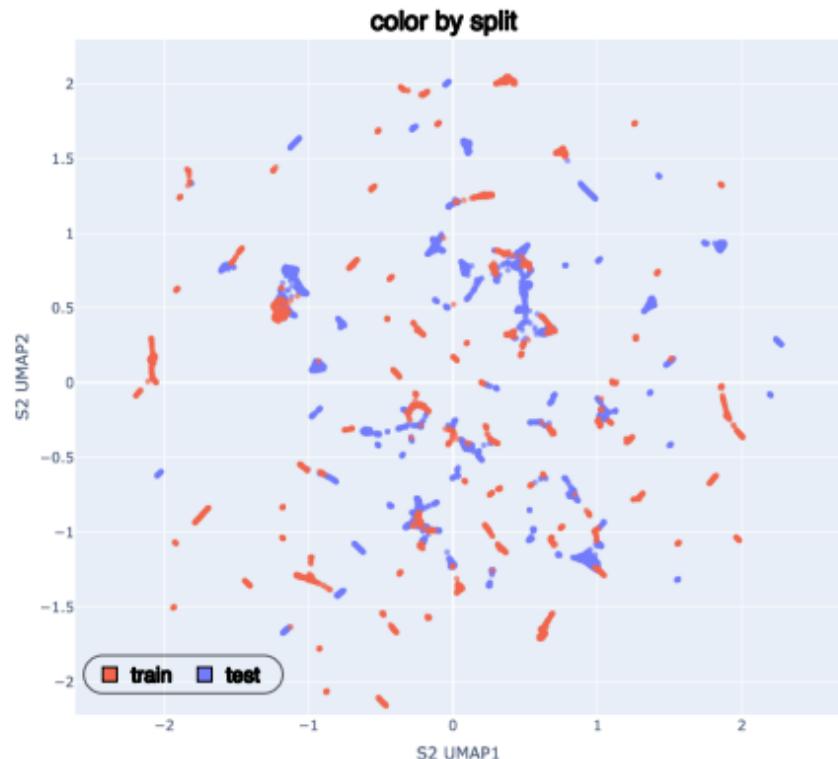
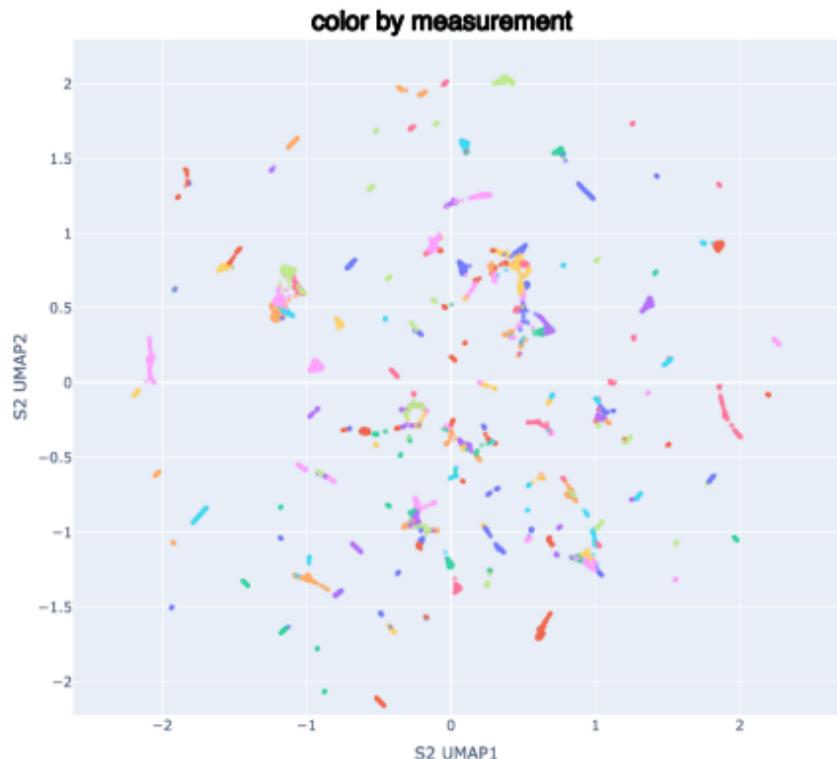
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Result: Stage 2 Model captures wave shape, but absolute BP values are shifted



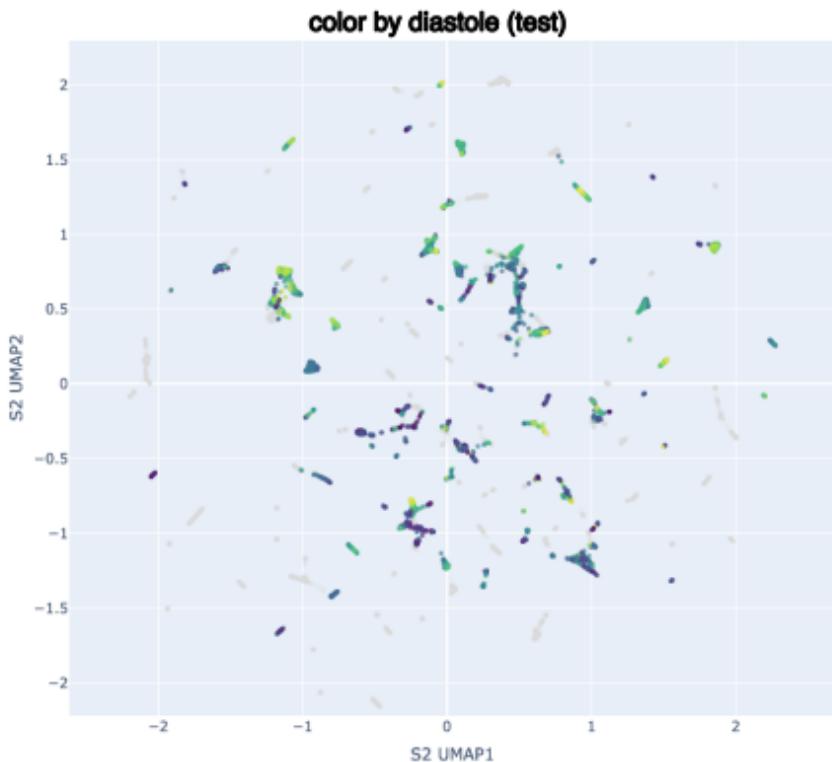
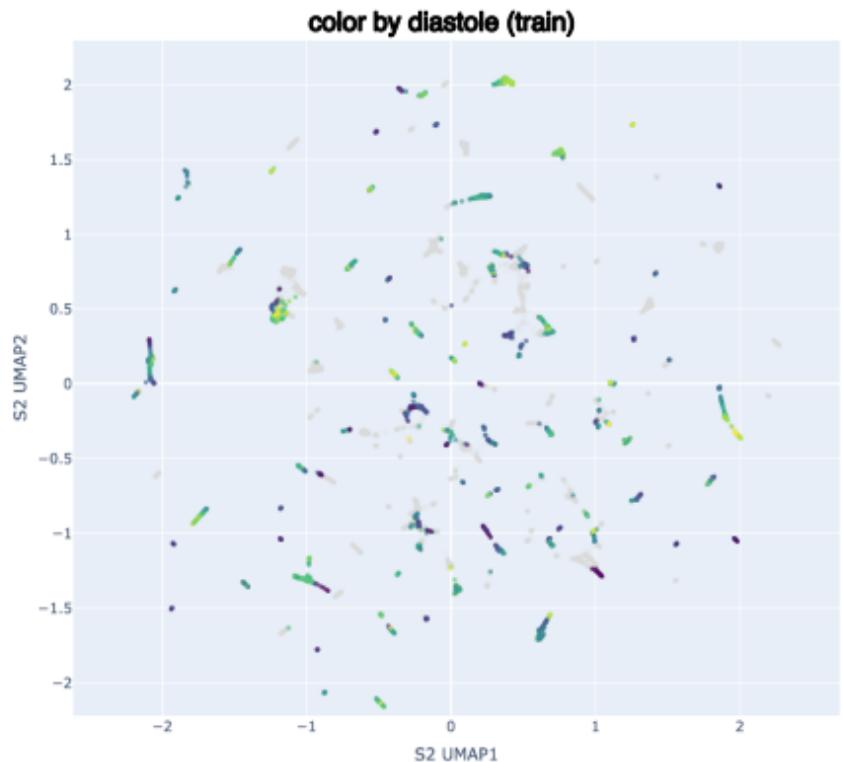
Result: Stage 2 Representations become more subject-specific



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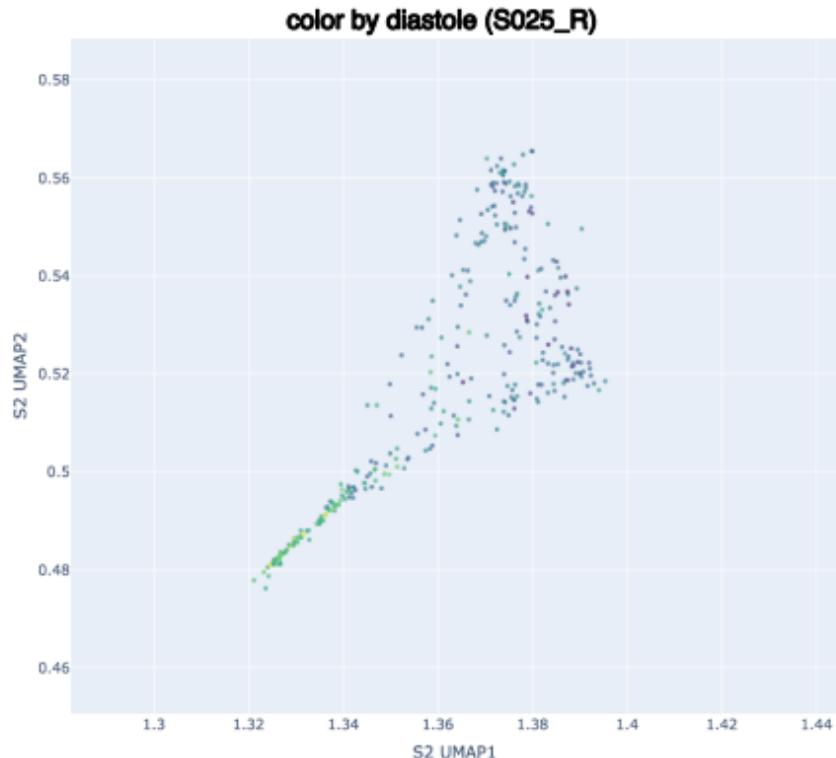
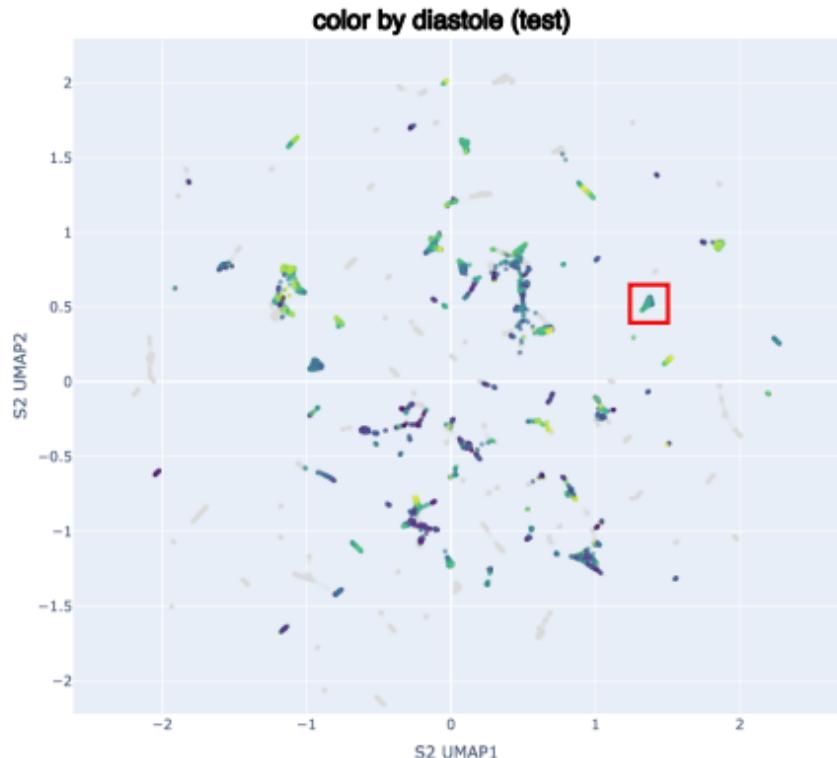
Result: Stage 2 Representation follows BP variation



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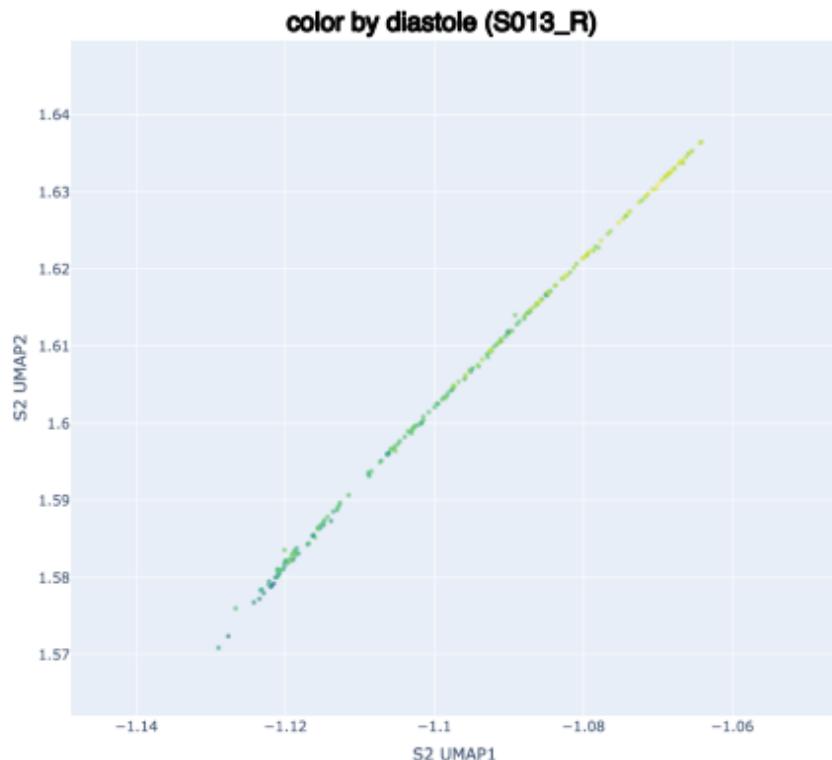
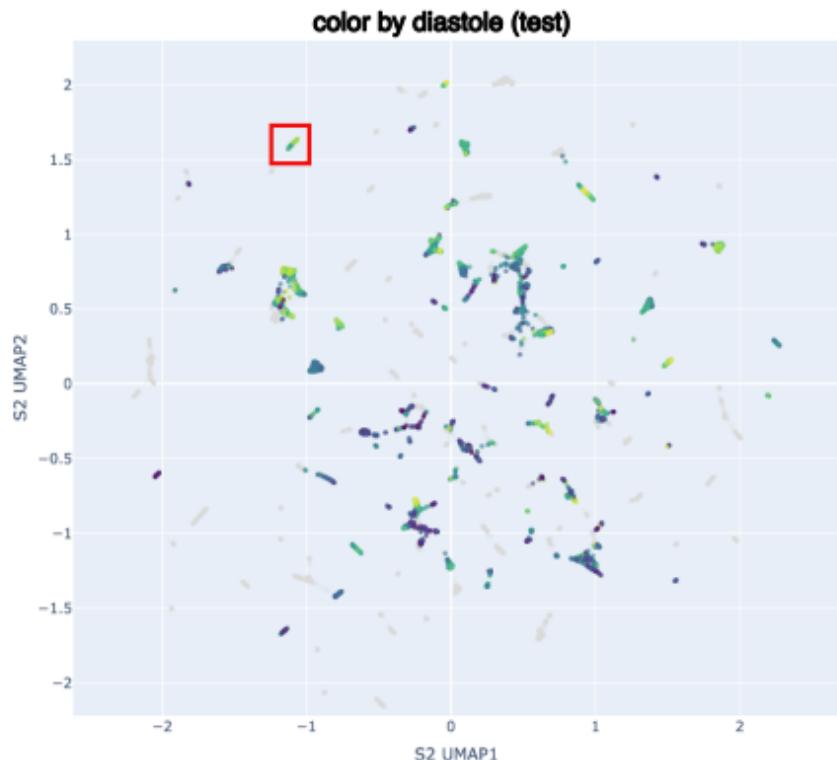
Result: Stage 2 Representations become more subject-specific



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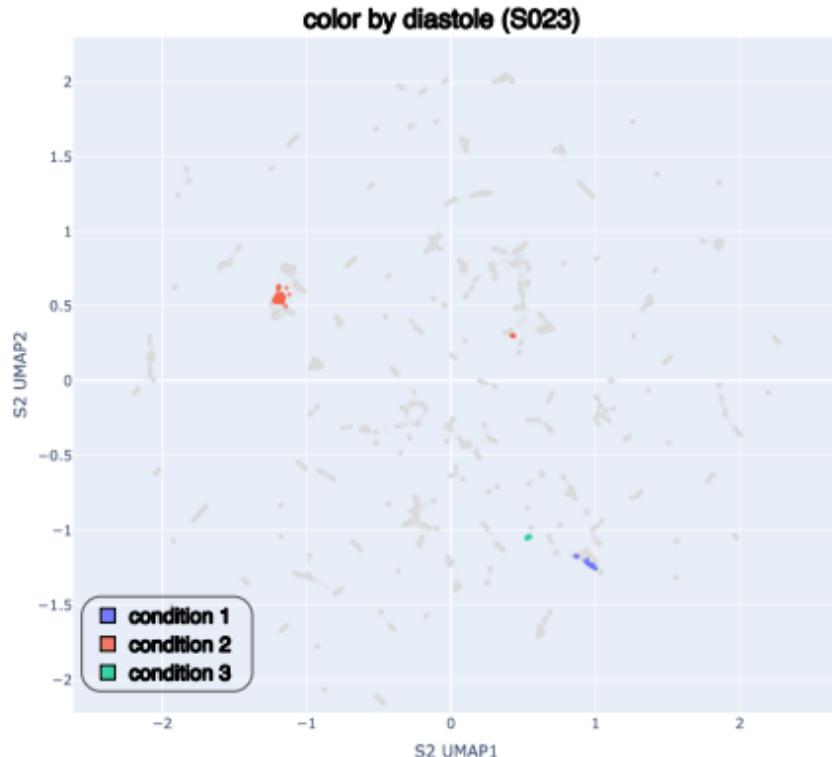
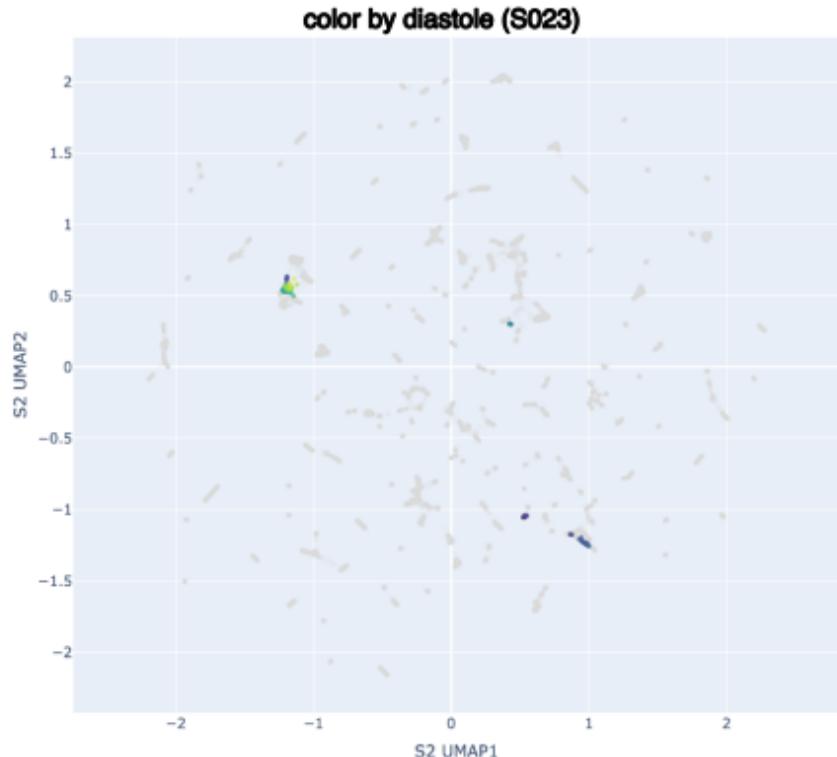
Result: Stage 2 Representations become more subject-specific



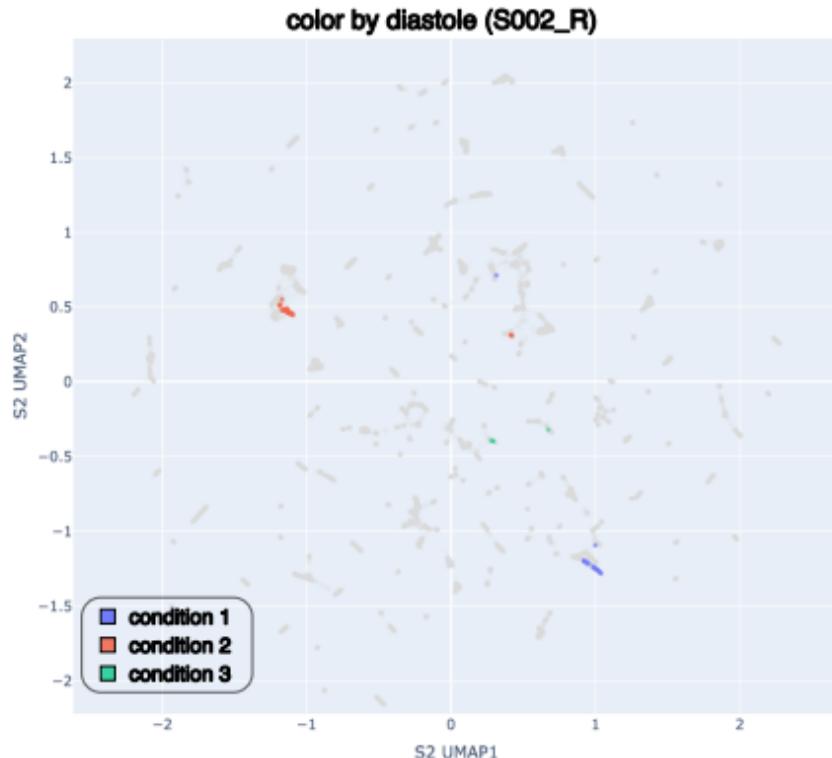
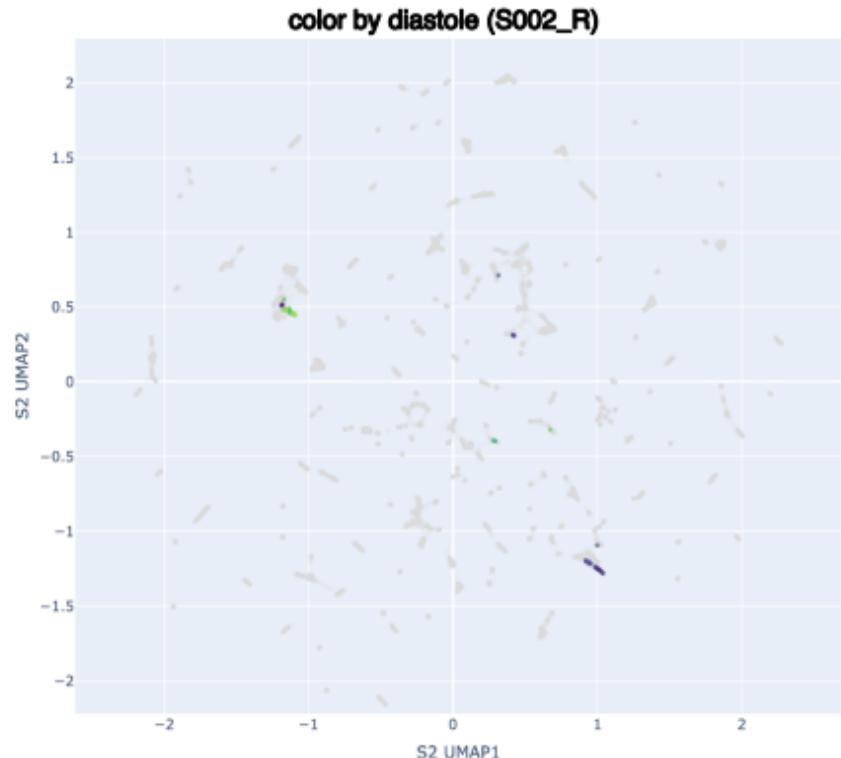
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Result: Stage 2 Different condition within a measurement no longer group together



Result: Stage 2 Different condition within a measurement no longer group together



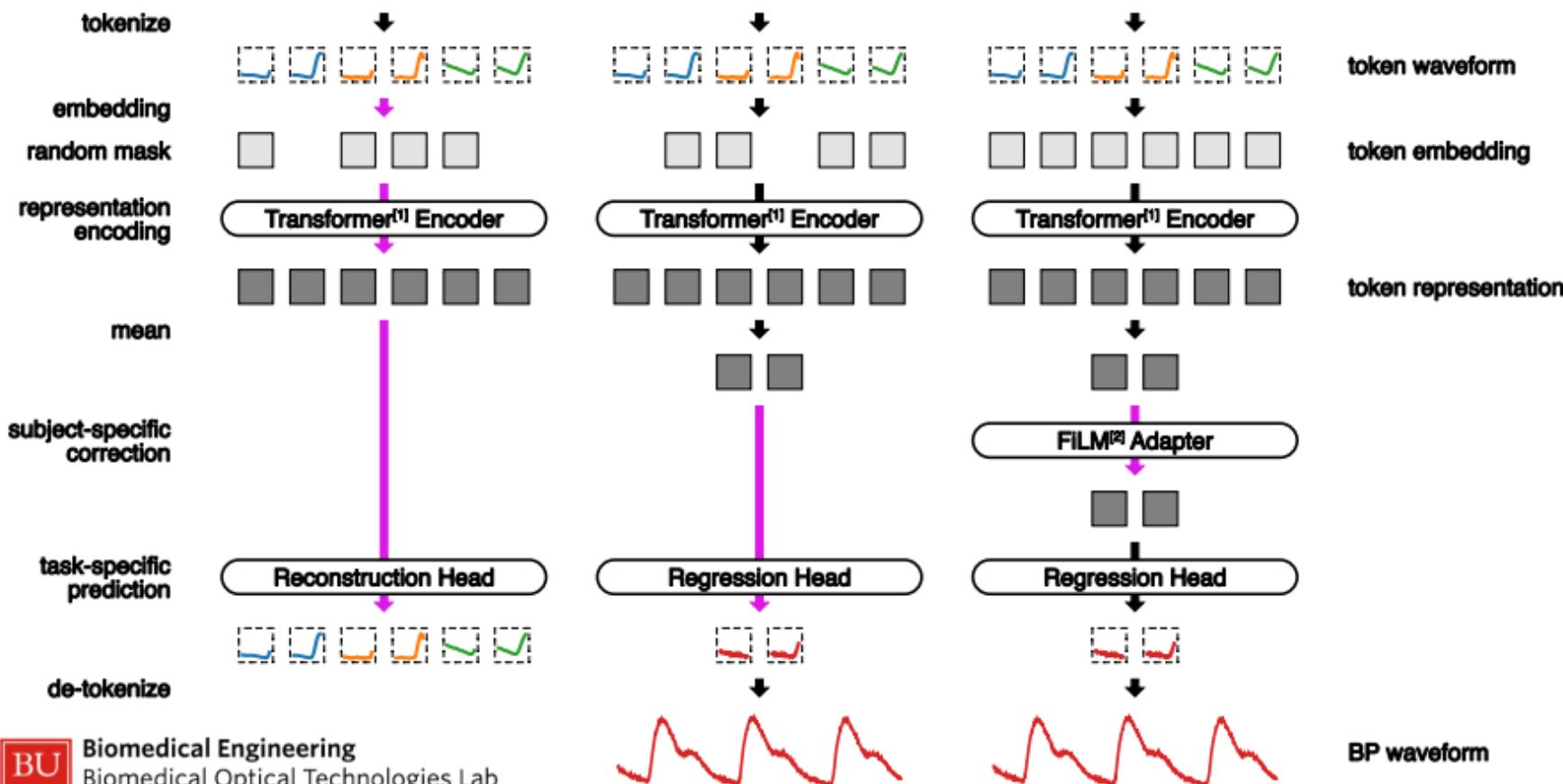
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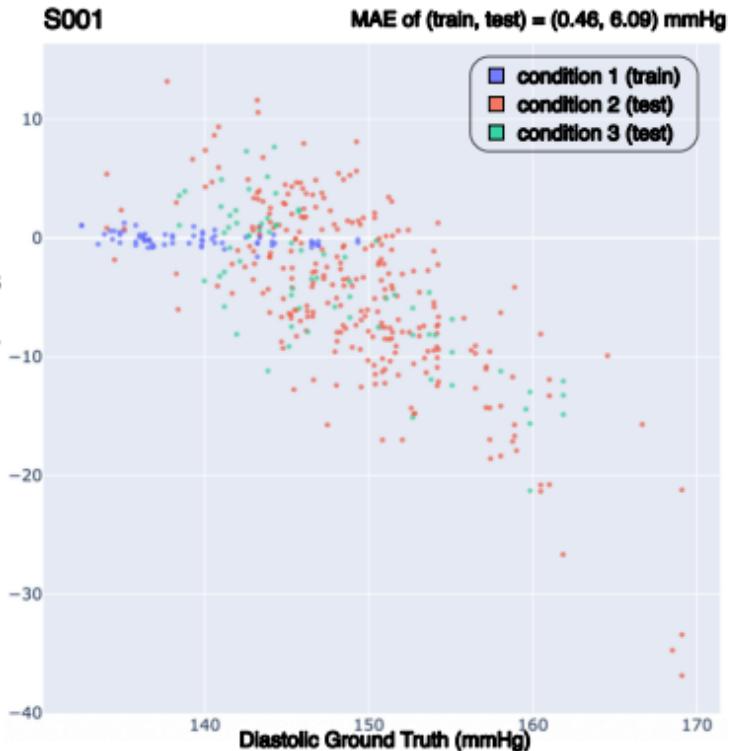
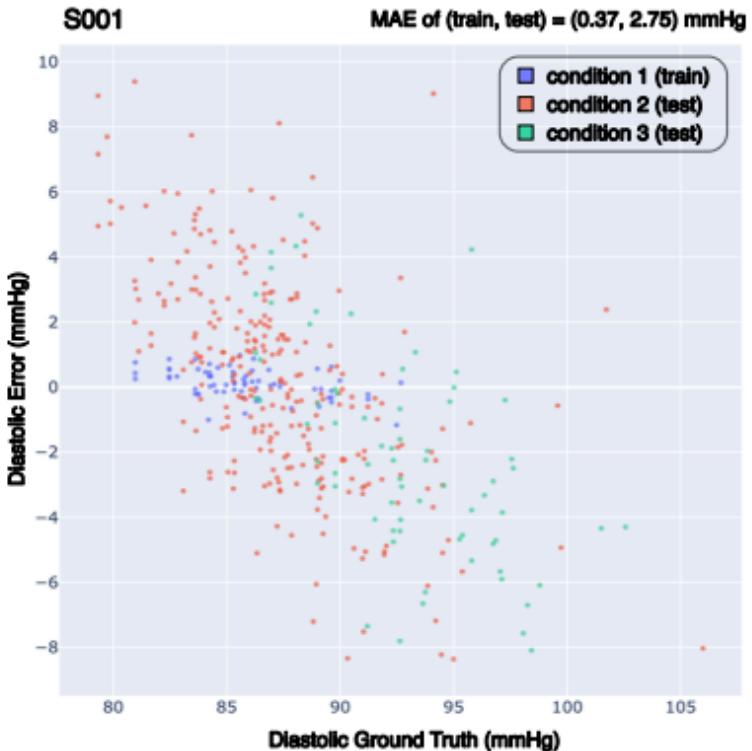
Model: Stage 3

- [1] Vaswani, A. et al. Attention Is All You Need. arXiv:1706.03762 (2017).
[2] Perez, E. et al. FILM: Visual Reasoning with a General Conditioning Layer. arXiv:1709.07871 (2017).

↑ trainable → fixed



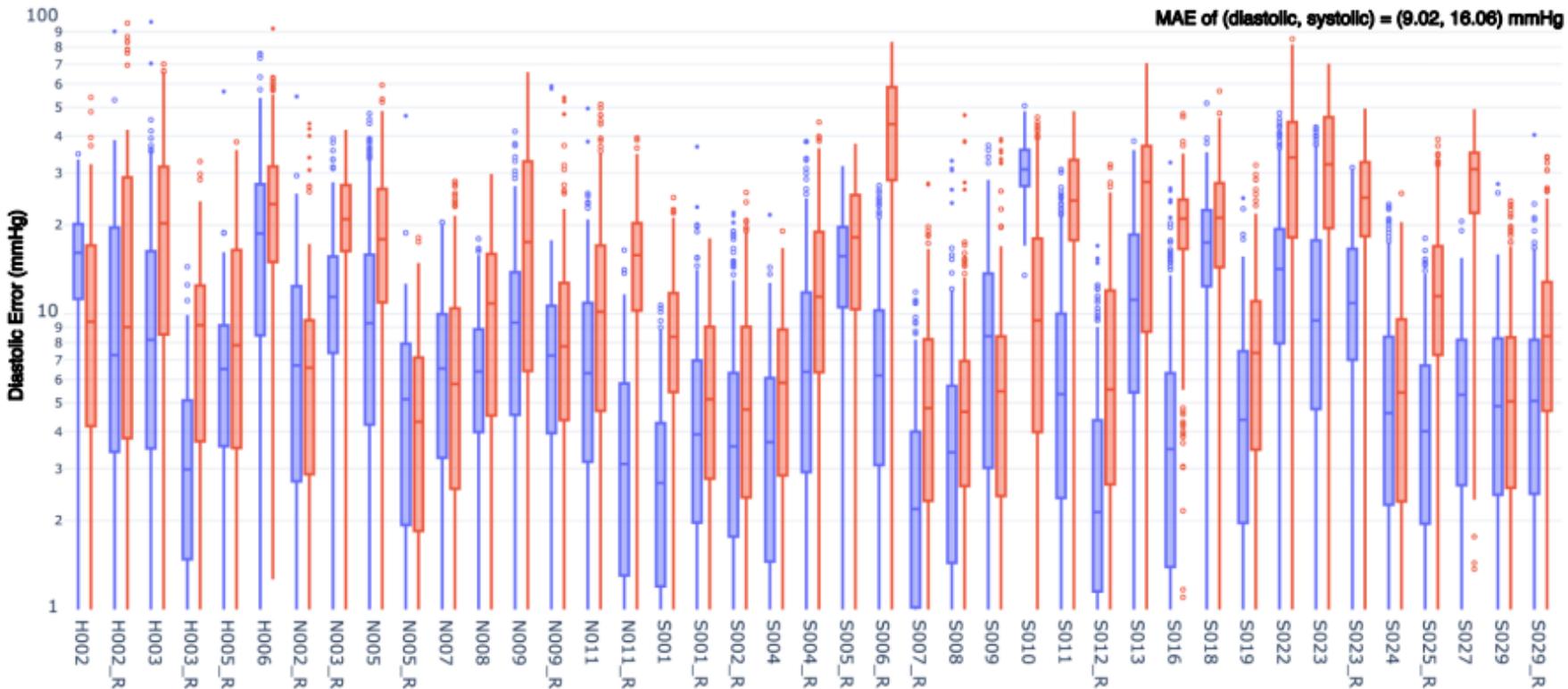
Result: Stage 3



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Result: Stage 3

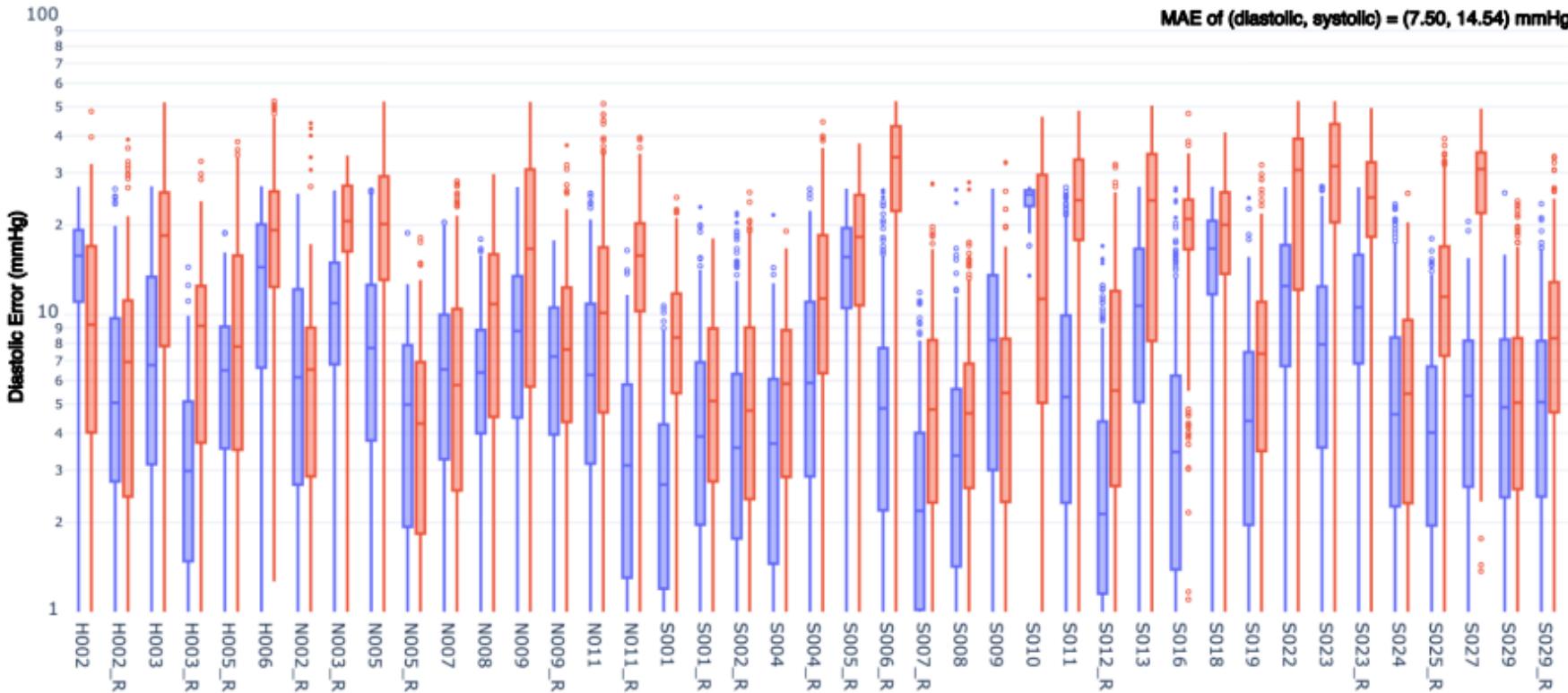


Result: Stage 3

Filtered extreme value of BP: keep 13095 samples (92.5%); removed 984

diastolic
systolic

MAE of (diastolic, systolic) = (7.50, 14.54) mmHg



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