Learning Paradigm Architectures for Surgical Action Prediction

Model-Based RL **Model-Free RL Supervised Imitation Learning** Frame Sequence → GPT-2 (Causal) State + Action → Transformer Video Frames → RL Policy → Next Frame + Action Prediction → Next State + Rewards → Direct Action Selection • Pure autoregressive modeling • Action-conditioned simulation • Direct video interaction • No action conditioning • World model + RL policy • No world model required **Shared Training Data: CholecT50 Dataset**

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Frame Embeddings • Expert Actions • Surgical Phases • Reward Signals

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Unified Evaluation: Surgical Action Prediction

Single-step: state → action_probabilities (identical for all paradigms)



Performance Results (mAP)

Supervised IL: 0.737 | Model-Free RL: 0.706 | Model-Based RL: 0.702

All paradigms achieve comparable performance!