



FALMOUTH
UNIVERSITY

COMP220: Graphics & Simulation

7: Rigging and animation

Learning outcomes

- ▶ **Explain** the role of rigging in 3D animation
- ▶ **Describe** how a rigged model is transformed to produce animation
- ▶ **Use** skeletal animation in your own programs

Scene graphs



Coordinate spaces

Coordinate spaces

Model space

Coordinate spaces

Model space



Model matrix

Coordinate spaces

Model space



World space

Model matrix

Coordinate spaces

Model space



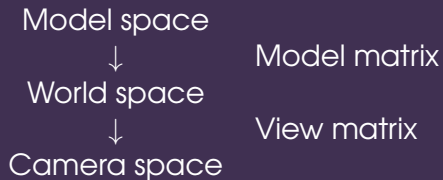
World space



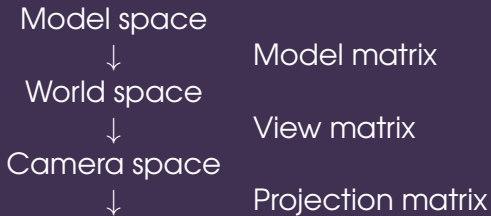
Model matrix

View matrix

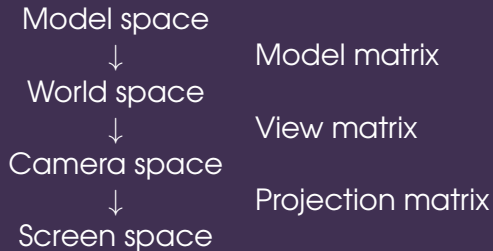
Coordinate spaces



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- ▶ E.g. when performing lighting calculations, ensure your fragment position, normal, light direction, eye direction are all in the **same** space

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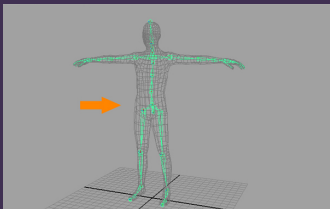
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- ▶ The model matrix is the **product** of model matrices for the node and its ancestors

Skeletal animation

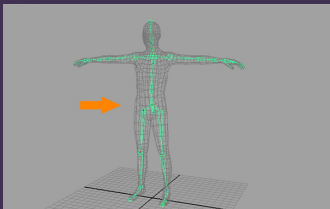


Rigging



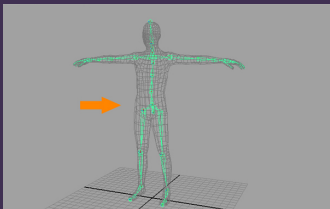
Rigging

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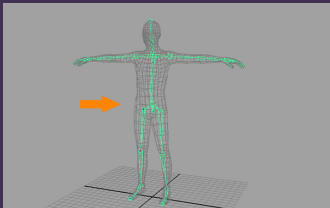


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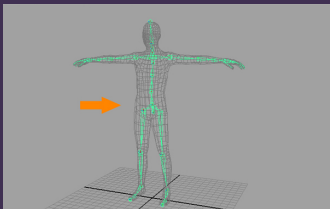


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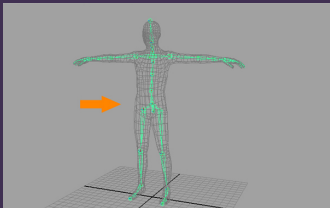
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Rigging



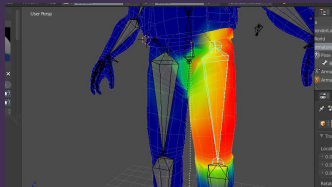
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Rigging



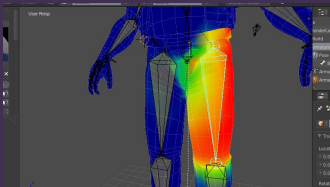
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- ▶ Arranged in a **hierarchy**
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 - ▶ Usually just rotation around a pivot point
 - ▶ 3D modelling software often represents bones as lines from parent bone to child bone

Bone weights

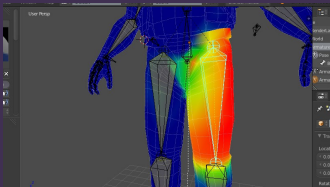


Bone weights

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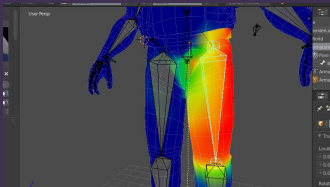


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- ▶ Weights specify how much each vertex is affected by each bone’s transformation

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- ▶ Generally handled by a **vertex shader**

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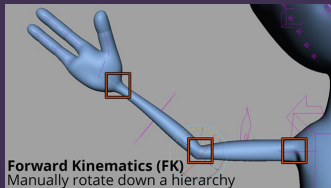
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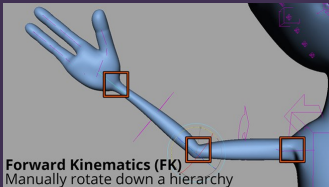
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 - ▶ E.g. bottom half plays “walk” animation, top half plays “fire weapon” animation

Forward kinematics (FK)

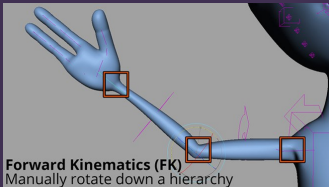


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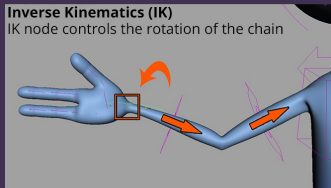
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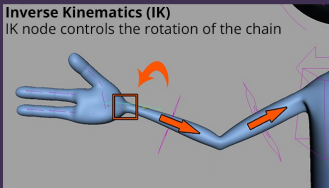


- ▶ Bone transformations are set **explicitly**
- ▶ Children are affected by parent transformations, e.g. if upper arm rotates, lower arm rotates with it

Inverse kinematics (IK)

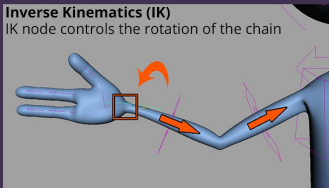


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- ▶ Bone transformations are calculated to reach a **target**
- ▶ E.g. we want character's hand to touch an object; IK calculates rotations of upper and lower arm to achieve this subject to constraints

The most common use for IK

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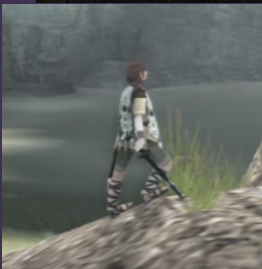
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Ragdolls



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- Attach a **rigid body** to each bone and run a **physics simulation**

Ragdolls



- ▶ Attach a **rigid body** to each bone and run a **physics simulation**
- ▶ Often used for death animations

Procedural animation

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Advanced animation



Animating with Math

<http://www.gdcvault.com.ezproxy.falmouth.ac.uk/play/1023249/Animating-With>