

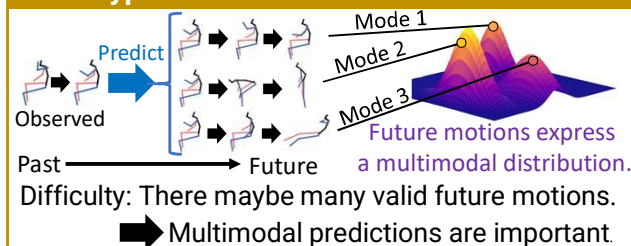
MMCM: Multimodality-aware Metric using Clustering-based Modes for Probabilistic Human Motion Prediction

Kyotaro Tokoro, Hiromu Taketsugu, Norimichi Ukita
Toyota Technological Institute



Project page

Multi-hypothesis Future Motion Prediction



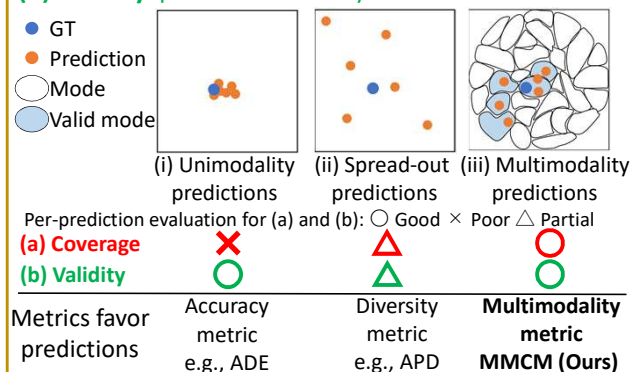
Prediction Methods: Probabilistic Models

Probabilistic models (e.g., VAEs, diffusion models) enable multiple predictions.

Limitation of current evaluation metric

Metrics: Evaluation Metric for Multimodality

- (a) **Coverage**: predictions are distributed to multi-modes
- (b) **Validity**: predictions fall only within valid modes

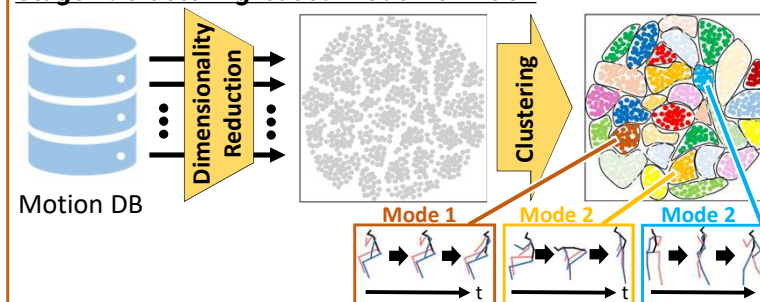


Our Proposed Metric

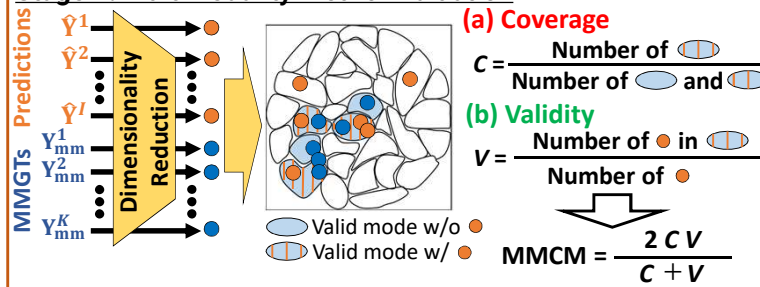
Contributions

- (a) **Coverage**: Define motion modes through clustering and evaluate whether predicted motions cover multiple modes.
- (b) **Validity**: Leverage MMGTs (which is pseudo multiple GTs) and assess the validity of each prediction.

Stage 1: Clustering-based Mode Definition



Stage 2: Multimodality Metric Evaluation



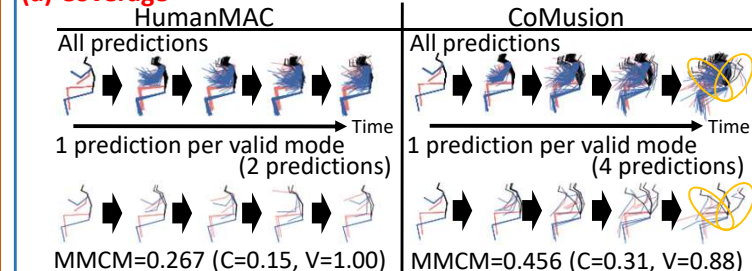
Results

Quantitative comparison

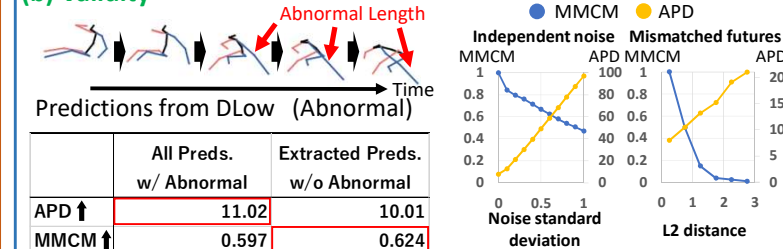
Method	Human3.6M					AMASS				
	MMCM $\uparrow$ (C $\uparrow$ / V $\uparrow$)	APD $\uparrow$	ADE $\downarrow$	FDE $\downarrow$		MMCM $\uparrow$ (C $\uparrow$ / V $\uparrow$)	APD $\uparrow$	ADE $\downarrow$	FDE $\downarrow$	
DLow [1]	0.487(0.569/0.539)	11.230	0.421	0.515		0.314(0.657/0.265)	13.169	0.590	0.611	
HumanMAC[2]	0.504(0.471/0.737)	6.235	0.369	0.479		-	-	-	-	
BeLFusion[3]	0.509(0.511/0.653)	7.618	0.372	0.472		0.386(0.637/0.382)	9.378	0.513	0.561	
CoMusion [4]	0.521(0.528/0.666)	7.644	0.351	0.459		0.378(0.642/0.403)	10.842	0.494	0.547	

Analysis

(a) Coverage



(b) Validity



Unlike APD, MMCM penalizes abnormal motions.
MMCM can successfully measure (b) Validity.

References

- [1] Ye Yuan, et al., "DLow: Diversifying Latent Flows for Diverse Human Motion Prediction." ECCV, 2020.
- [2] Ling-Hao Chen, et al., "HumanMAC: Masked Motion Completion for Human Motion Prediction." ICCV, 2023.
- [3] Germán Barquero, et al., "BeLFusion: Latent Diffusion for Behavior-Driven Human Motion Prediction." ICCV, 2023.
- [4] Jiarui Sun, et al., "CoMusion: Towards Consistent Stochastic Human Motion Prediction via Motion Diffusion." ECCV, 2024.