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:


We showed an example of this in Monday's class that involved character posing with a two-level priority system, where the point which the user clicks and drags is given top priority as the IK target, and constraint points are satisfied as well as possible with secondary priority using projection into the nullspace. For details, have a look at this paper:


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 on Monday.


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.

http://www.andreasaristidou.com/FABRIK.html
https://www.youtube.com/watch?v=tN6RQ4yrNPU

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.

http://people.csail.mit.edu/sumner/research/meshik/

http://dl.acm.org/citation.cfm?id=2982433

If you are interested in reading further, you may want to take a look at the following references, which we did not get to in class, but which all offer interesting twists on inverse kinematics.
The following paper covers posing using lines of action and has been used as a final project topic in this class.

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

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 which adds physics cleanup to motions in an interactive keyframing setup.

https://www.youtube.com/watch?v=UmwAR4wnYIM

.. and this paper uses anatomical constraints for IK for the human hand.

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

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.”

http://www.cse.chalmers.se/~marcof/publication/cgf2017/

This paper has a similar goal

https://www.youtube.com/watch?v=urf-AAwNYk

And this one allows you to move around in an “emotion space.”

https://www.youtube.com/watch?v=dkrMOQel8rU
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.