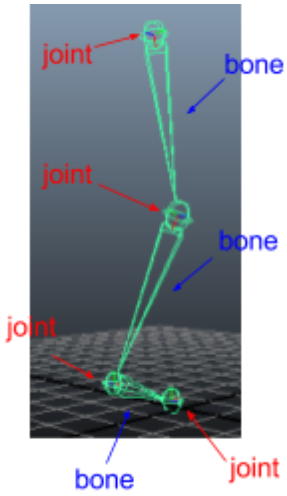
Maya 2015 Rigging

Joints

Joints are the fundamental unit of a rig. They hold on to rotation + position and are used to mimic the functionality of a skeleton.

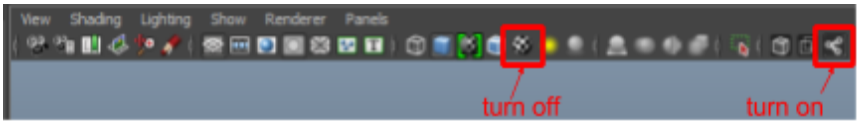
While joints can be standalone, bones are often used to connect two or more joints together.



In Maya, bones are NOT an explicit object (like joints are). They automatically show up between joints once you parent one joint to another.

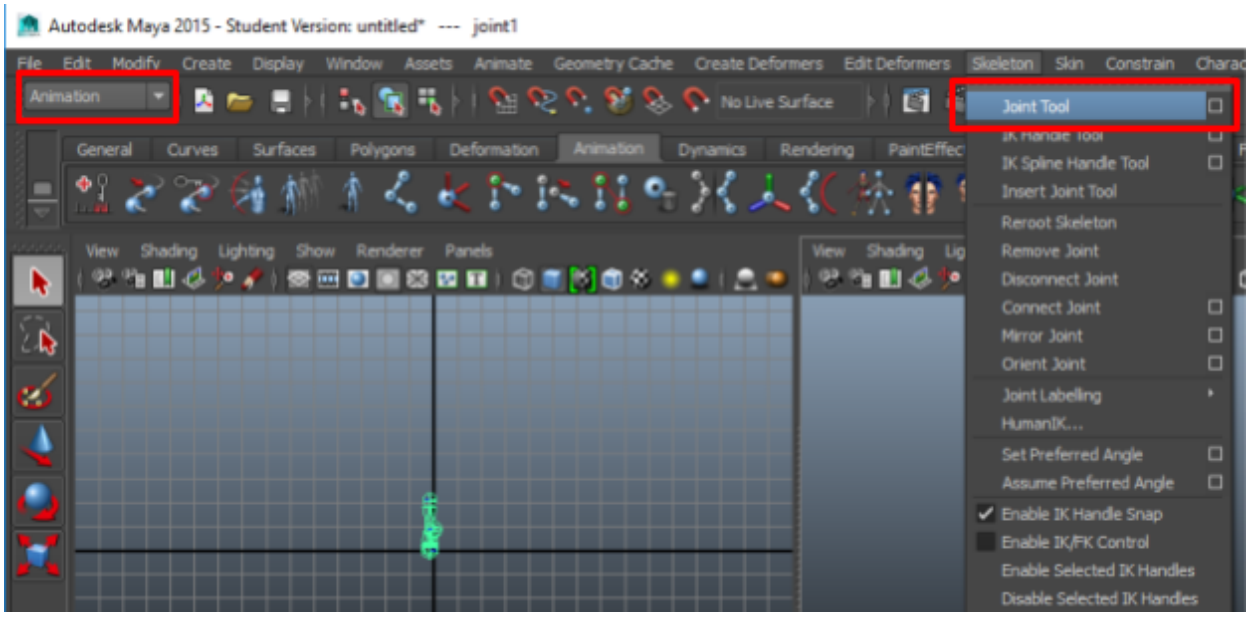
Depending on the type of rig you're doing you may have lots of bones or barely any. For example, It's unlikely that joints for a rig of a face will have many bones, while the joints for a rig of a body will have lots of joints.

> **HINT**: Before doing anything with joints, make sure to turn on the joint xray feature in the viewports and turn off texturing (Press 4 to go into smooth shading mode only). Texturing sometimes makes it tough to see joints.



Creating Joints

To create joints, begin by going to Skeleton -> Joint Tool (must be in animation menuset).



Once the tool is active, you can click in your viewport to create a set of connected joints and hit Enter once you've placed your last joint.

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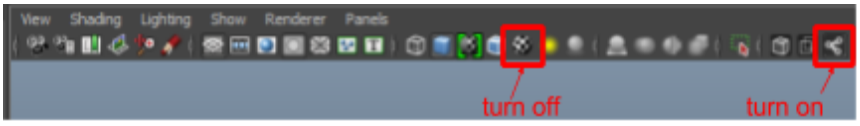
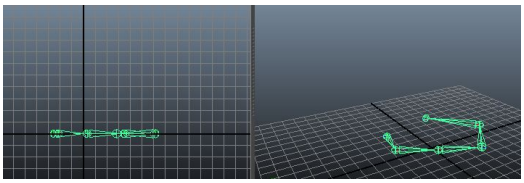


Joint Placement

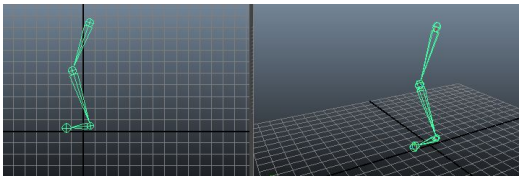
> **NOTE**: If you want to tweak the position of your nodes while you're still in creation mode, you can MMB click-and-drag the node to revise it.

You'll notice that the joints get placed on the grid plane of your viewport. So for example…

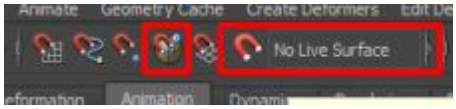
- if you created joints in perspective view, they'll end up on the ground.



- if you created joints in side view, they'll end up on the YZ plane.



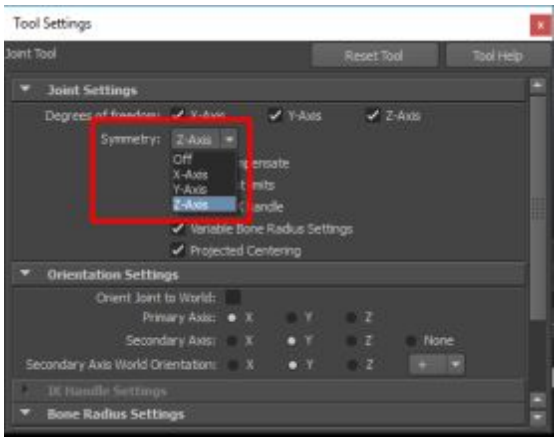
There are a couple of ways to get around this.

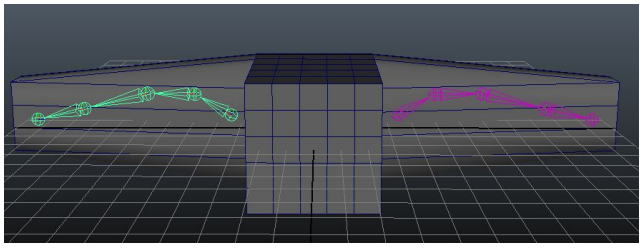


1. Select an object and set it as a live surface. Created joints will sit on the surface of that object.
2. Enable snap to projected center. Created joints will sit in the center of whatever part of whichever object you hit when you create the joint.

Joint Mirroring

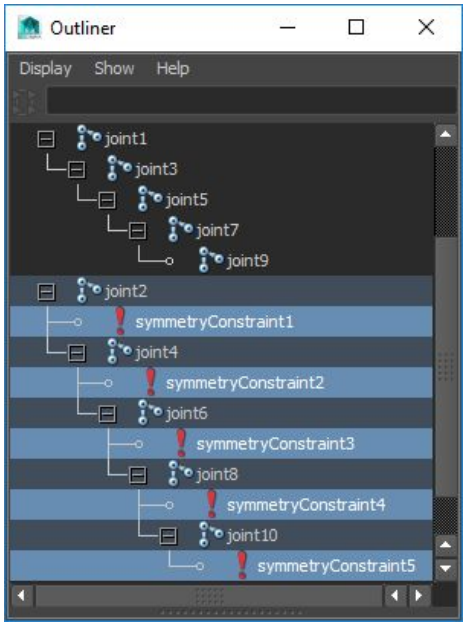
If your model is symmetrical, you can go into the joint tool options and turn on symmetry before you begin creating your joints. Symmetry will mirror joint creation across to the on whatever axis you specify.



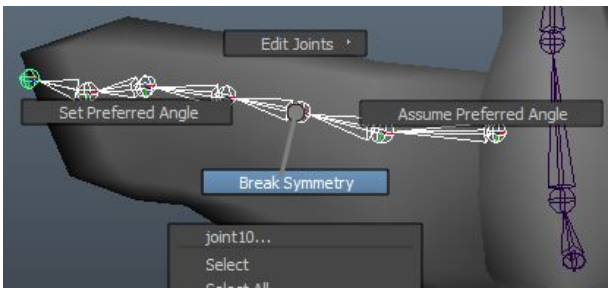


When you create joints with symmetry enabled, the mirror joints will take on the transform properties of the original. As such, any scale/rotation/translation you apply to one will get applied to the other.

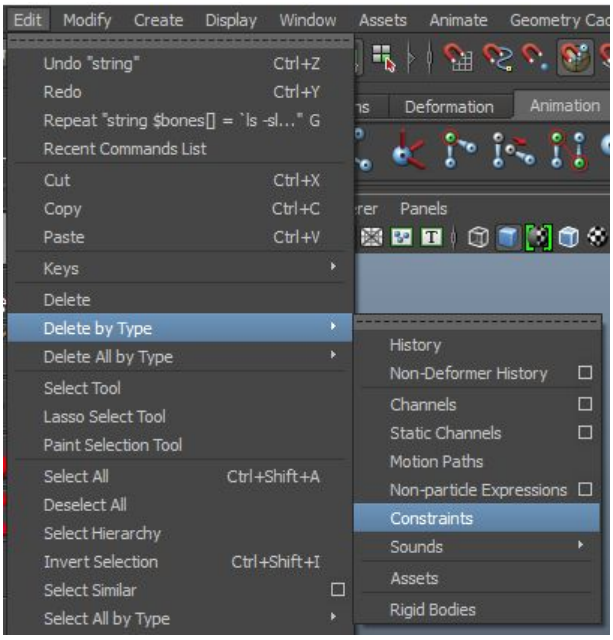
To stop this from happening, you can remove the symmetry constraints from the mirrored joints. Once you do this the mirrored joints will become independent.



NOTE: You can also right manually select each joint (not just the parent, but every single joint -- use the outliner if you have to), right-click to get the marking menu, and choose Break Symmetry.



NOTE: If the only constraints you have are from mirrored joints, you can go to Edit -> Delete By Type -> Constraints.



Modifying Joints

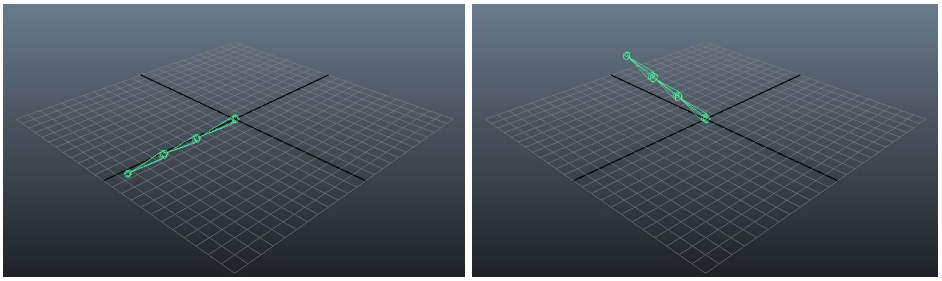
The top most joint in a chain/tree of joints is called the root joint. Remember that bones automatically show up between joints that a parent/child relationship.

> **NOTE**: Reminder that to parent one object to another, select and press P. To unparent one object from another, select and press Shift+P. See parenting/grouping section for more information on parenting.

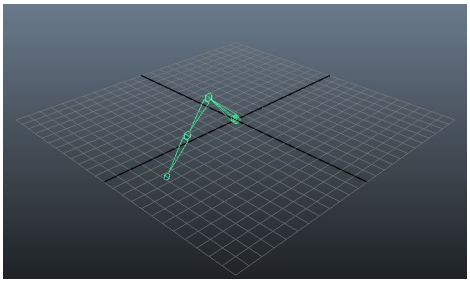
The fact that there's a parent/child relationship means that there are a couple of important properties in relation to joint manipulation. Child joints have local coordinates for rotation and translation. That means that…

1. Any rotation applied to a parent joint will get passed down to child joints.

   In the following example, only the root joint was rotated by 45 degrees. Note how all the children down the chain are also rotated 45 degrees around the root.

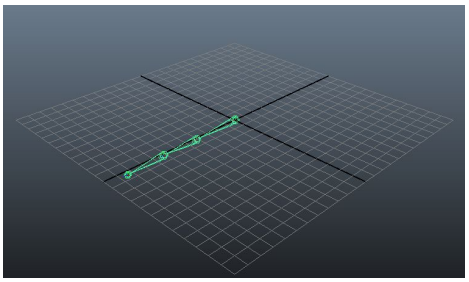
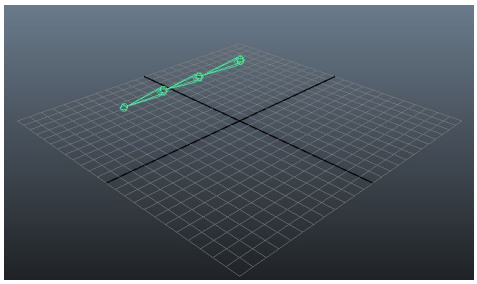


If I go down 1 child from the root and rotate by -90 degrees, we see all the children coming after it also rotated -90 degrees around the joint that had the rotation applied to it.



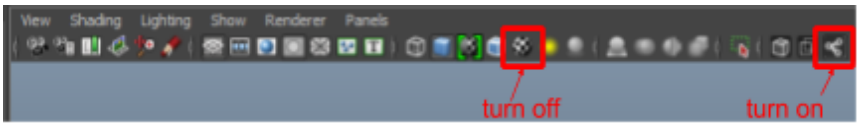
2. Any translation applied to a parent joint will get passed down to child joints.

   In the following example, only the root joint was translated up by 5. Note how all the children down the chain also pick up that same translation.

Note that scale isn't automatically applied to child joints. Neither is radius.

HINT: Before doing anything with joints, make sure to turn on the joint xray feature in the viewports and turn off texturing (Press 4 to go into smooth shading mode only). Texturing sometimes makes it tough to see joints.

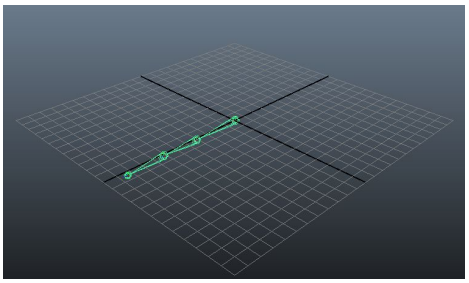
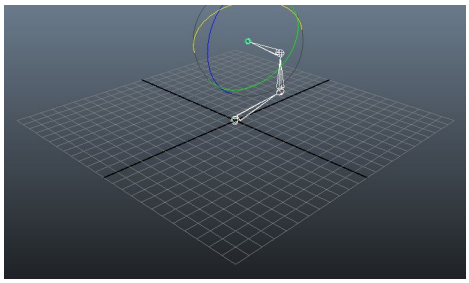


NOTE: If you're wondering what radius is, it controls how large the joint is when viewed in a viewport. It has no effect on the joint -- it's just a visual thing. You can find it in the channel box when a joint is selected.

NOTE: The rotation and translation shown in the channel box / attribute editor for child joints contain LOCAL coordinates. That means that what's displayed is an offset from the parent, not the total change from the root.

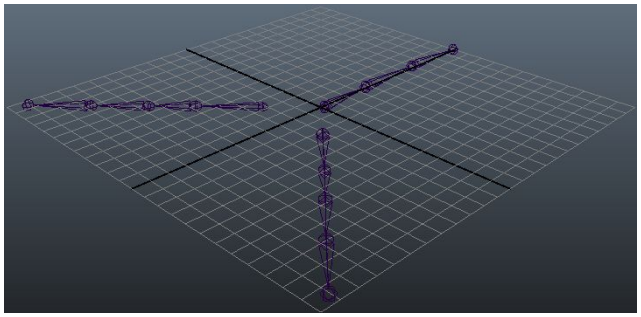
NOTE: If you want to apply the same amount of rotational offset / translational offset / scale to each joint, just select ALL joints in the chain and rotate (can't use the marquee

tool for this -- either use the outliner or hold shift and manually select each joint in the viewport). For example, if you select ALL joints and rotate them (instead of just selecting the parent and rotating), the skeleton will look like it's curling in on itself. This is because each joint is taking all the rotations up the chain and adding its own rotation as well.

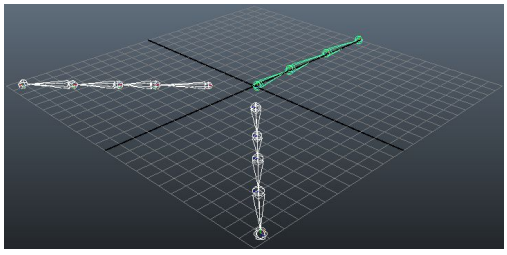
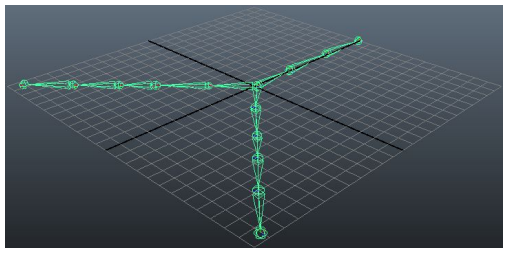



Connecting Joints

You can add bones between joints by parenting them together. For example, there are 3 separate skeletons....



If you want to select join them the diagonal skeletons to the skeleton going straight up, you need to parent them. To do this, first select the root joints of the diagonal skeletons, then select the root joint of the straight skeleton, then hit P.

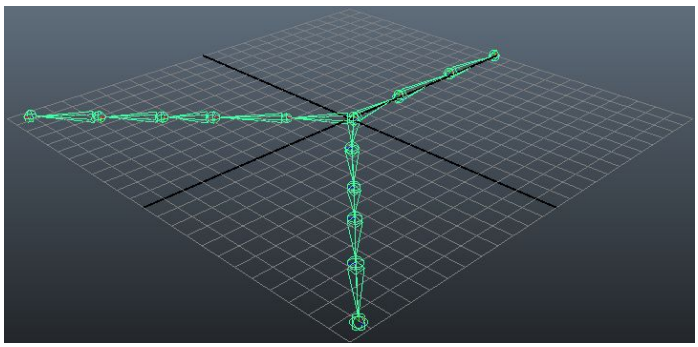



This will cause the skeletons the root joint of the diagonal skeletons to parent with root joint of the straight skeleton, combining them into a single skeleton with the root joint being the original root joint of the straight skeleton (the joint at the origin).

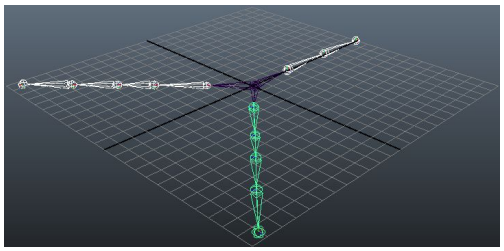
> **NOTE**: Remember how parenting works… The LAST node you select will be the parent. Everything you selected before it becomes a child of that parent.

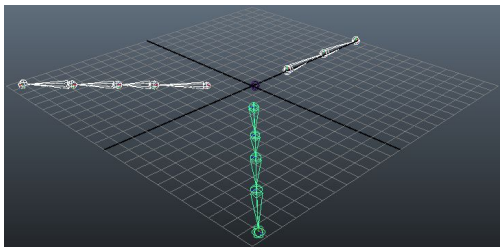
Disconnecting Joints

You can remove bones between joints by unparenting the. For example, There's a single skeleton that branches out 3 ways…



The root joint for the skeleton is in the middle. If we want to remove the root joint from the 3 branches, we can select the joints just after the root joint and hit Shift+P.





> **NOTE**: Remember how unparenting works… You select the CHILD and unparent it. You can't unchild the parent, you have to unparent the child. You can also unparent by breaking links in the hypergraph or the outliner.

Renaming Joints

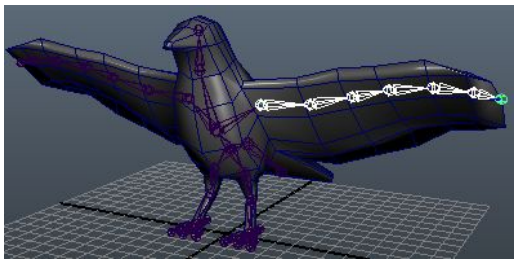
When you create joints, Maya will use the default joint name for every joint you create (e.g. joint1, joint2, …). What we want is to have a more intuitive naming scheme for our skeletons. For example, if we had a skeleton of a human body, we want the joints for the right arm to be prefixed with "r_arm", the left arm to be prefixed with "l_arm", the torso with "torso", etc..

Rather than manually renaming these joints one-by-one, we can use Maya's bulk renaming functionality.

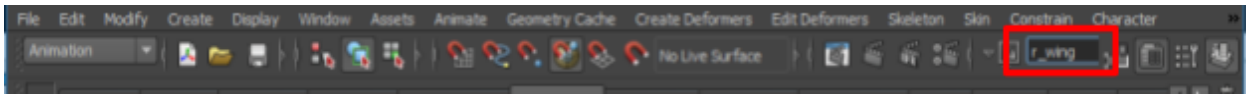
If you haven't already done so, expand the toolbar to expose the rename tool…

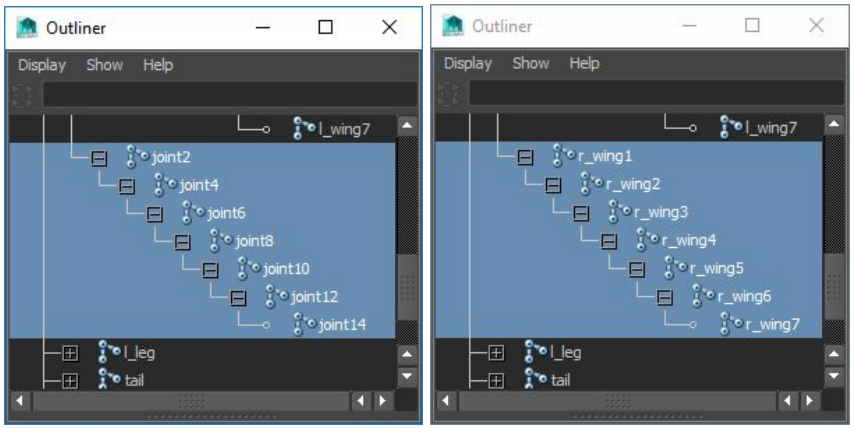
Once you've done that, individually select the joints you want to rename IN THE PROPER ORDER. That is, if you're selecting joints in an arm, you want to start by selecting the top-most joint first, then the second most top-most, all the way down to the leaf/child joint.

It doesn't matter if you're selecting in the viewport or the outliner or the hypergraph. ALWAYS SELECT IN THE PROPER ORDER because when you rename, it will append a number to each joint (the first one you selected will be appended with 1, the second one will be appended with 2, and so on and so forth).

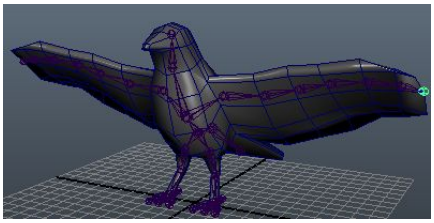


Once you're done selecting, go into the rename toolbox, type in your new name and hit Enter. The joints will now be renamed.

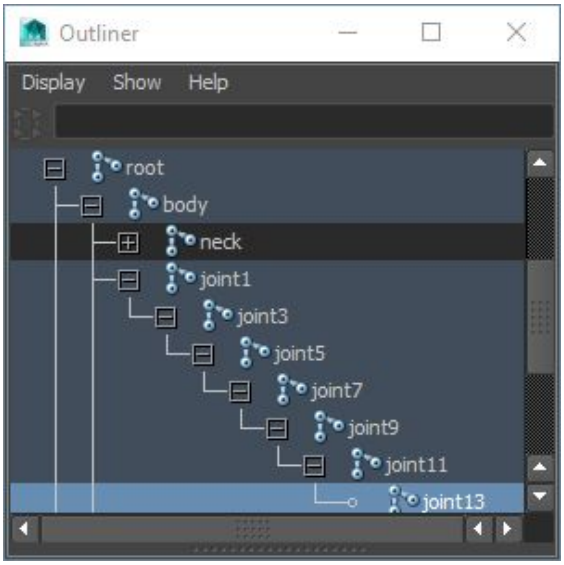




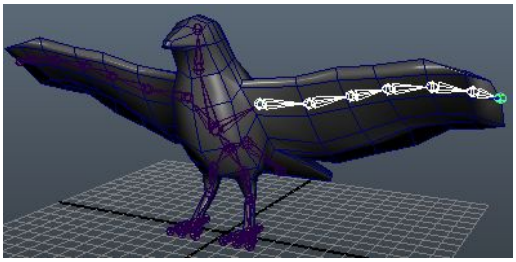
PRO-TIP: If you have the Outliner open, you can go into your viewport and select the leaf node.

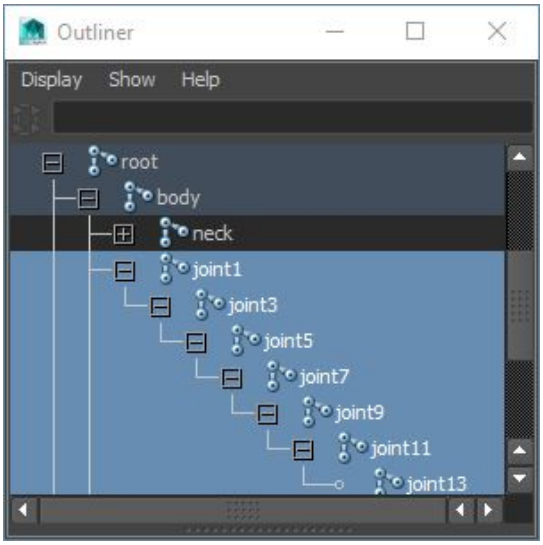


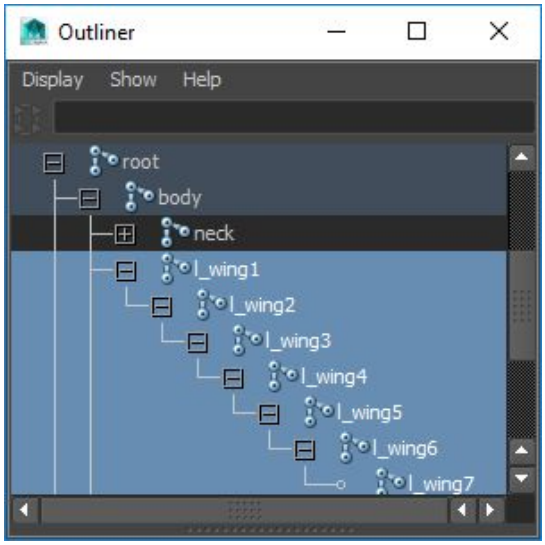
Then, in the outliner, you can right-click Reveal Selected to expand.



Click the top-most node and shift-click the bottom-most/leaf node. MAKE SURE TO DO IT IN THIS ORDER. You can rename at this point.



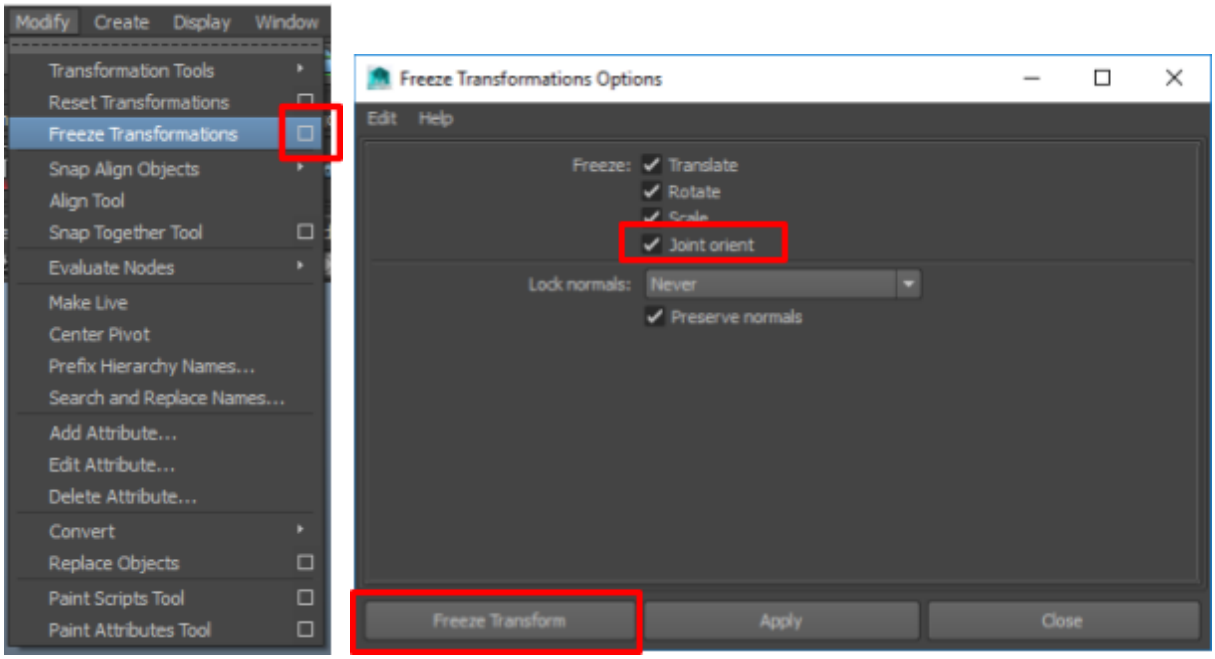




Finalizing Joints

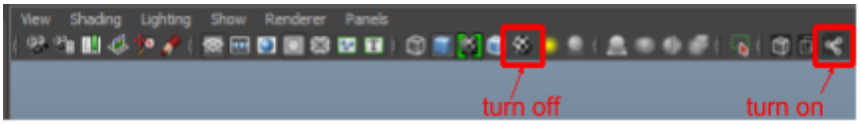
Once you've finished moving around and rotating your joints such that they're in their default/base position, you need to freeze the transforms. To do this…

1. Select all your joints.
2. Go to Modify -> Freeze Transform and click the little box on the right to open the options.
3. Make sure "Joint Orientation" is checked and click "Freeze Transform".



Once you do this, you'll notice that the rotations zero out and any scale you set gets reverted back to 1.

> **HINT**: Before doing anything with joints, make sure to turn on the joint xray feature in the viewports and turn off texturing (Press 4 to go into smooth shading mode only). Texturing sometimes makes it tough to see joints.

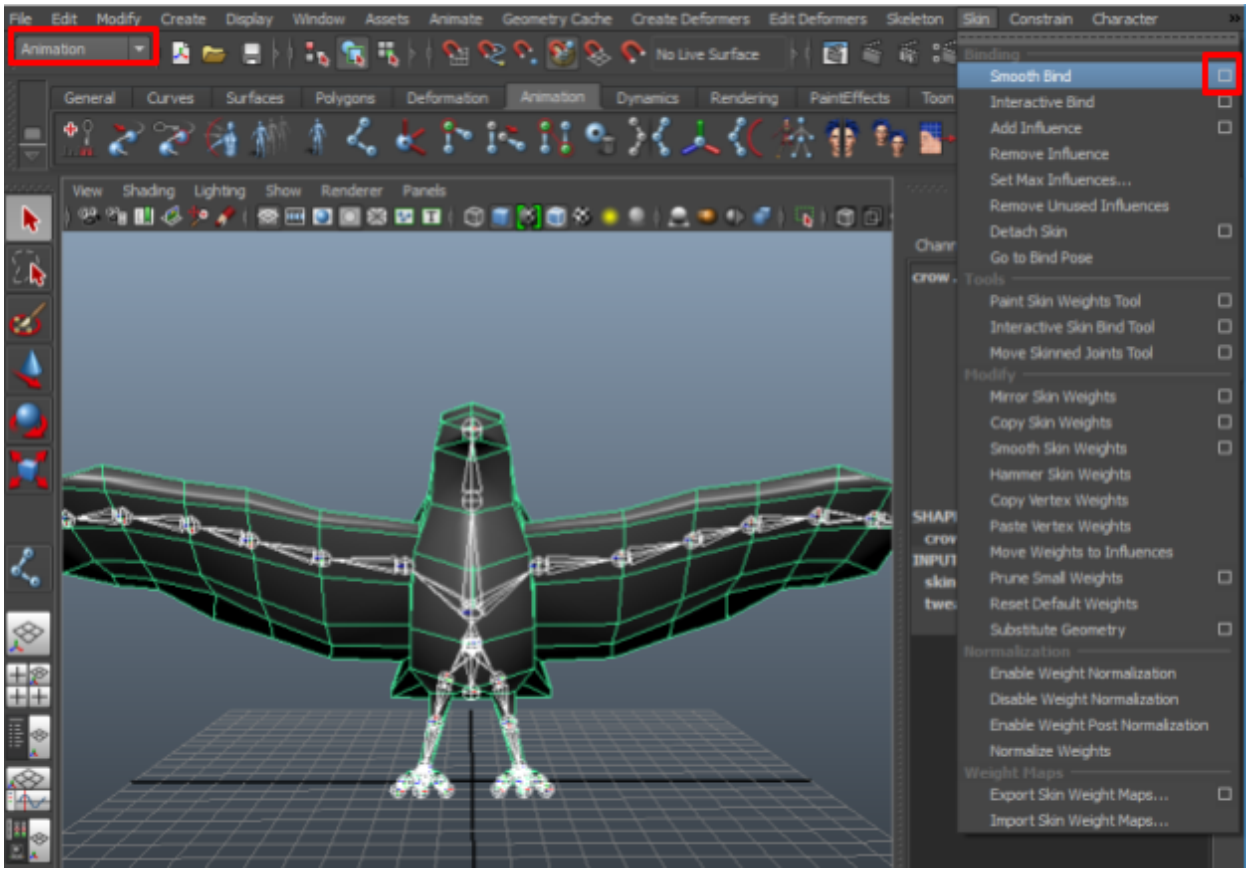


Creating Skinned Geometry

For joints to have any value, they need to be bound to geometry (also called skinning). Binding to geometry means that when you transform the joint those transformations also get applied to the geometry they're bound to (geometry in this case means a set of vertices). Since there may be multiple joints, a single vertex may be influenced by multiple joints.

Initially, we can assign the geometry of some object via the smooth bind tool.

1. Make sure you're in the Animation menu set.
2. Select both your joints and your object (multi-select), starting with the joints.
3. Go to Skin -> Smooth Bind and open the tool options (click the little box on the left).


File Edit Modify Create Display Window Assets Animate Geometry Cache Create Deformers Edit Deformers Skeleton Skin Constrain Character
Animation
No Live Surface
General Curves Surfaces Polygons Deformation Animation Dynamics Rendering PaintEffects Toon
View Shading Lighting Show Renderer Panels
Binding
Smooth Bind
Interactive Bind
Add Influence
Remove Influence
Set Max Influences...
Remove Unused Influences
Detach Skin
Go to Bind Pose
Tools
Paint Skin Weights Tool
Interactive Skin Bind Tool
Move Skinned Joints Tool
Modify
Mirror Skin Weights
Copy Skin Weights
Smooth Skin Weights
Hammer Skin Weights
Copy Vertex Weights
Paste Vertex Weights
Move Weights to Influences
Prune Small Weights
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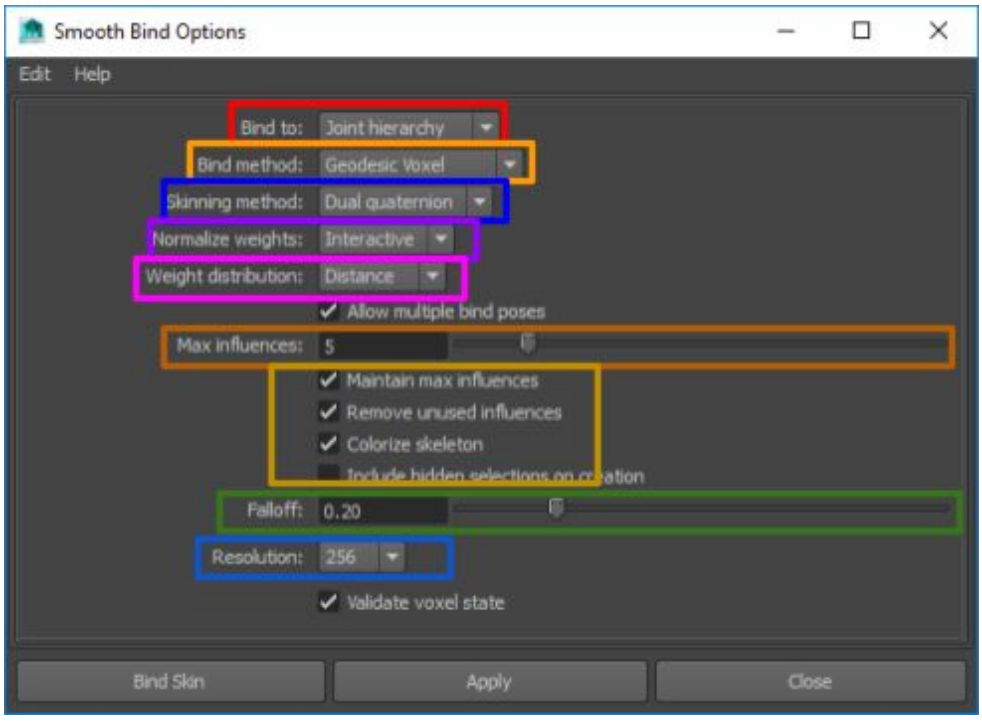
Enable Weight Post Normalization
Normalize Weights
Weight Maps
Export Skin Weight Maps...
Import Skin Weight Maps...


Smooth Bind Options
Edit Help
Bind to: Joint hierarchy
Bind method: Geodesic Voxel
Skinning method: Dual quaternion
Normalize weights: Interactive
Weight distribution: Distance
Allow multiple bind poses
Max influences: 5
Maintain max influences
Remove unused influences
Colorize skeleton
Falloff: 0.20
Resolution: 256
Validate voxel state
Bind Skin
Apply
Close

NOTE: Many of these options are confusing. I've described them as best I could based on the content I'm learning from. If in doubt, use the options in the screenshots as the default.

Bind to

Options here include Joint hierarchy, Selected joints, and Object hierarchy. Typically you would use Joint hierarchy as you want your object to be bound to the entire skeleton.

Sometimes, we may want something different: we want to have joints that help control other joints, but we don't want these helper joints to be attached to any geometry. In that case, Selected joints may be more appropriate.

Bind method

For this, you almost always want to use Geodesic Voxel. This method automatically subdivides your geometry into voxels (voxel = cube / 3D pixel). You won't see this process taking place nor will you be able to view the voxel grid when it's done -- all of this is done internally.

Apparently Geodesic Voxel produces the most accurate binding. But, be advised that it does take a bit of time to apply (it doesn't happen instantly, you need to wait a few seconds/minutes for it to complete). If you can't deal with the wait, the next 2 best choices here are Closest in distance or Closest in hierarchy.

Skinning method

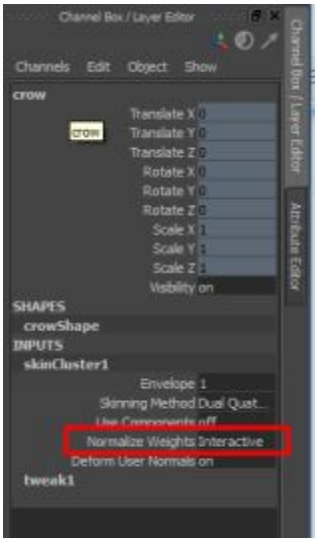
For this, you almost always want to use Dual Quaternion. This method tries to preserve the volume of your geometry, meaning that if you start twisting your joints you're less likely to end up with a sausage-linking effect that causes the volume of your object to go to 0.

Normalize weights

Interactive -- updates all of the weights every time you make a change to a vertex.

Post -- allows you to make changes to multiple vertices without having all of the weights update.

Post is usually a little easier to work with, but if you have a small number of vertices you can leave it as interactive. You can always change this option later on via the attribute editor / channel box. Once you finish skinning, select your object and choose the skinCluster node…



Weight distribution You almost always want to use Distance. This option looks at the distance each vertex is from each joint and weight it accordingly.

Max influences The max number of joints that will be attached to any single vertex.

Options Maintain max influences -- prevents going over the max influence setting (the option just above this one)

Remove unused influences -- removes influences with 0 weight.

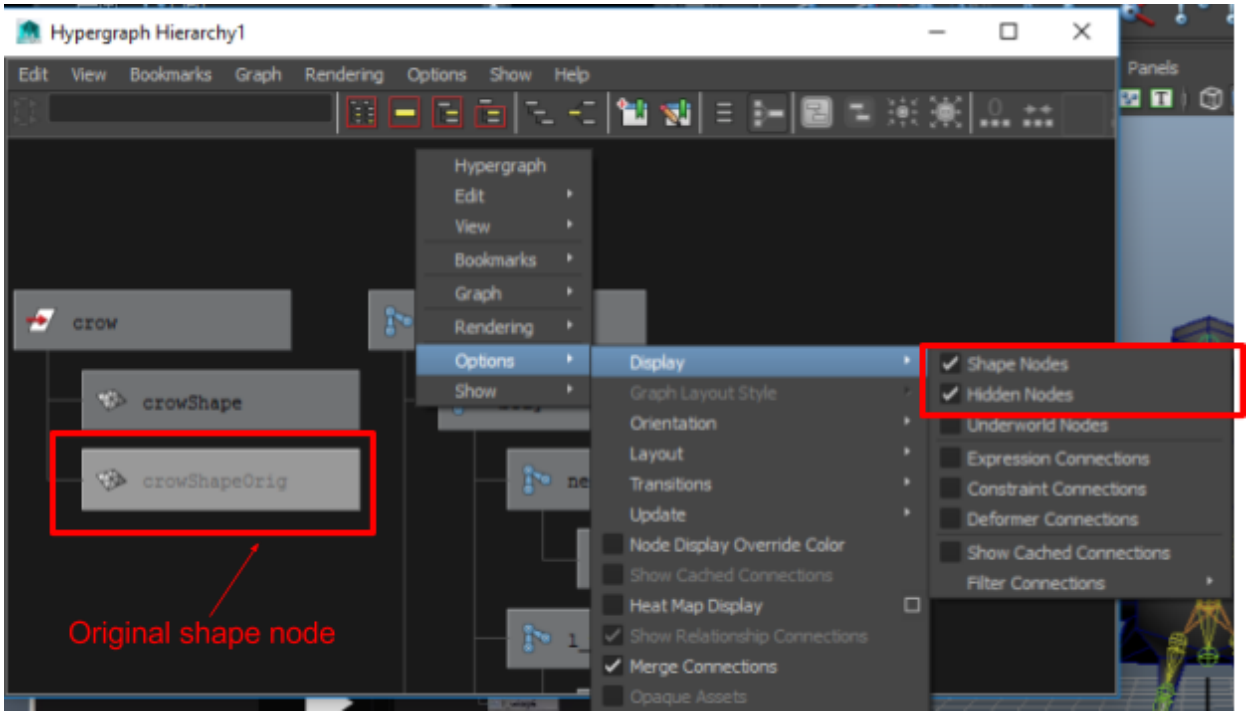
Colorize skeleton -- helps see which joints are bound to which vertices

Falloff No idea what this does. Seems to be related to geodesic voxel bind method.

Resolution Controls the number of voxels that'll be built for the geodesic voxel binding method. The higher the voxel count, the more detailed your weight distribution will be.

For low-poly/low-detail/low-resolution objects, you don't need a high number. For more details models (e.g. if you have a model with tons of little appendages like a centipede), you need to jack this number up.

No matter what binding method you choose, the end result will always be the same in the hypergraph. If you go into the hypergraph and turn on shape nodes + hidden nodes, you'll notice that the shape node for your geometry has been forked off to another node and a new shape node has taken its place.



The original shape node holds on to what the original object actually looked like before skinning. Transforming the joints causes deformations from that original object shape.

Updating Skinned Geometry

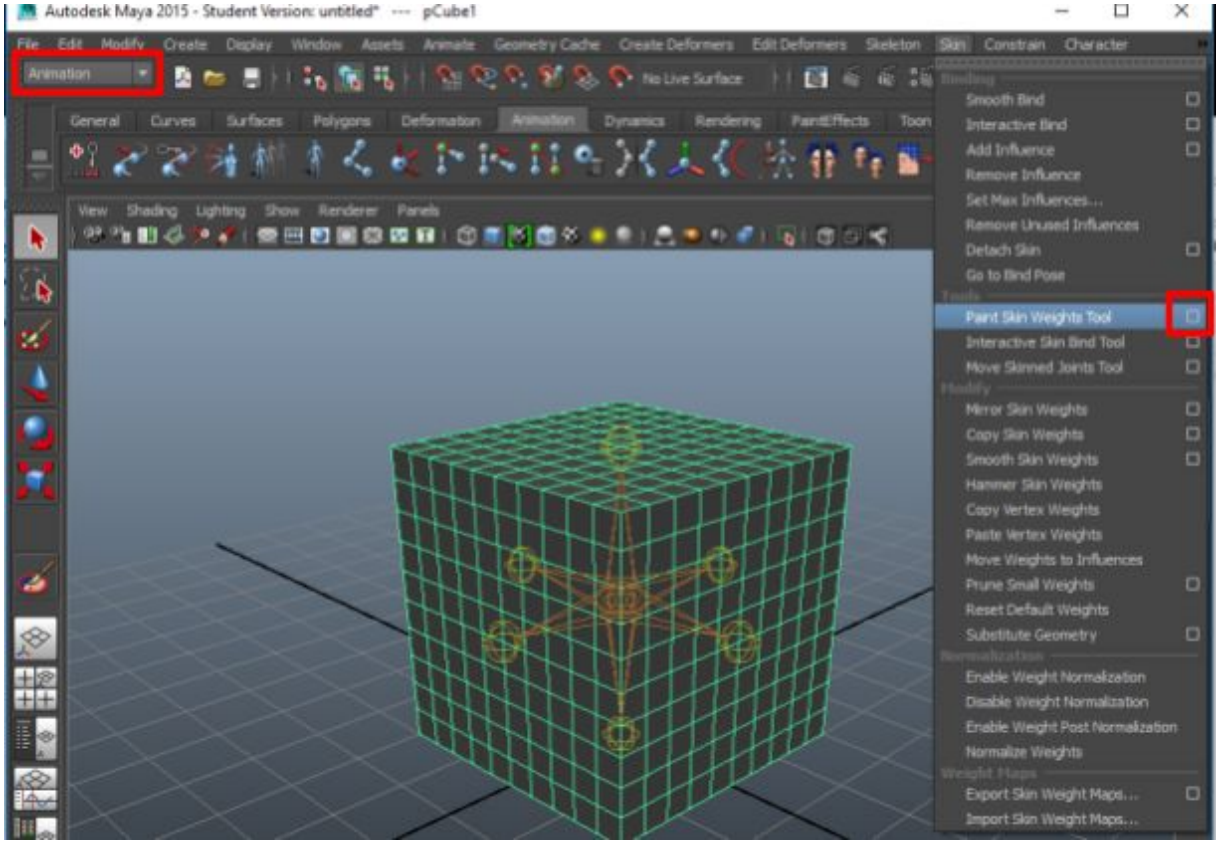
Once you've skinned your geometry, things may not come out exactly as you expect them to. Transforming certain joints may influence parts of your geometry that they shouldn't. For example, if you had a model of the hand and you curled in a finger, you don't want the joints in that finger to modify the geometry for the wrist.

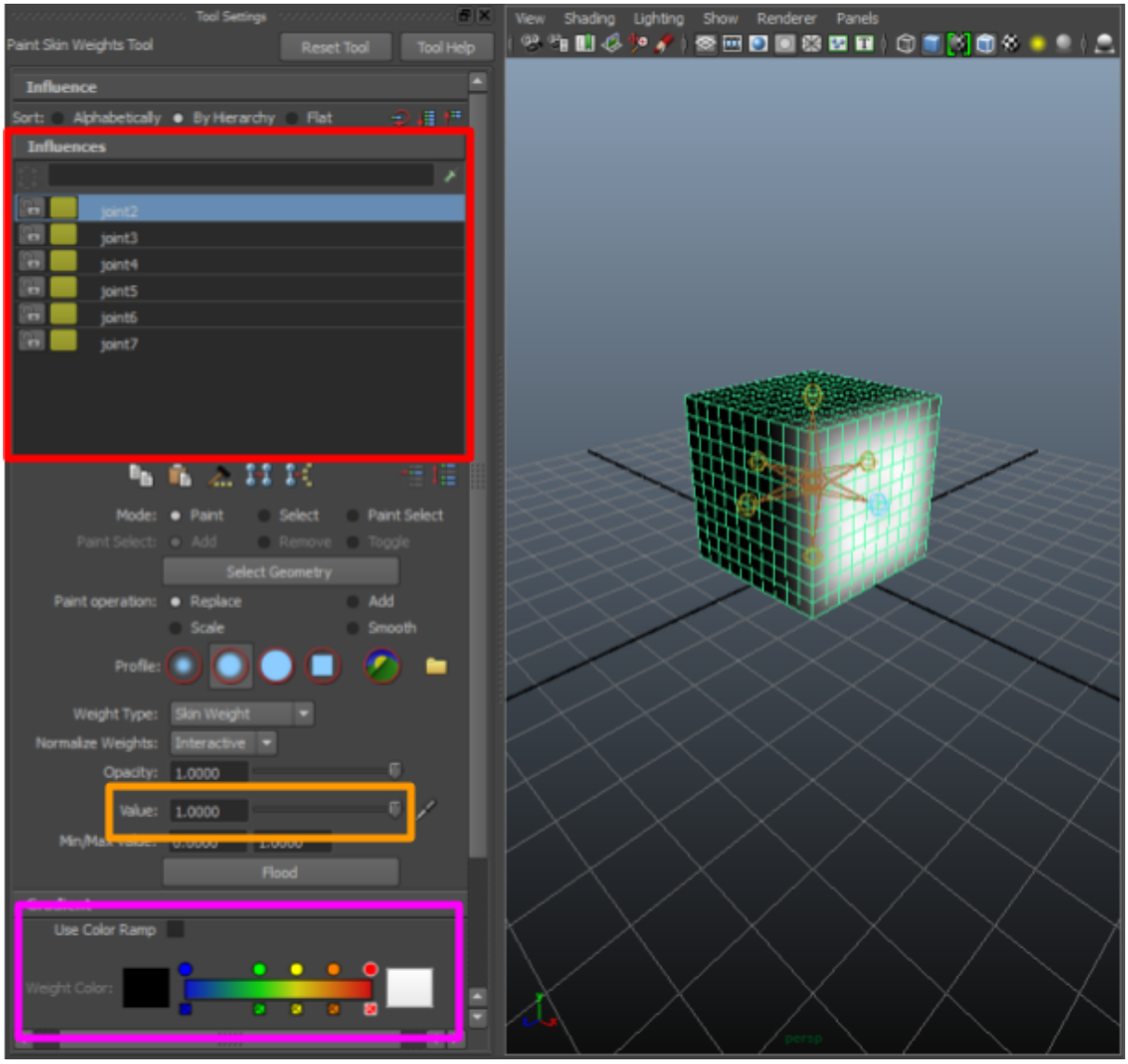
The following sections describe some tools you can use to modify/correct the skin weights on vertices.

Painting Weights

You can paint the weights on your geometry using the Paint Skin Weights tool.

1. Select your object
2. Go into the Animation menuset.
3. Open the Paint Skin Weights tool, go to Skin -> Paint Skin Weights Tool (choose the little box on the right to open the tool options as well)...


Autodesk Maya 2015 - Student Version: untitled* --- pCube1
File Edit Modify Create Display Window Assets Animate Geometry Cache Create Deformers Edit Deformers Skeleton Skin Constrain Character
Animation
No Live Surface
General Curves Surfaces Polygons Deformation Animation Dynamics Rendering PaintEffects Toon
View Shading Lighting Show Renderer Panels
Smooth Bind
Interactive Bind
Add Influence
Remove Influence
Set Max Influences...
Remove Unused Influences
Detach Skin
Go to Bind Pose
Paint Skin Weights Tool
Interactive Skin Bind Tool
Move Skinned Joints Tool
Mirror Skin Weights
Copy Skin Weights
Smooth Skin Weights
Hammer Skin Weights
Copy Vertex Weights
Paste Vertex Weights
Move Weights to Influences
Prune Small Weights
Reset Default Weights
Substitute Geometry
Enable Weight Normalization
Disable Weight Normalization
Enable Weight Post Normalization
Normalize Weights
Export Skin Weight Maps...
Import Skin Weight Maps...



Before you start painting, there are a few things you should do...

1. Select which joints your changes should influence and lock off all the other joints by clicking the lock button next to the name. Note that you can multi-select here and lock/unlock at the same time.

2. Value determines how much influence to assign to the selected joints….

   A value of 0 will REMOVE.
   A value of 1 will ADD.

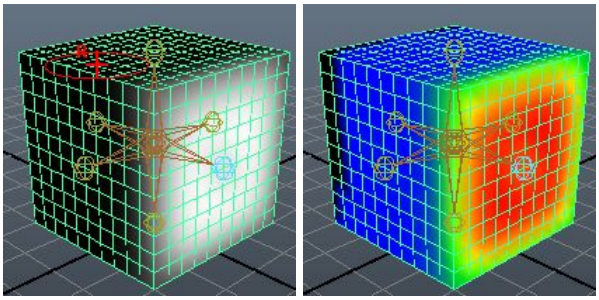
   If you don't want to fiddle with this value too much, you can always temporarily flip this while painting but holding down the Ctrl key (e.g. if value is set to 1, it'll be set to 0 while

Ctrl is held down).

NOTE: There are some intricacies with adding/removing weights that are described in the respective subsections.

3. Enable the color ramp. Which vertices are influenced are shown as grayscale by default. For lighter influence weights, it's hard to tell the difference. With Color Ramp selected it becomes much easier (small influences show up in black/blue and large influences show up in red/white).

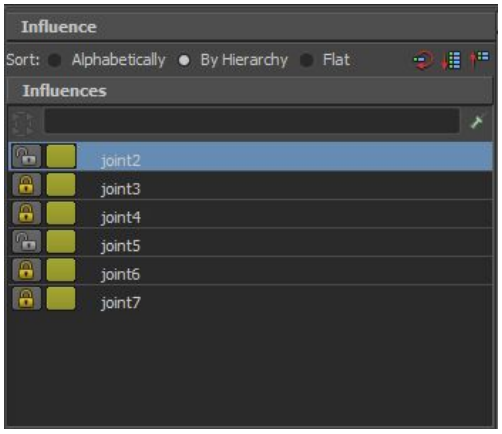
   In the example below, you can see a lot more definitively which vertices are influenced by the selected joint and by how much they're influenced.



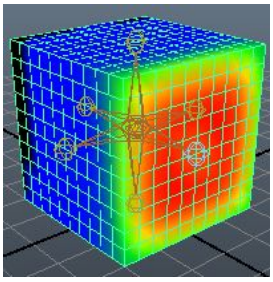
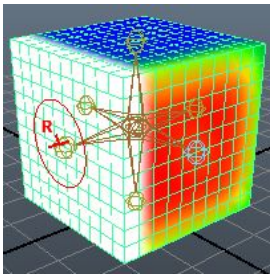
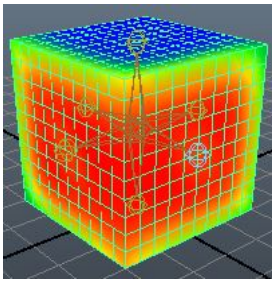
Adding Weights

Remember that the total weight on a vertice has to always equal 1. That means that when you're increasing the influence/weight of a joint on some vertices, the influences/weights that other joints have on those vertices will need to be decreased accordingly.

You can use the locking mechanism to indicate which joints influences/weights should be taken from…



In the above example, I'm working on joint2. The only joints I have unlocked are joint2 and joint5. When I start painting vertices such that they're more influenced by joint2, it'll take those influences from joint5.

> **NOTE**: Be careful when you're painting with locked joints as the colors showing up during the painting process are not representative of the total weights on the vertices. In the example above, you're setting things up such that you can only take weight away from joint5 and add it to joint2 -- for some vertex, you can't take away more influence than joint5 has on it.
>
> Your paint job may look like it it's assigned ALL of the weights for some vertices to joint2, but that isn't the case. As soon as you click away from joint2 and back again you'll see the colors for the true weights.
>
> Original weights for joint2…
>
> 
>
> Painting all of one side to joint2…
>
> 
>
>
> Clicking away from joint2 and clicking back on it again…
>
> 
>
> You've only taken weight/influence away from joint5 and assigned it to joint2. All the

other joints that have an influence/weights on those vertices still have the same influence/weight values! That's why the color ramp doesn't stay white.

If you do the same thing without joint locks, it'll work the way you expect it to.

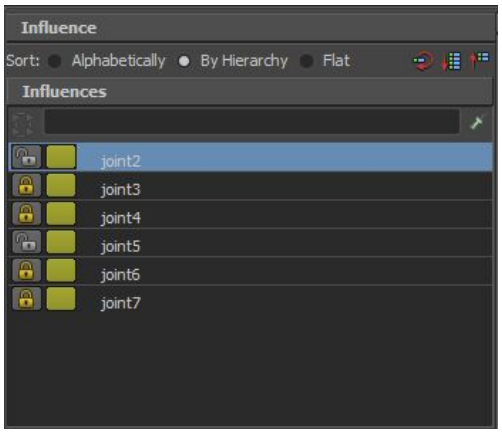
Removing Weights

NOTE: This is pretty much the same as the Adding Weights subsection, but we're removing here. The same process applies except we're removing instead of adding.

NOTE: Remember that to remove weights, you can set value to 0 in the Tool Settings of the paint tool, or you can just hold Ctrl while you paint.

Remember that the total weight on a vertice has to always equal 1. That means that when you're decreasing the influence/weight of a joint on some vertices, the influences that other joints have on those vertices will need to be increased accordingly.

You can use the locking mechanism to indicate which joints influences/weights should be taken from…



In the above example, I'm working on joint2. The only joints I have unlocked are joint2 and joint5. When I start painting vertices such that they're less influenced by joint2, it'll increase joint5's influence on those vertices accordingly.

NOTE: Be careful when you're painting with locked joints as the colors showing up during the painting process are not representative of the total weights on the vertices. In the example above, you're setting things up such that as you remove weights, they're only getting taken away from joint2 and being added to joint5 -- for some vertex, you can't take away more influence than joint2 has on it.

Your paint job may look like it it's remove ALL of the weights for some vertices from

joint2, but that isn't the case. As soon as you click away from joint2 and back again you'll see the colors for the true weights (or click on the other joints and you'll see there is still color on those vertices from the other joints).

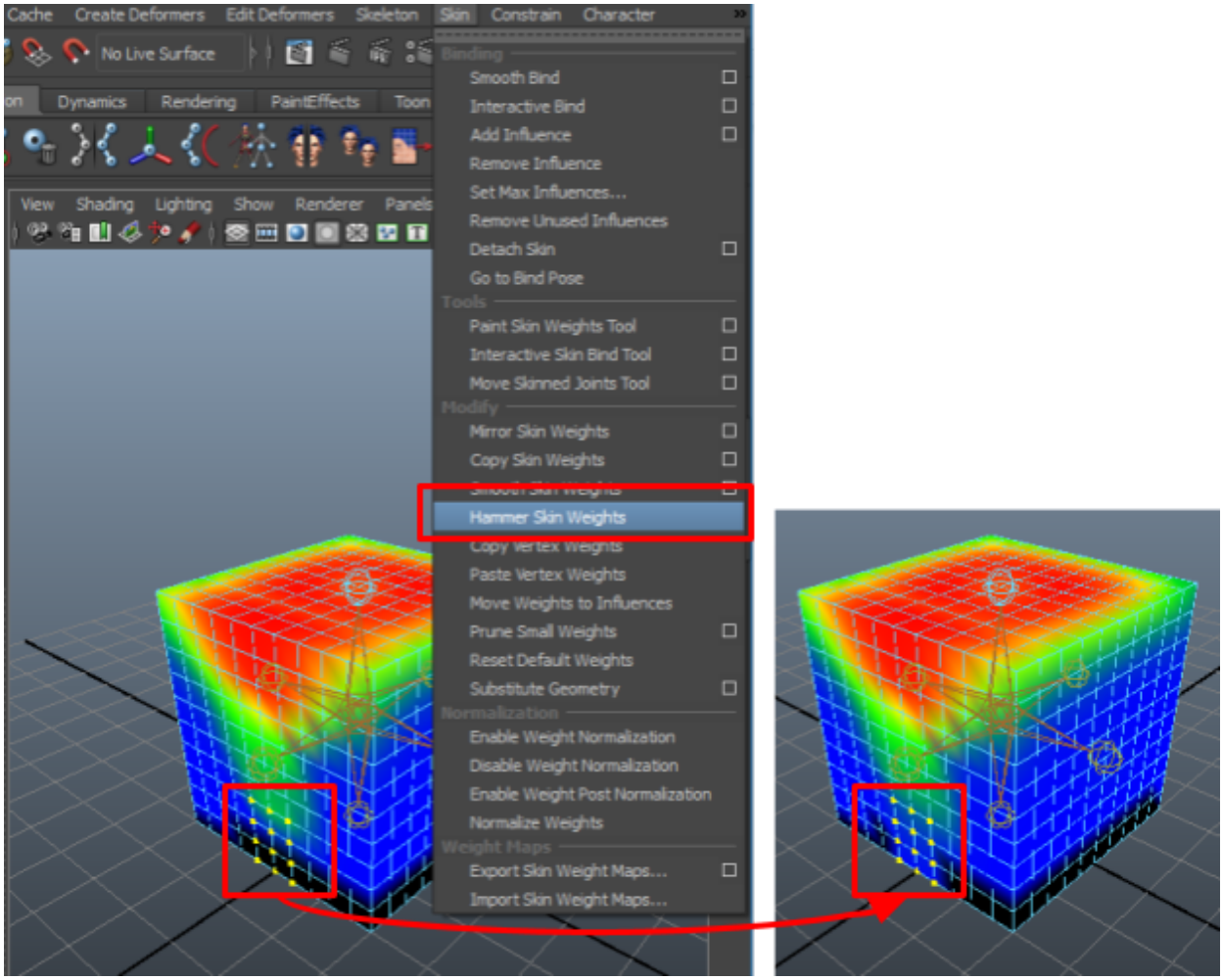
SEE THE EXAMPLE IN THE ADDING SUBSECTION. THIS IS JUST THE OPPOSITE. SAME THING APPLIES.

Hammering Weights

HINT: Use this instead of painting when you want to make small tweaks.

You can pick one or more vertices and "hammer" in the weights of the vertices that surround it/them by using the Hammer Skin Weights tool. The tool will assign weights by averaging the surrounding vertices.

To do this, go into vertex selection mode and select the vertices you want to "hammer", then go to Skin -> Hammer Skin Weights (make sure you're in the Animation menuset).



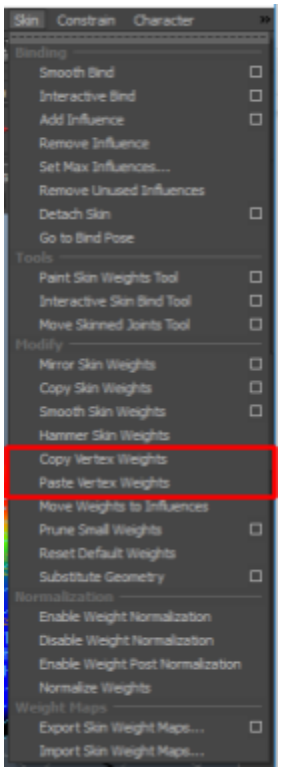
Copy/Paste Weights

> **HINT**: Use this instead of painting when you want to make small tweaks.

You can copy the weights from one vertex to another using the Copy Vertex Weights / Paste Vertex Weights tool.

Make sure you're in the Animation menuset…

1. Go into vertex selection mode.
2. Select the vertex you want to copy, then go to Skin -> Copy Vertex Weights.
3. Select the vertex you want to paste to, then go to Skin -> Paste Vertex Weights.

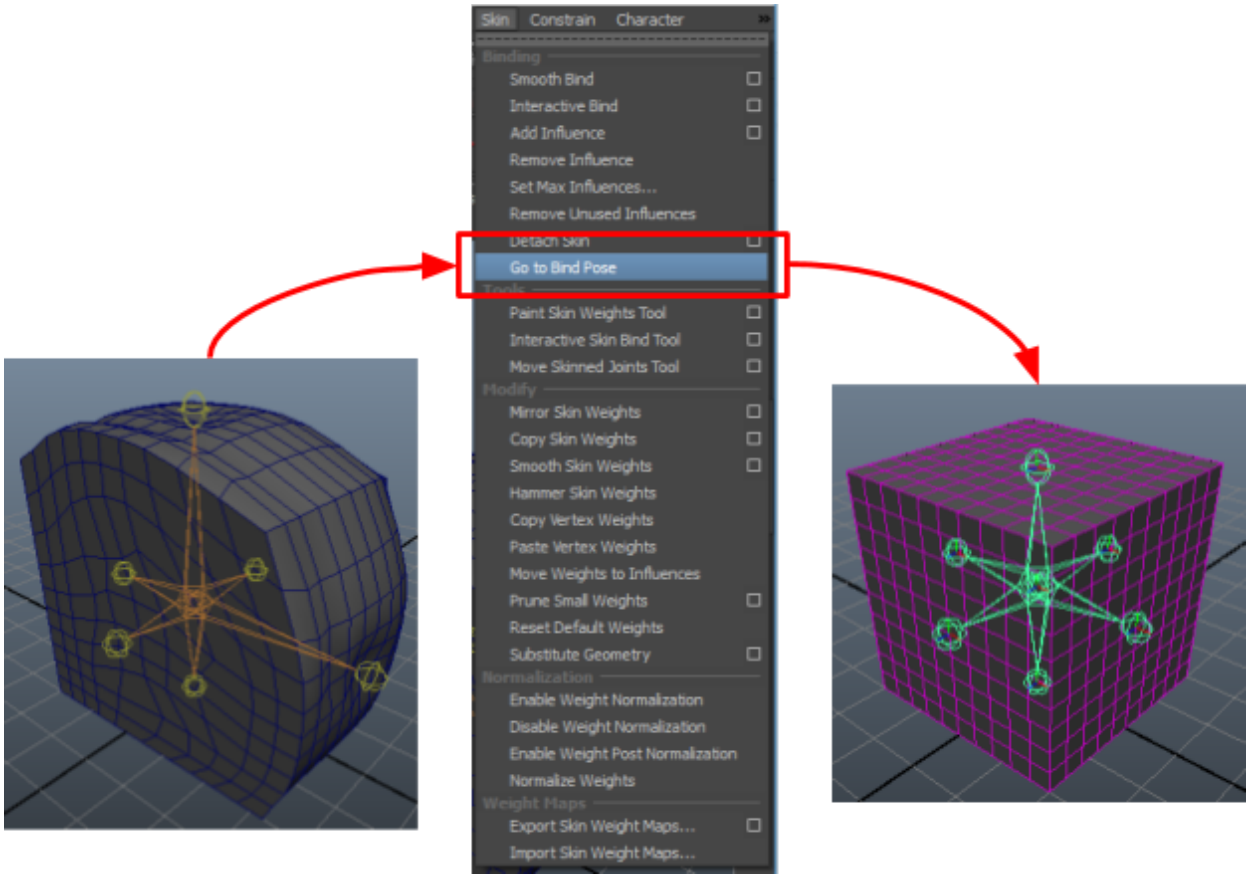


Mirroring Weights

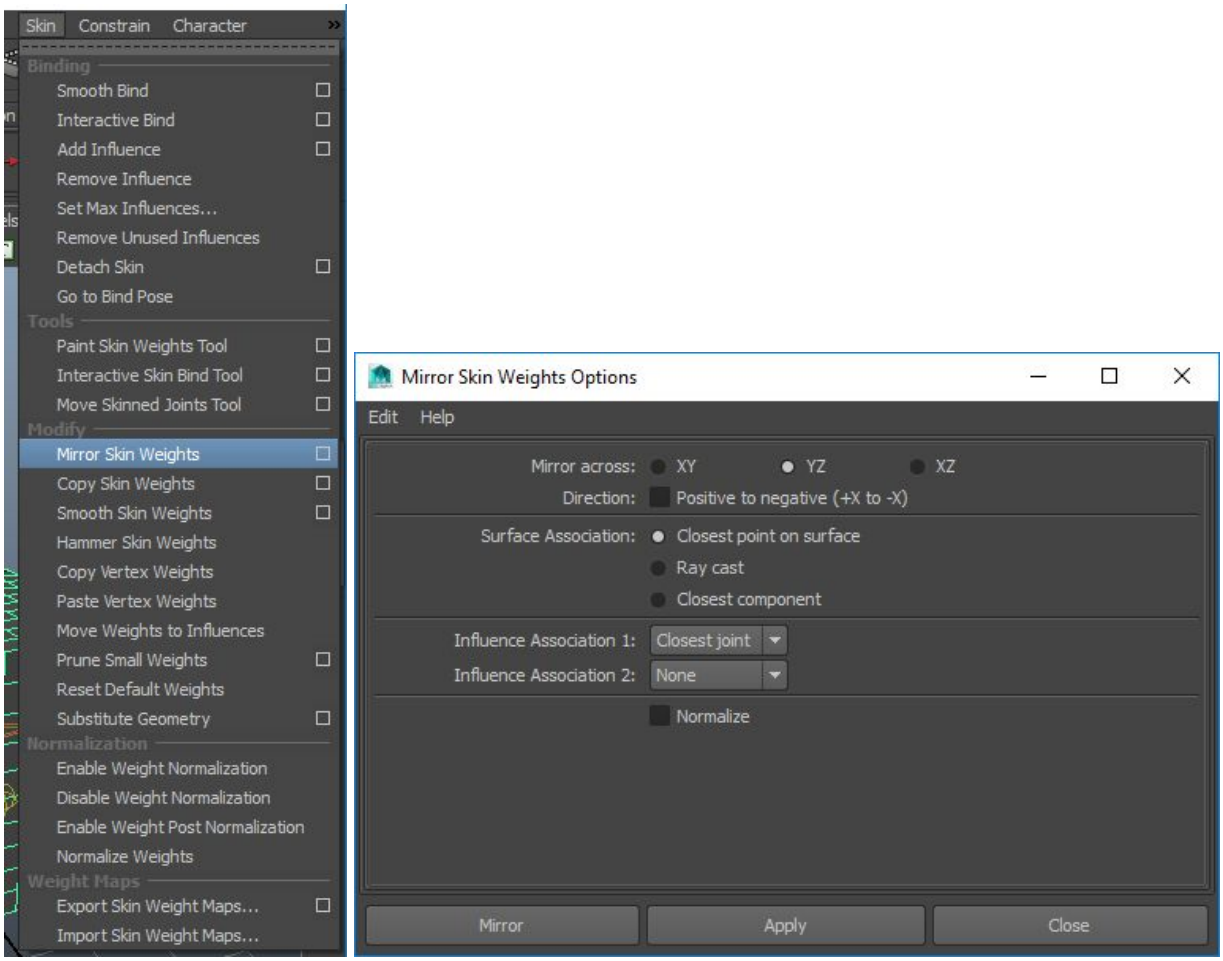
HINT: This is a big timesaver. You only have to properly weight half your model.

For mirroring weights to work, you must be in the default pose and the model/rig must be symmetrical.

To get back to your default pose, first select the root joint, then go to Skin -> Go to Bind Pose...

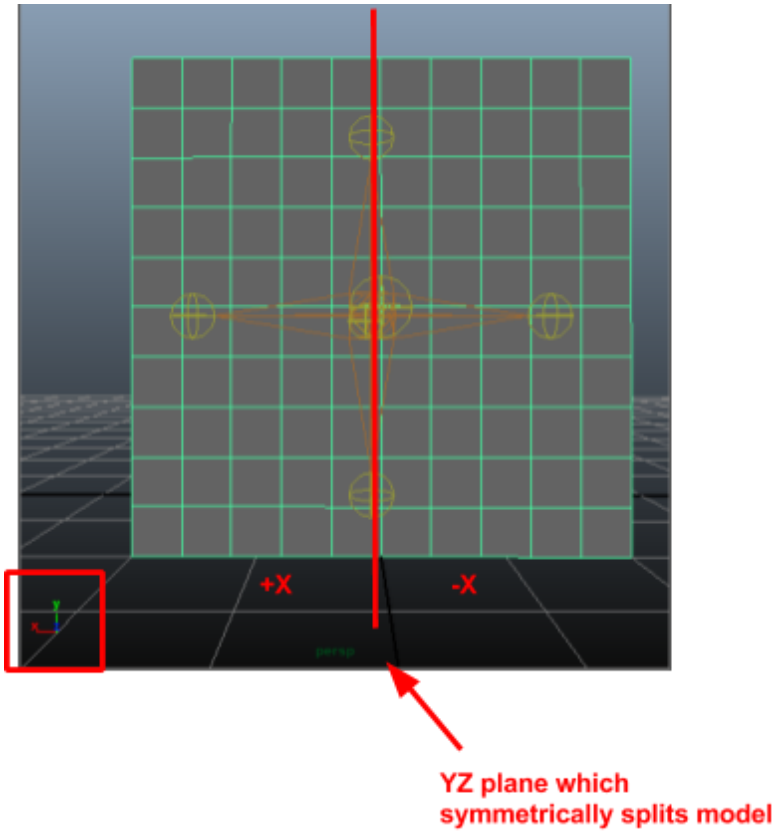


Once you've done that, you can mirror the weights by selecting the object (not the joints) and going to Skin -> Mirror Skin Weights (choose the little box on the right to open the options)...



The first 2 properties specify which plane you want to mirror across (which plane cuts your model symmetrically in half) + the direction to mirror from.

So If I choose YZ and I have Positive to negative checked, my model must be cut in half by the YZ plane, and I want weights copied from the side where X is positive to the side where X is negative...



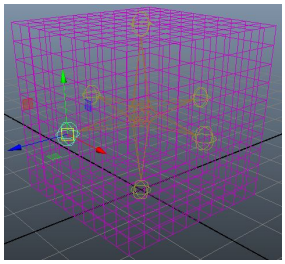
For the rest of the options, pick the defaults in the screenshot. They're almost always what you want.

Updating Joints Post-skinning

If you've already created your skin but you realized that you made a mistake and you need to tweak the joint positions/orientations, you can do this using the Move Skin Joints Tool.

1. Go into the Animation menuset.
2. Open the Paint Skin Weights tool, go to Skin -> Paint Skin Weights Tool.
3. Select the joint you want to change and change it.

Once you select the joint, the associated geometry will go into wireframe mode and you can move around the joint without deforming the geometry. You can switch away to the select tool once you're done and your changes will be saved.



One thing to keep in mind here is that unlike normal joint selection, selecting a joint here does not automatically select its children. If you want to move around a joint chain / multiple joints, you need to multi-select them (Shift+LMB click each joint).

IK (Inverse Kinematics) Handles

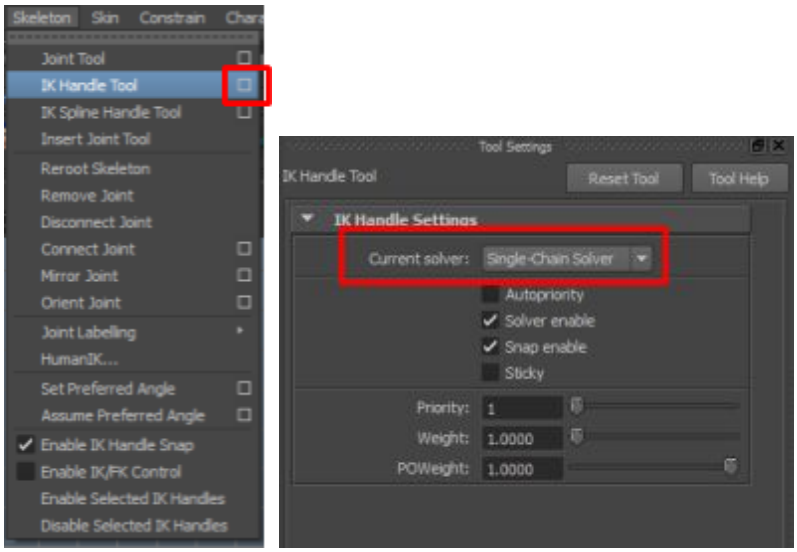
IK (Inverse Kinematics) is a system used to pose joint chains in a realistic manner using a single action. As you pose/animate joint chains, the IK handle figures out how to rotate and pose all the different joints in the chain.

IK handles are used for things like: limbs, fingers, tails, necks, spines, tentacles, etc...

Typically, a Maya IK handle requires you to specify an end joint (also called end effector). All joints between that end joint/effector and the root joint (can you choose a value that isn't root?) will get oriented and positioned automatically.

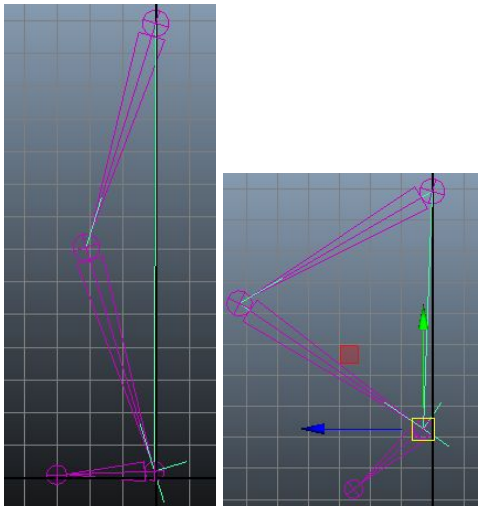
To create an IK handle on your skeleton…

Go to Skeleton -> IK Handle Tool and open the options (little box on the right).

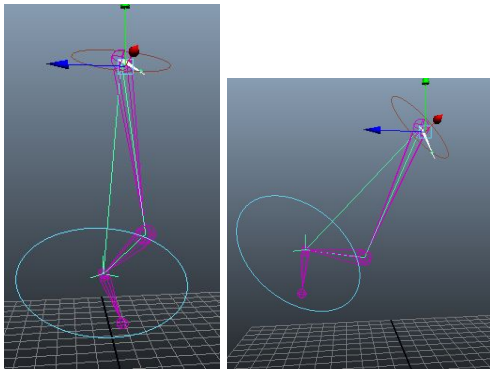


In the tool settings, you can choose which type of IK handle you want: single-chain solver or rotate-plane solver.

In the following example, I made a simple leg and used a single-chain solver and between the hip joint and the ankle joint. Note how there's a line running through the 2 joints that I selected. Now when I move the end joint, the entire chain (minus the foot because it isn't part of the IK handler) translates/rotates itself to look proper.



What's the difference between the single-chain (SC) and rotate-plane (RP) solvers? I don't know. The SC solver lets you rotate your leg skeleton from the end joint/end effector, but the RP solver has this circular hat on top of the start joint where the plane adjusts as the end effector moves around. RP rotations are done on whatever plane that hat is on + you have to rotate using the translate tool instead of the rotate tool….

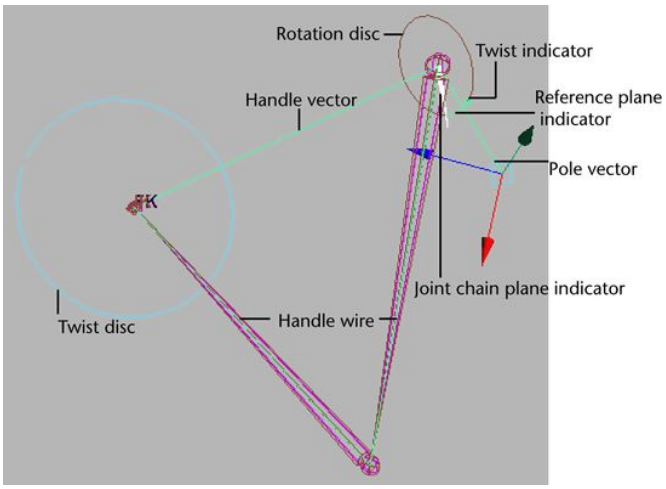


> **NOTE**: To access the translate tool on the rotational-plane top hat thing, select your end effector and hit T. To get back to being able to translate the end joint/effector, hit the normal translate tool hotkey (W)

NOTE: Why would you ever want a rotational-plane handler? Maya's website says why… It sounds like for things like rotating legs/shoulders? Constrain the rotational plane handler to something so that you can make the leg automatically turn in certain situations? For example, if you're leaning in, you want the leg to rotate inward? I still don't really know what this is for.

https://knowledge.autodesk.com/support/maya/learn-explore/caas/CloudHelp/cloudhelp/2016/ENU/Maya/files/GUID-9942FFB5-65C2-46E2-B5A3-297667A9FB5D-htm.html

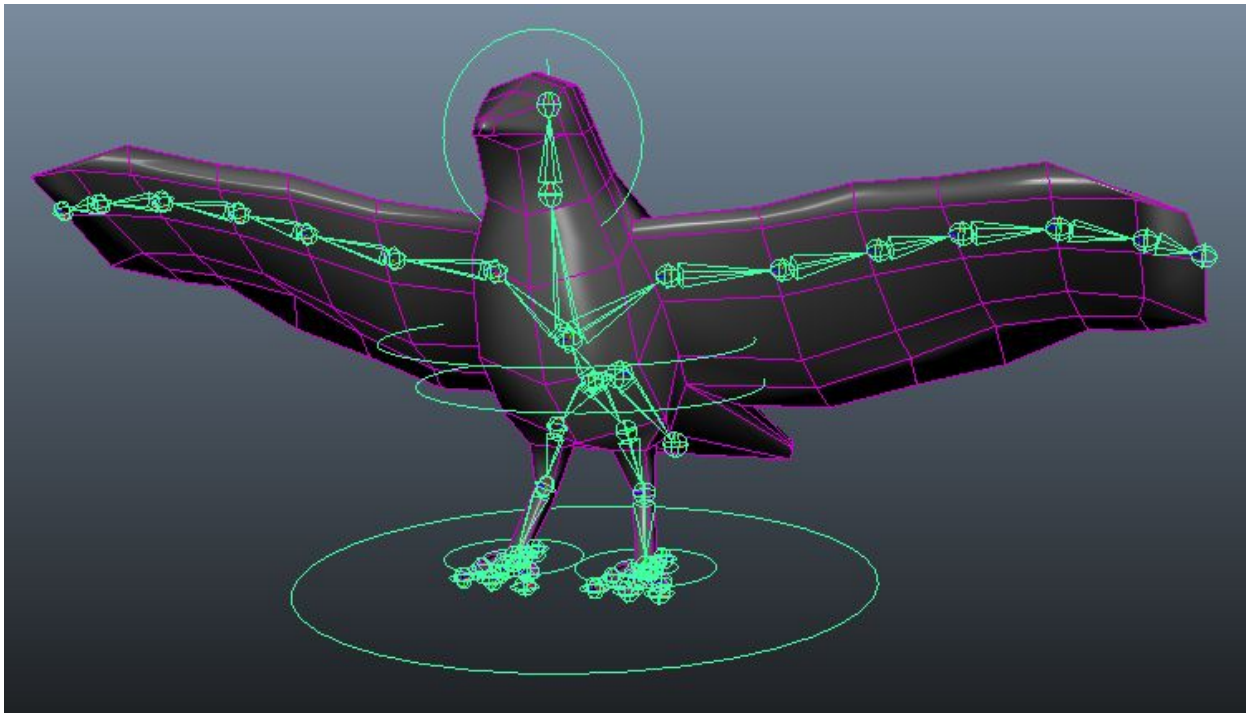
The rotate plane solver is ideal for posing joint chains (such as arms and legs) that you want to stay in the same plane. For example, the shoulder, elbow, and wrist joints of an arm driven by a rotate plane IK handle all stay within the same plane as the elbow rotates. The plane itself can be rotated from the shoulder joint by the pole vector.



Rig Controls

"Rigging" is the art of adding controls to animate an object. Adding these controls makes animating these objects easier.

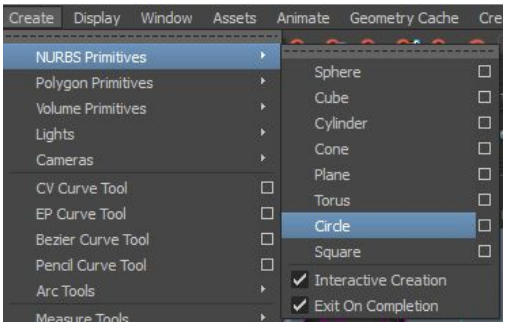
Rarely ever do you want to animate by manually manipulating the joints/skeleton. The typical workflow is to add control handles on top of the joints and move those instead.



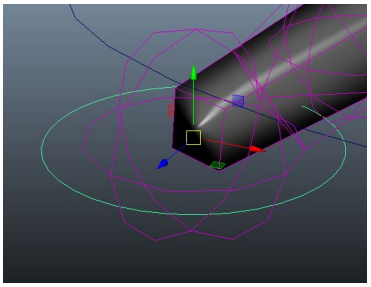
In the screenshot above, the crow has a bunch of NURBs circles constrained to various joints on its skeleton. For example, if you wanted to orient the head, rather than manually moving the head joint you would move the NURBs circle that's around its head.

How would you go about creating a rig control? (make sure you're in the animation menuset)

1. Create your NURBs circle

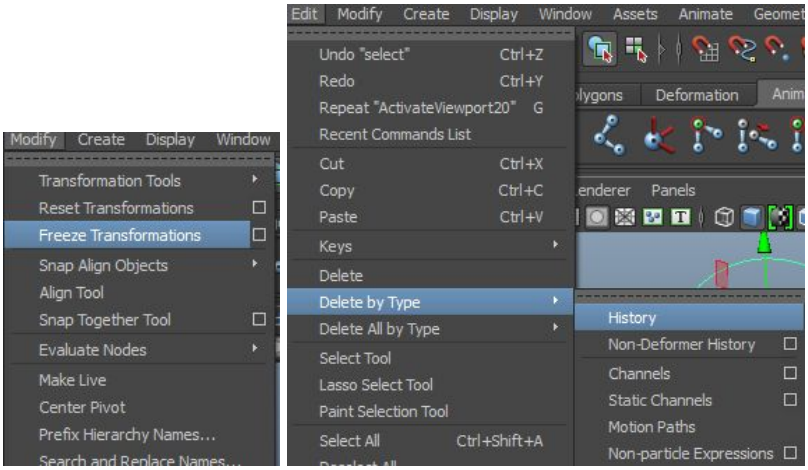


2. Center and orient the NURBs circle around the joint you want to control

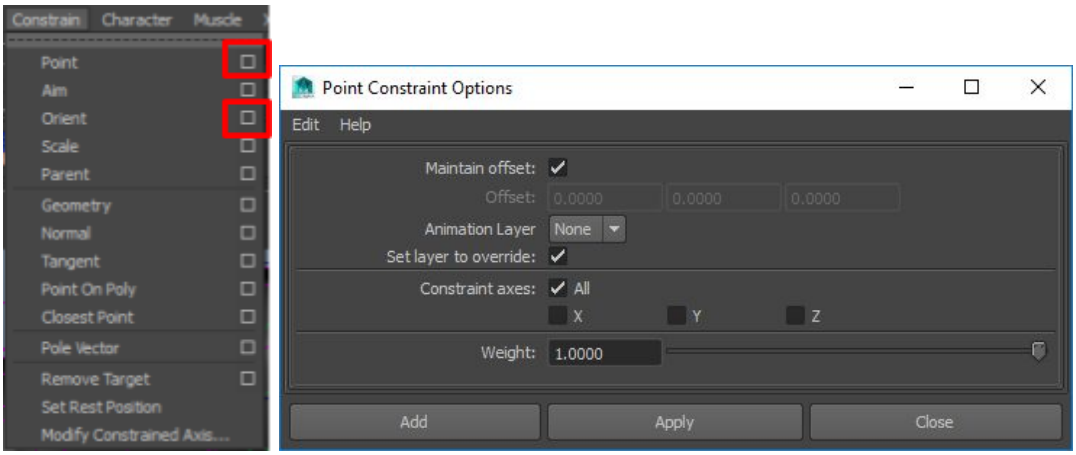


HINT: Use snap-to-point tool (hold V before moving) to position your circle exactly in the center of the joint.

3. Freeze the NURBs circle's transforms + delete it's history



4. Constrain the point and orientation of your NURBs circle to the joint (or IK handle)



NOTE: Order is important here. Select your circle first, then select your joint, then add add the constraint. <u>The first thing you select is where the constraint values are coming from</u>.

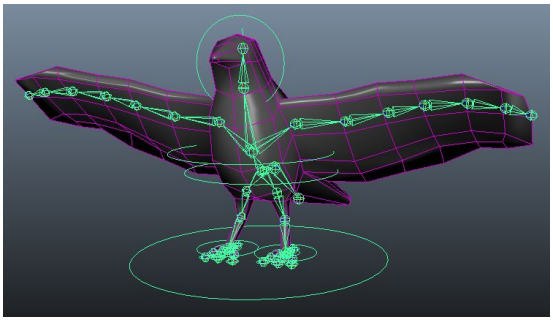
Typically you would want to have Maintain offset checked… this prevents the existing transform/rotation settings on the circle from screwing up the joint that the constraint is being placed on. We don't really need this because we've already freezed transforms, but it usually doesn't hurt to have this one.

Constraint axes defines what axes your constraint is for. For example, setting it to X only means that you can only translate/rotate on the X-axis.

NOTE: The constraints that you're setting here through the menus, you can set graphically via the node editor. See the section on node editor for more information.

HINT: It's typical to have one super control where all the actual rig controls are parented to this super control. You can use the super control to easily move around the entire rig in its current state. If you don't have this, you would have to multiselect all the controls individually and move them around together.

In the example below, the big circle on the bottom is the parent of all the other controls.



HINT: In addition to point/orient constraints, another useful constraint is the parent constraint. The following is from http://help.autodesk.com/cloudhelp/2016/ENU/Maya/files/GUID-29785337-D109-48C5-AFC4-8A7A1D0C246F.htm…

With a parent constraint, you can relate the position—translation and rotation—of one object to another, so that they behave as if part of a parent-child relationship that has multiple target parents. An object's movement can also be constrained by the average position of multiple objects.

When a parent constraint is applied to an object, the constrained object does not

become part of the constraining object's hierarchy or group, but remains independent and behaves as if it is the child of its targets. The constraining object is also known as the target object.

An object with a parent constraint does not behave the same as an object with a point and orient constraint. When a Parent constraint is used, rotating the target object(s) affects the constrained object's rotation along the world axis. When a Point and Orient constraint are used, rotating the target object(s) affects the constrained object's rotation along its local axis. This is shown in the following figure.