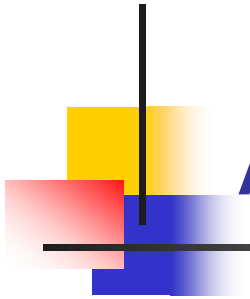
CS 112 - Hierarchical Model Representation

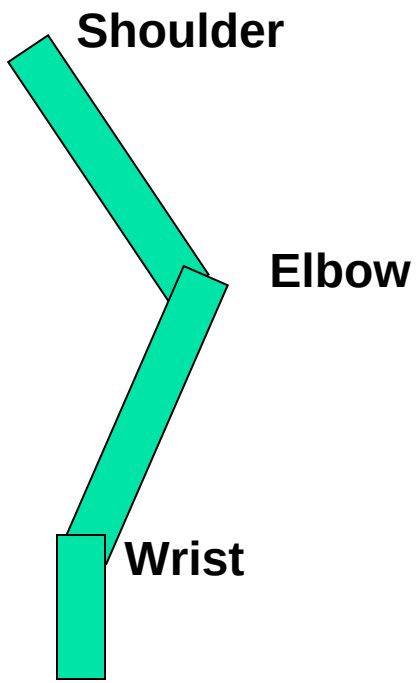


Animations

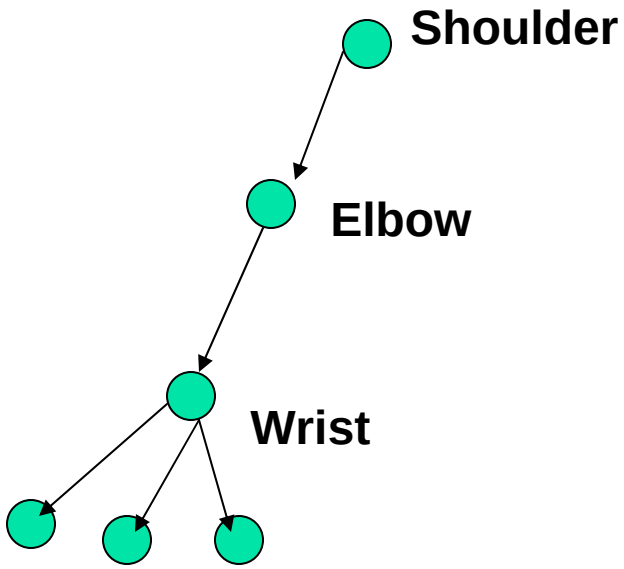
- Need efficient representation of
  - Model geometry
  - Motion
  - Interactive rendering

Inherent relationship of parts

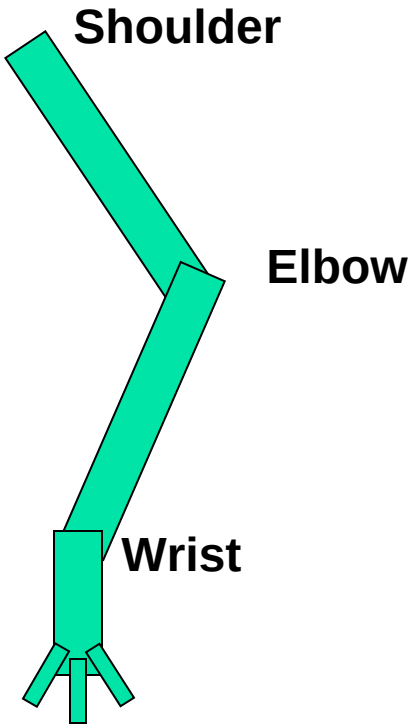
- Arm – Simple model
- Shoulder moves all the three parts
- Elbow moves everything below it
- Inherent hierarchical relationship

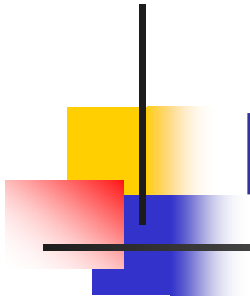


Inherent relationship of parts



Directed Acyclic Tree



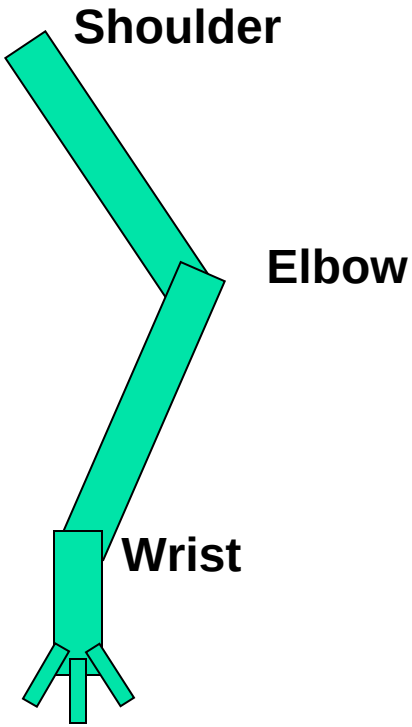


Dependency

- Any transformation applied to the parent will be undergone by the children
  - Children must be placed appropriately with respect to the parent
- Children may have their own independent movement
  - Not transmitted to the parent

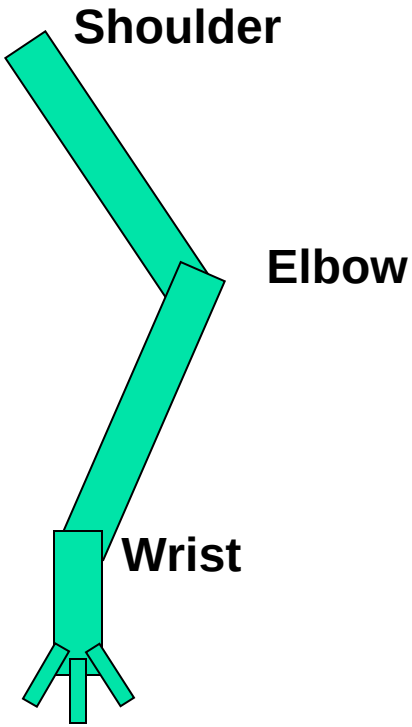
Representing Transformations

- Transformation with respect to the parent
- Transformation to place it appropriately with respect to the parent



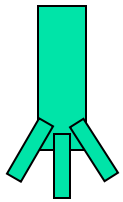
Representing Transformations

- Transformation with respect to the parent
- Transformation to place it appropriately with respect to the parent



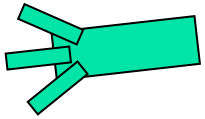
Representing Transformations

- Assume each part is defined with origin at center



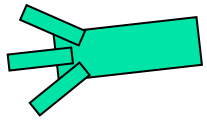
Representing Transformations

- Assume each part is defined with origin at center
- R_w



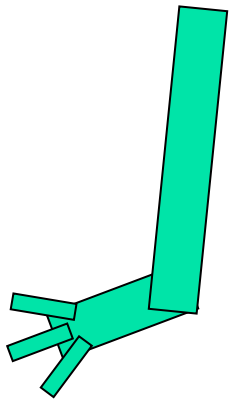
Representing Transformations

- Assume each part is defined with origin at center
- R_w
- T_{we}



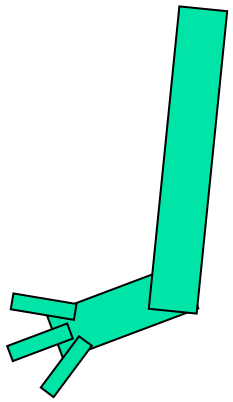
Representing Transformations

- Assume each part is defined with origin at center
- R_w – Wrist
- T_{we} - Wrist
- R_E – Elbow and Wrist



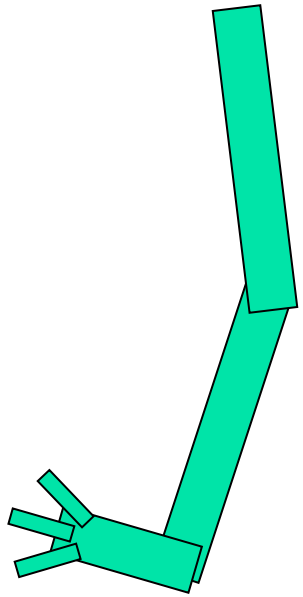
Representing Transformations

- Assume each part is defined with origin at center
- R_w – Wrist
- T_{we} - Wrist
- R_e – Elbow and Wrist
- T_{es} – Elbow and Wrist



Representing Transformations

- Assume each part is defined with origin at center
- R_w – Wrist
- T_{we} - Wrist
- R_e – Elbow and Wrist
- T_{es} – Elbow and Wrist
- R_s – Shoulder, elbow and wrist



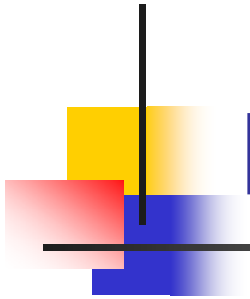
Representing Transformations

- Assume each part is defined with origin at center
- R_w – Wrist
- T_{we} - Wrist
- R_e – Elbow and Wrist
- T_{es} – Elbow and Wrist
- R_s – Shoulder, elbow and wrist

Wrist: $R_s T_{es} R_e T_{we} R_w$

Elbow: $R_s T_{es} R_e$

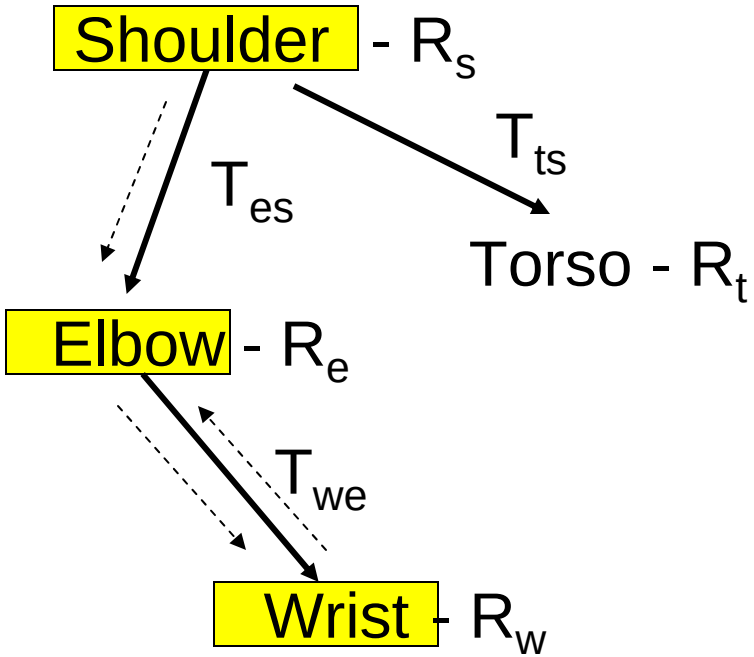
Shoulder: R_s



Data Structure

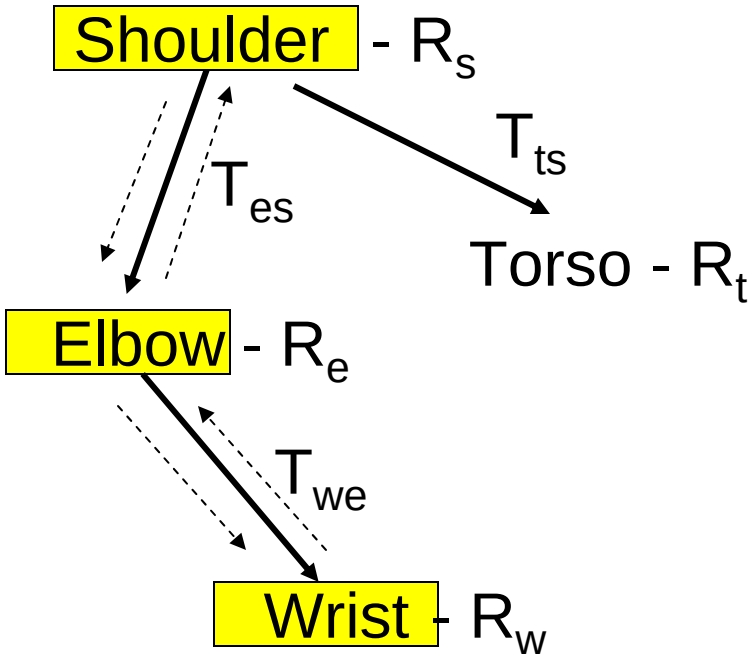
- Depth first traversal of the tree
- Push matrix when entering a node
- Pop matrix when leaving a node
- Render the node as you encounter it
- Example

Data Structure



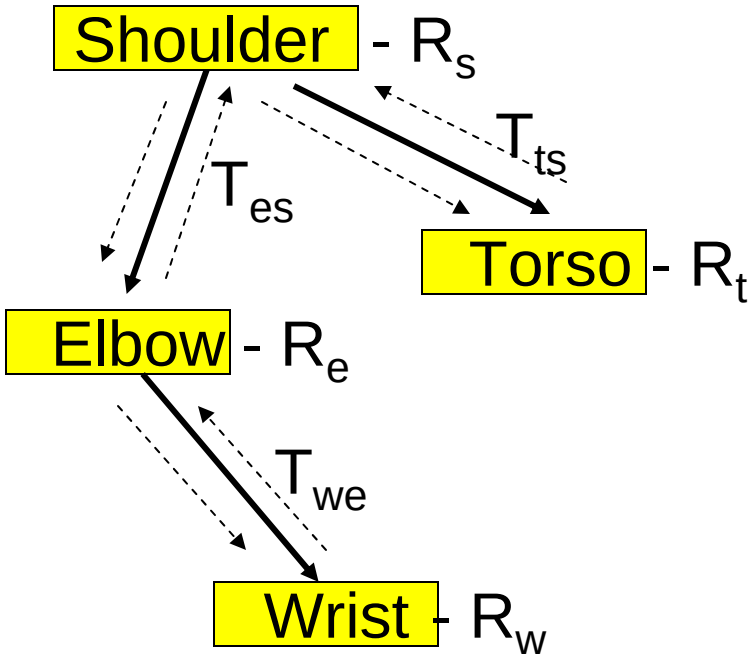
$R_s T_{es} R_e T_{we} R_w$
$R_s T_{es} R_e$
R_s

Data Structure



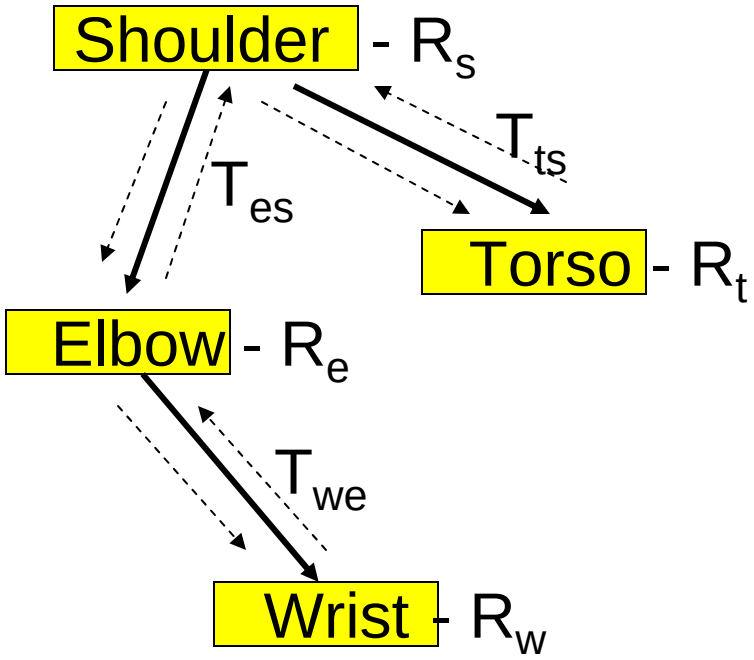
$R_s T_{es} R_e$
R_s

Data Structure



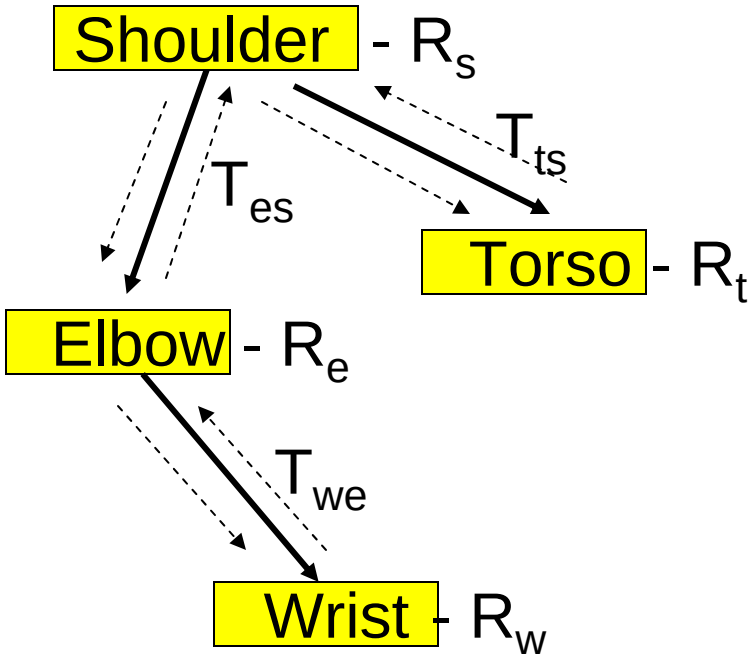
$R_s T_{ts} R_t$
R_s

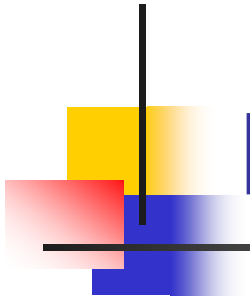
Data Structure



R_s

Data Structure





Representing Motion

- Keyframes
  - Generate the transformations for key postures
    - Done manually
  - Interpolate everything in between
    - Done automatically