

StrokeRehab: A Benchmark Dataset for Sub-second Action Identification

Aakash Kaku*, Kangning Liu*, Avinash Parnandi*, Haresh Rengaraj Rajamohan, Kannan Venkataramanan, Anita Venkatesan, Audre Wirtanen, Natasha Pandit, Heidi Schambra#, Carlos Fernandez-Granda#

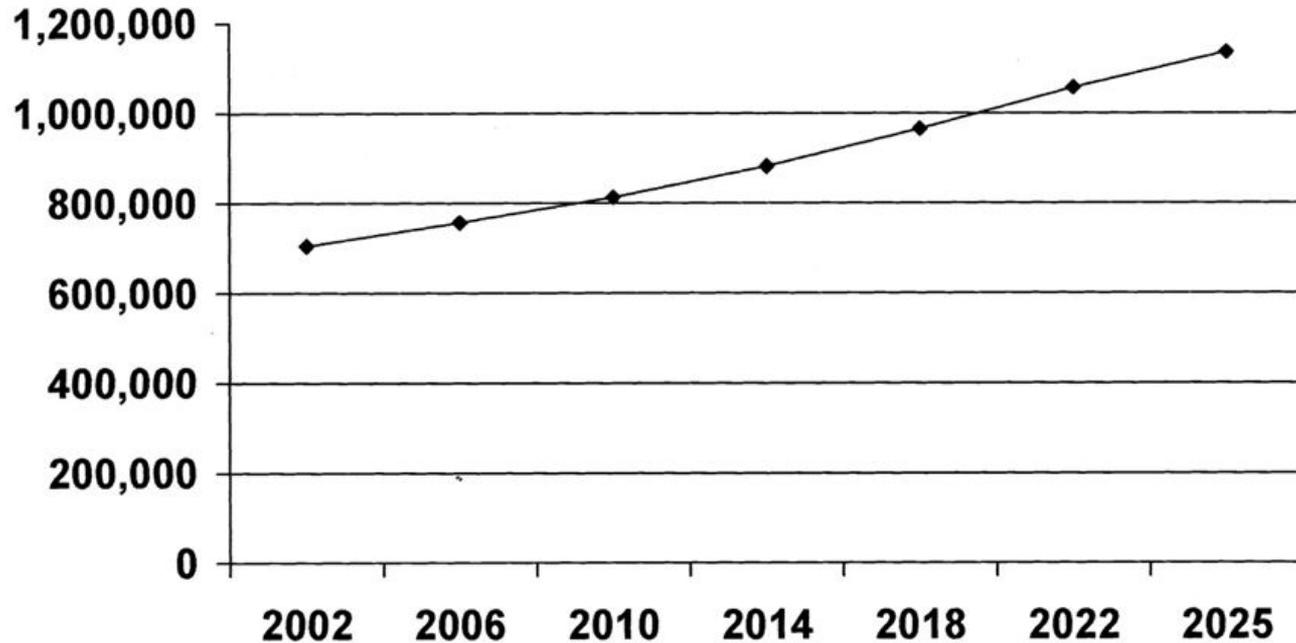
(* Equal contribution, # Joint corresponding/last authors)



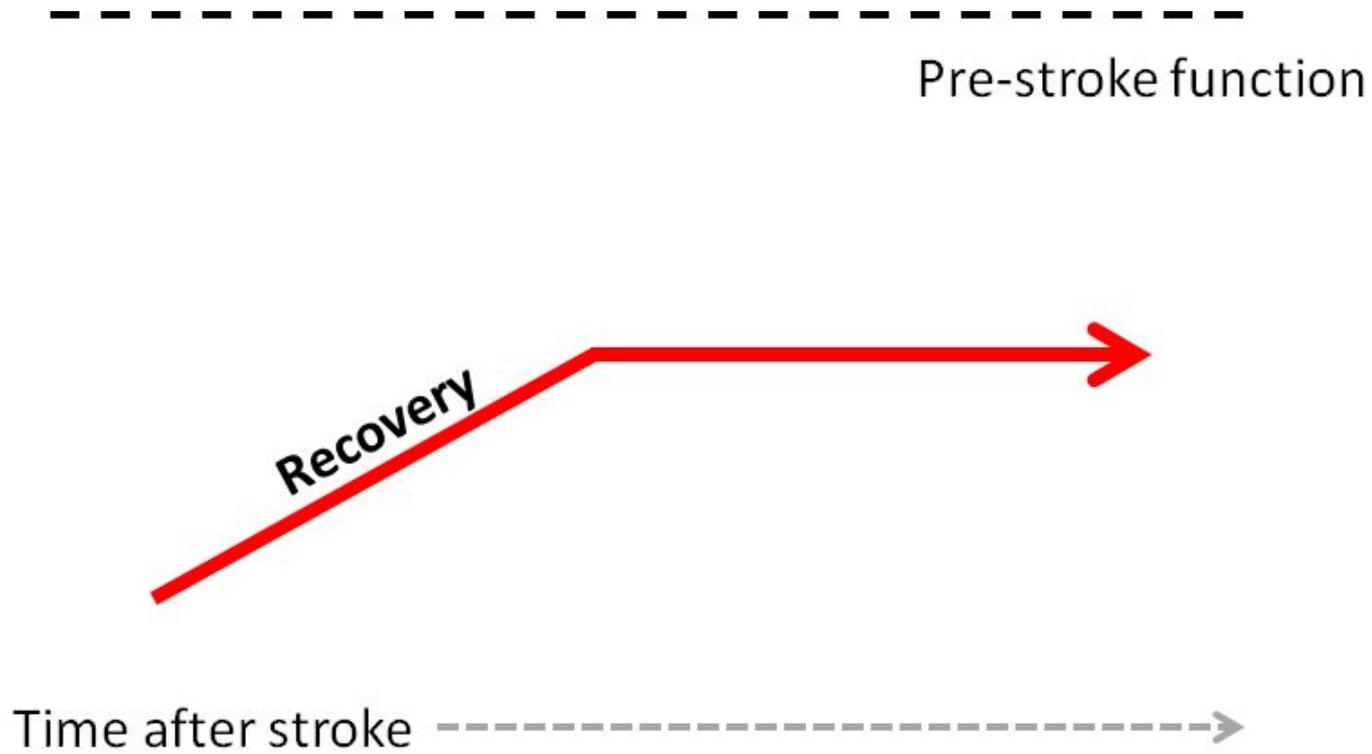
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Stroke is the **LEADING CAUSE** of disability in the US

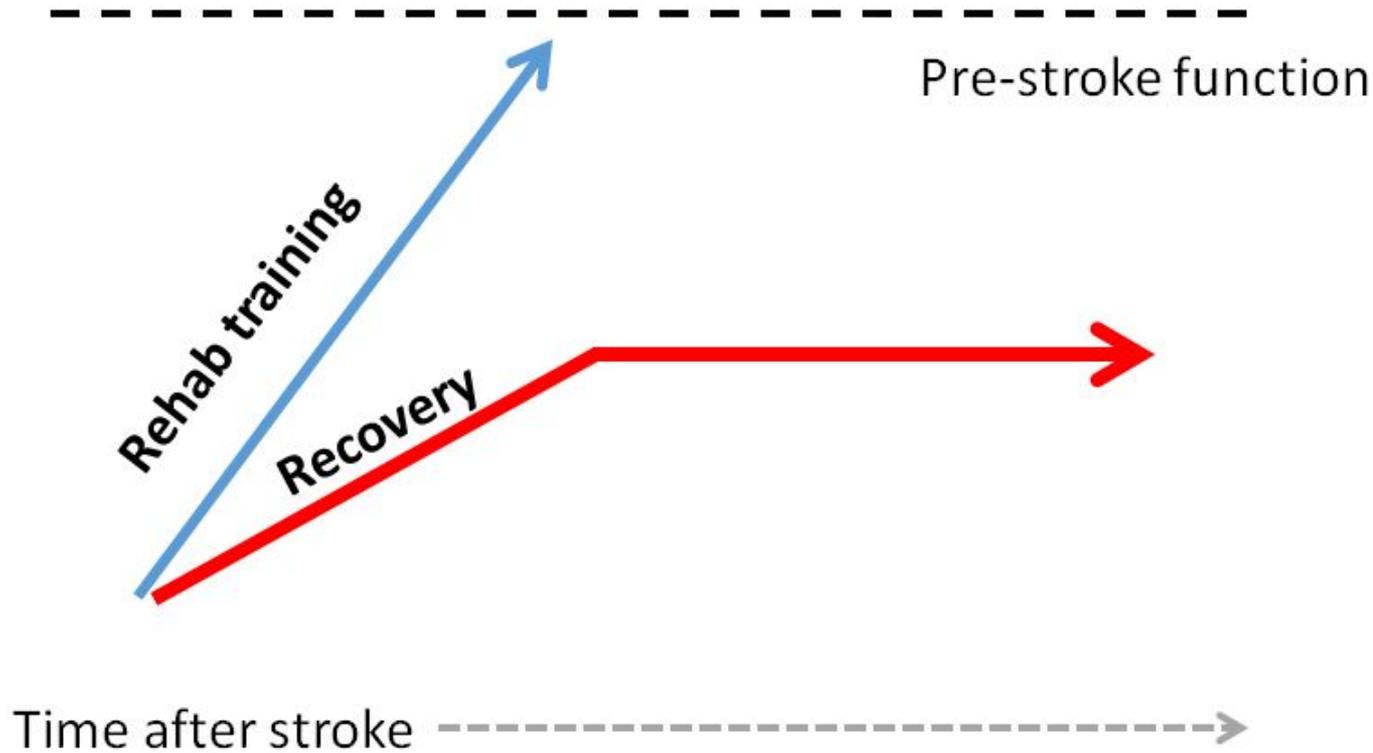
Number of strokes is increasing



Post-stroke recovery



Approaches for improving recovery

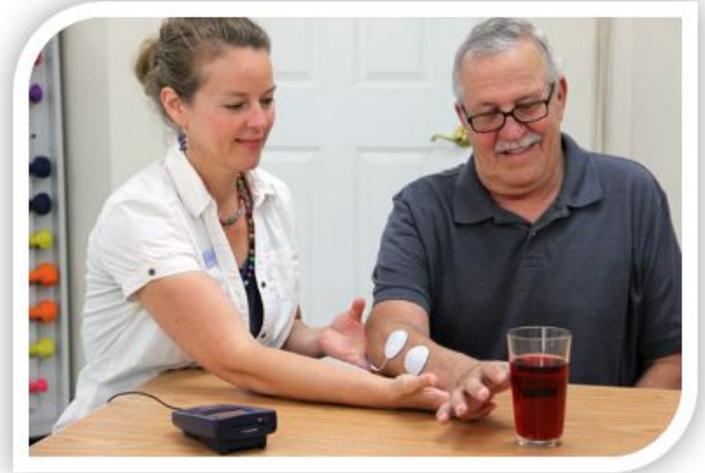


What is involved in rehab training?

Practicing activities of daily living

Rehab dose is measured by counting repetitions of different motions:

1. Reach
2. Transport
3. Reposition
4. Stabilize
5. Idle



What is the optimal dose of rehab training?



Animals require 200-1000+ reps/day to boost recovery



Some studies suggest that we are likely under-dosing our patients by 10x

Quantifying dose is challenging



“idle”



“reach”



“transport”



1 min video = 1 hour of labeling
1 therapy session (45 mins) = 1

Machine learning

StrokeRehab Dataset

Multi-modal data

- 3,372 trials of rehabilitation activities
- 51 stroke-impaired + 20 healthy subjects
- High quality labels (high inter-rater reliability: Cohen Kappa > 0.96)
- Time taken to label: ~2700 hours
- 44 hours of recorded training

Video data



IMU data



Dataset	StrokeRehab	FineGym	Breakfast	Jigsaws	50Salads
# of annotated actions	120,891	32,697	11,656	1,701	999

Demography of participants

	Training set (Mild + Moderate)	Test set (Mild + Moderate)	Severe set	Healthy control
n	35	8	8	20
Age (in years)	56.56 (21.2-82.7)	60.8 (42.6-84.2)	59.73 (41-74.3)	62.47 (42-82.9)
Gender (Female : Male)	18 F : 15 M	4 F : 4 M	5 F : 3 M	9 F : 11 M
Time since stroke (in years)	6.5 (0.3-38.4)	3.1 (0.4-5.7)	3.46 (1.14-6.43)	NA
Paretic side (Left : Right)	18 L : 15 R	4 L : 4 R	4 L : 4 R	NA
Fugl-Meyer Assessment score	48.1 (26-65)	49.4 (27-63)	16 (8-23)	66

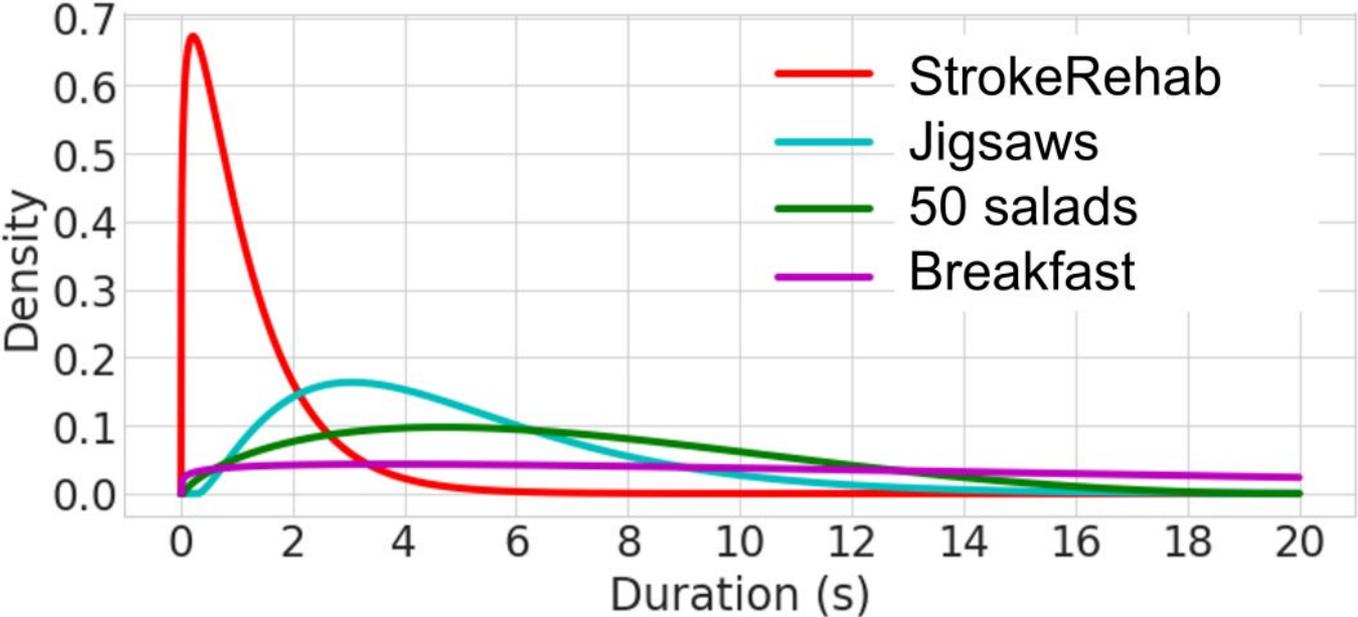
Capturing multi-modal data



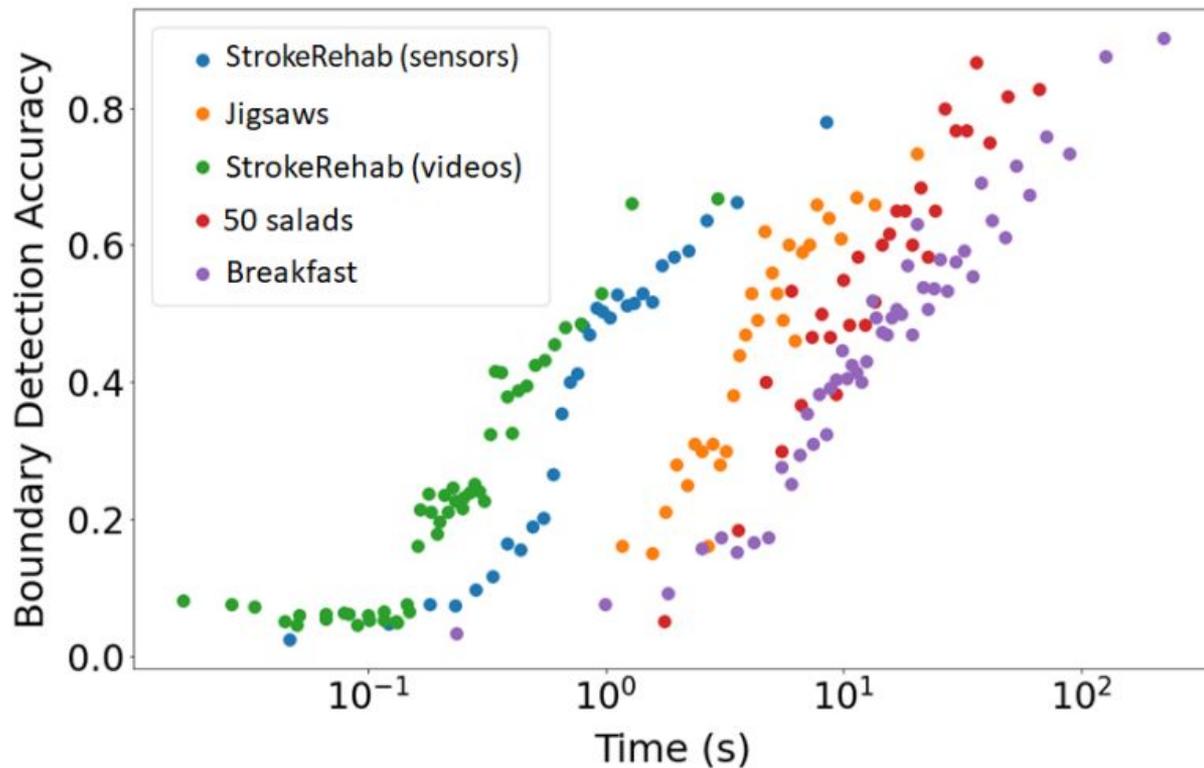
Contributions of StrokeRehab dataset

- First benchmark for short-duration actions
- Contains multiple modalities (video + wearable sensors)
- Contains realistic and challenging distribution shift (stroke patient vs healthy subjects)
- Clinically-meaningful benchmark for quantitative stroke rehabilitation

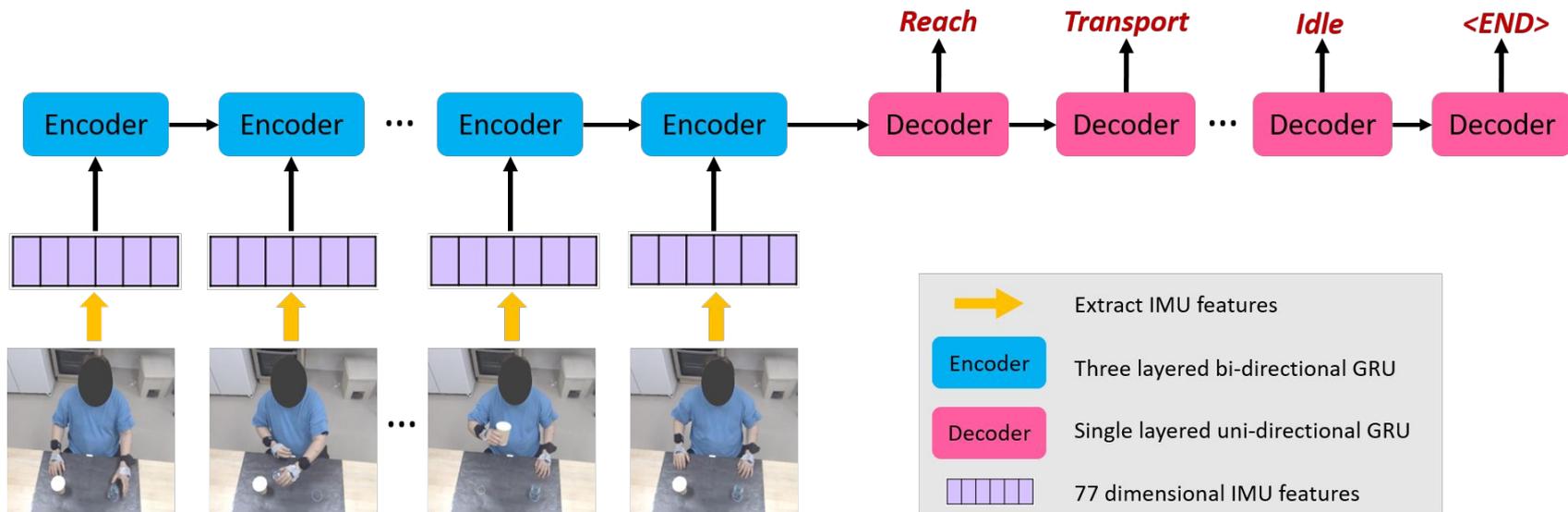
Action durations compared to existing benchmarks



Segmentation-based methods fail for short-duration actions



Methodological insight: Sequence-to-sequence model outperforms segmentation-based approaches

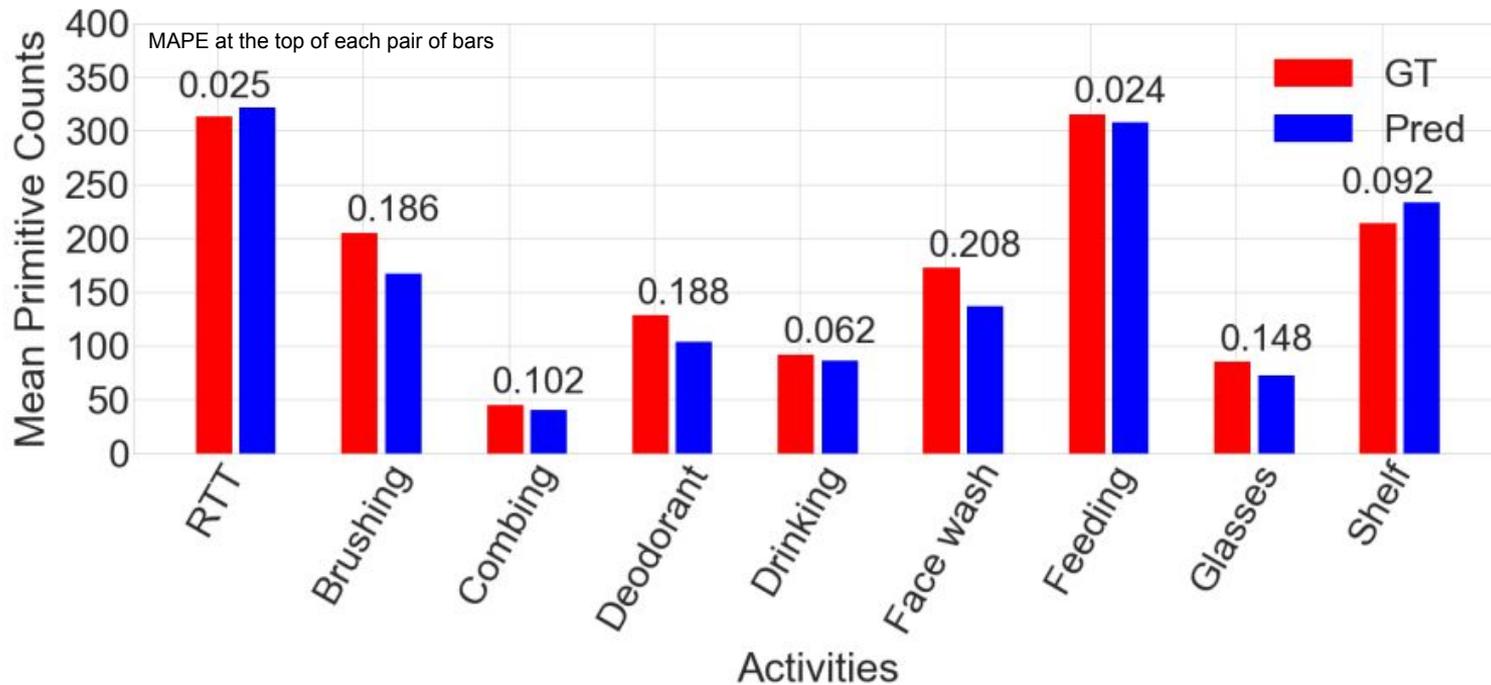


Dataset has realistic distributional shifts

Tested on	Healthy subjects	Stroke patients	Severely impaired
Trained on			
Healthy subjects (HS)	0.281	0.405	0.819
Stroke patients (SP)	0.286	0.305	0.612
HS + SP	0.287	0.297	0.604

Action Error Rate (Lower the better) (Similar to character error rate in speech recognition)

Clinically-meaningful metric: Motion counts



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