We started with a brief review on the board of Jacobian based approaches to inverse kinematics taken from this paper, noting that these approaches have some limitations due to their iterative nature, slow speed, lack of repeatability, difficulty of selecting good parameters, and tendency to become “tangled up” for lengthy chains. However, they are widely used and considered “go-to” techniques for character IK:


My go-to reference for explaining these techniques and how to put them together into a character animation system is the following paper. This paper uses the Jacobian damped pseudoinverse with nullspace projection to do character posing with a two-level priority system. The point which the user clicks and drags is given top priority as the IK target, and secondary constraints include satisfying constraint points, moving the character towards a reference pose, and resolving joint limits. These secondary constraints are satisfied as well as possible with secondary priority by cleverly making use of the opportunity to project desired goals into the nullspace associated with the top priority motion.


The classic Jacobian based approach to IK has been parallelized to work quickly for many degree of freedom characters on a modern GPU. We took a brief look at this paper, which is also worth reading for one more description of the classic Jacobian based approach to inverse kinematics.


However, in some applications, even faster results may be desired. For fast IK, CCD is the standby approach, as we saw last week. However, CCD can create artifacts such as the end effector curling in on itself. The following approach is also very fast and in the same style, but seems to create more visually pleasing and consistent results under some circumstances.

You can see from the other papers listed on the same webpage that the authors have made this model work for humanoid characters, using heuristics to reconstruct full body character poses from a few markers or end effector trajectories. 

https://www.youtube.com/watch?v=wjn19jBzjCE

The following classic IK paper points out that using iterative approaches does not really make sense if we only want the final pose. Why not pose the problem as a more general optimization problem and let one of the vast library of solvers out there do the work of finding an answer? I think this is an important idea that we should consider any time we are about to choose or implement an IK algorithm.


Inverse kinematics is possible even when you have only a mesh and no skeleton at all. We took a look at the following paper, which is the classic paper on this topic. The second offers suggestions for improvements.


We went on to have a look at some more recent papers that all take somewhat different looks at the inverse kinematics problem. The following paper covers posing using lines of action and has been used as a final project topic in this class.


This paper creates poses from silhouette drawings. You may check whether their software is available online to try out.


https://www.youtube.com/watch?v=8C3uZOXLBIA
This paper uses machine learning techniques to model human motion with the goal of constructing very realistic looking motions from a few “handles” or “pins.”


This paper facilitates creation of animated versions of motion captured on video.


And this paper brings many ideas together into a sketch based system for character creation and animation.


You may also be interested in this paper, which allows puppeteering non-humanlike characters using your entire body. This one has been the topic of a final project for this class. The students brought in a Kinect and let us try it out.