

# Towards Effective Human Motion Descriptors

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# Outline

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- Motion Capture Data
- Motivation
- Evaluation Methodology
- Results
- Summary



# Motion Capture Data

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- Digitalized human motion
  - ▣ joint coordinates, euler angles
- Features
  - Derived **descriptors**

Movement

MoCap Data

Features



# Optical Systems

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- ▣ Triangulations of the 3D position from image sensors data
- ▣ Multiple high-speed video cameras 2~48 (even 300)
- ▣ Markers or surface features
- ▣ **Passive** markers
  - Retro-reflective material reflects light generated near the camera lens
  - +Wireless -Marker swapping
- ▣ **Active** markers
  - LED emitting own light
  - Marker identified by modulation of amplitude, pulse width, time window

# Optical Systems, cont.

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- Passive **imperceptible** markers
  - Up side down approach
  - Photosensitive markers
    - Depth Map
- **Markerless**
  - Analysis of video
    - Identify human forms and break down into constituent parts for tracking
  - Stanford, UMD, MIT, MPI
  - MS Kinect, Asus Xtion, PrimeSense Carmine, Organic Motion, Xsens

# Non-optical systems

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- **Inertial** systems
  - Miniature inertial sensors
  - Wireless communication
  - Position error accumulates over time
  - Wii controller
- **Mechanical** systems
  - Exo-skeleton system tracks angles directly
- **Magnetic** systems
  - Relative intensity of the voltage or current of coils

# Applications

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- Health care – success of rehabilitative treatments
  - ▣ Range of joint angle rotation
- Sports – performance aspect comparison
  - ▣ Variability of same motion – pole-jump, figure skating
- Security – person identification, event detection
  - ▣ Gait recognition, stealing, fighting
  - ▣ Home for the elderly
- Computer animation – realistic motion synthesis
  - ▣ Motion retrieval

# Premise

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Ultimate descriptor solving problems of all applications does not exist



# Purpose

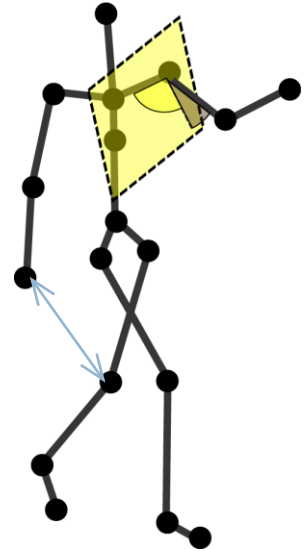
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- Application => Purpose
- Action oriented
  - ▣ What?
  - ▣ Action, style of action, event detection
  - ▣ Logically similar movements
- Subject oriented
  - ▣ Who?
  - ▣ Subject recognition, age, gender, drunkenness, pregnancy, skeletal disease

# Similarity Model

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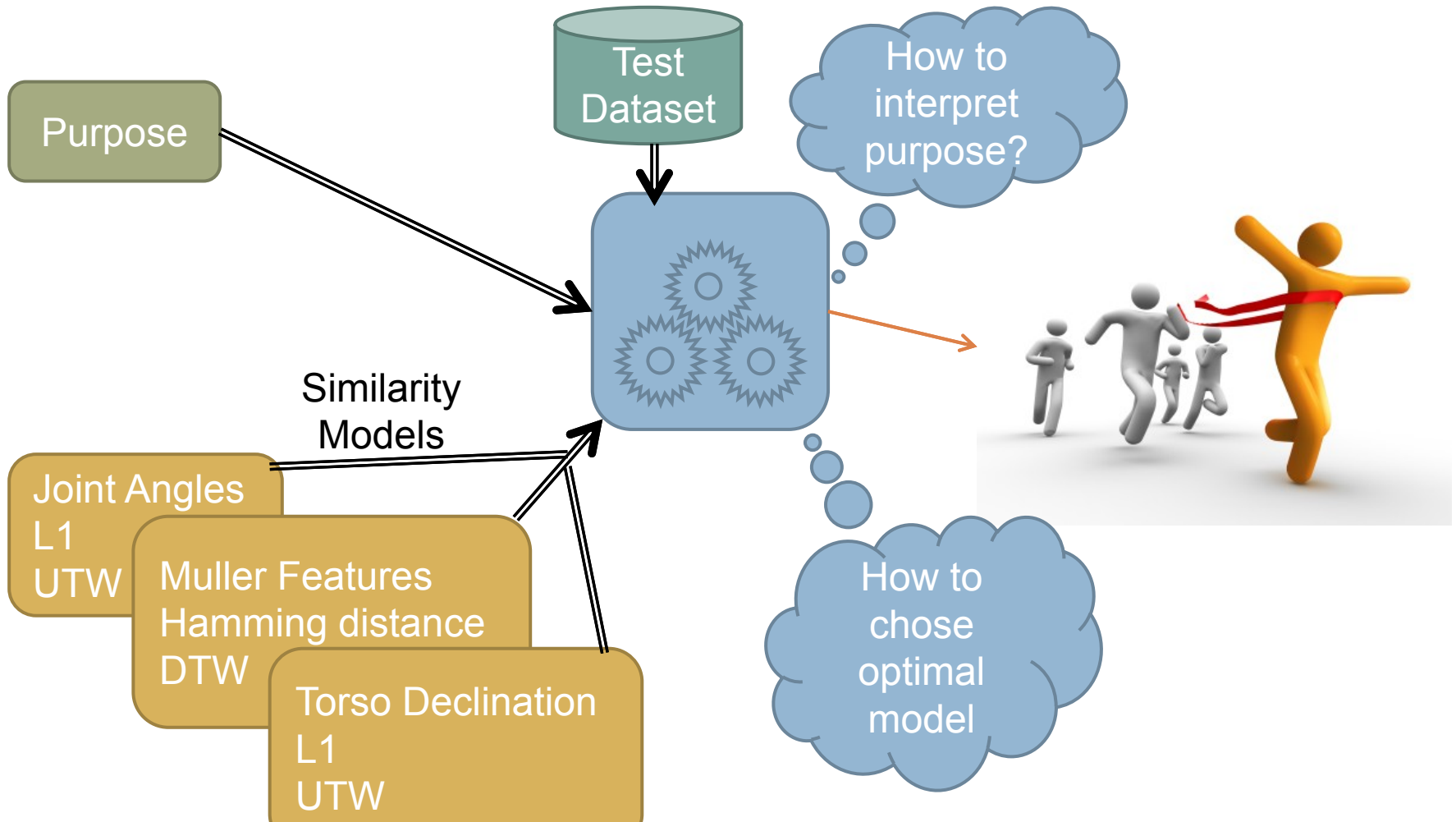
- Pose – skeleton configuration in one frame
- Pose features – extracted from one pose
  - ▣ Distances between joints/planes, joint angles, velocities, accelerations, powers, torques, directions
  - ▣ Optional quantization
    - relational features, fuzzy features
- Distance between:
  - ▣ **Poses** –  $L_P$ , Hamming, Mahalanobis
  - ▣ **Sequences** – DTW, UTW, Uniform scaling



# Evaluation Methodology

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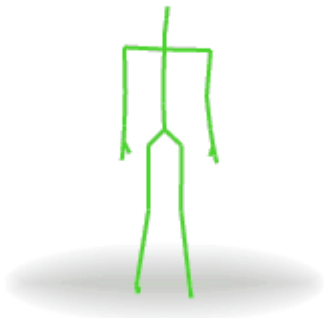
- **Choose optimal descriptor for given purpose**



# Ground Truth as a Purpose

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- Purpose represented by ground truth to the given test dataset
  - ▣ **Subject\_1**: Seq1, Seq4, **Subject\_2**: Seq2, **Subject\_3**: Seq3
  - ▣ **Bending**: Seq1, **Jumping**: Seq2, Seq4, **Throwing**: Seq3



# Measures

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- Retrieval Oriented
  - ▣ Mean Average Precision (MAP)
  - ▣ Mean Reciprocal Rank (MRR)
  - ▣ Discounted Cumulative Gain (DCG)
  - ▣ K-Nearest Neighbors
- Space Oriented
  - ▣ Dunn index
  - ▣ Davis-Bouldin index
  - ▣ Distance Distribution
- Time consumption

# Results

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- Dataset : HDM, CMU

# Summary

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- Purpose oriented descriptor evaluation
- Purpose represented as a ground truth
- Provided measures
  
- Future work
  - ▣ Distance distribution
  - ▣ Statistical testing

# Towards effective human motion descriptors

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Q & A

Thank you for your attention

