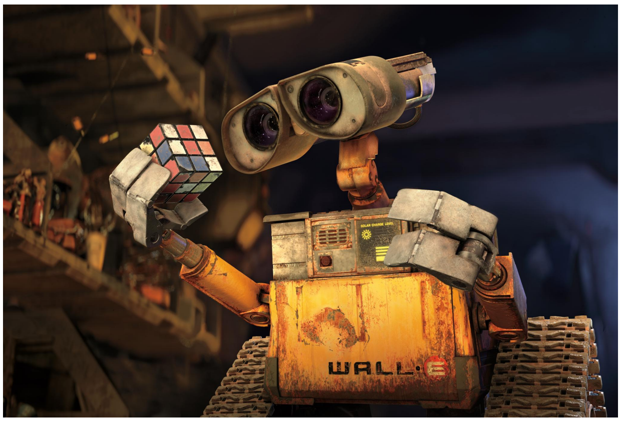
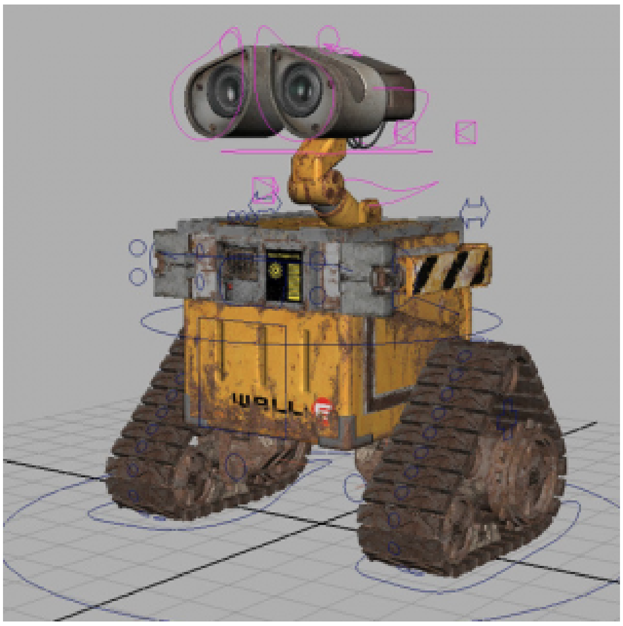
Week 4 Summary:

Hello everyone, David here again. I will use Wall-E as an example for answering all the questions.



1. Imagine you were asked to make an animation of your character dancing at the beach! Please describe the steps including but not limited to: modelling, texturing, rigging,skinning, keyframing, tweening, motion capture, …
    - In order to be able to play animate wall-e, we first need to model the component parts of the wall-e mesh (for example, the cube that acts like his body, wheels, etc.)
    - After that, we proceed to add the textures. The cube now has the dirt spots and wall-e's control buttons etc. attached to it.
    - Then, we need to create wall-e's skeleton by rigging the model. By skeleton we mean a fancier more palpable word for a matrix hierarchy that include the bones (generally bigger parts of data that move vertices around)
    - Skinning means that we are attaching our texture modelled to the skeleton
        - N.B. you might hear of terms such as skinning weights (this means that at shader level, you add another attribute called skinning weight to the vertex that basically changes the position of the vertex according to where in the hierarchy it is in a more efficient way). For example, if the head bone moves, the foot bone will not be affected. *See below for skinned and rigged Wall-E model (even though they are a robot)*
    - Then we define the keyframe (i.e. the initial and end state of an animation) that are filled in by a tweening process (making the transition smoother).
        - Fact: back in the day, main artists would draw the "Keyframe" of animation and INBETWEENERS (long for tweeners) will manually draw the transition.
    - If motion capture is available for Wall-E, we would dress someone up as a little robot, or create our little studio robot with motion tracking markers (sensors) attached to it. This will give us a roadmap for the skeleton essentially and we can use inverse kinematics (as we know the end effectors of the motion) to map it to it for example.
    - Render: we want to see something that we made at the end



2. Which statement is true about rigging?
   Inverse kinematics is to find the motion to reach a desired position
3. Why is motion capture useful?
   a. More realistic, accurate movement
   b. Saved time for all the calculations we would use in order to figure out what the equations are for a certain type of movement
   c. Can capture more discrete emotions, motions (a twitch for example etc)

4. What is the particle system? What are the attributes of particle systems? Discuss thesteps for making such a waterfall.

To answer this question, we must think of what a particle really is. It is a data structure representing a UNIT of the entire system. The unit can vary in attriubutes, but it is replicable in such way that it create a system. For example a volcano shooting out stones during an erruption can be seen as a particle system just as as rain etc.

So, a particle should contain attributes such as position, initial velocity and entry angle, lifespan, colour, children (think of a main firework particle that explodes into smaller ones or let your imagination loose) and any other attributes (resistance, bounciness etc.)

In the waterfall, we observe that all the particles are falling down from an initial point (an emitter that generates N number of particles every frame (or chosen time period)), this is due to the fact that we generate a vector field for GRAVITY, which essentially creates a vector that affects the y motion of the particles by adding the force of gravity (F = m*a, where a=9.8). If a particle is shot out of a cannon, all the other coordinates are gonna be modelled using the normal newtonian mechanics (or any other mechanics if you are feeling fancy).

At the end the particles bounce of the water (this can be modelled either via some collision detection algorithm or a simple check for y-position) and then they die. Most of the attributes are often randomized so you can a more realistic effect instead of all the particles dying at the same time.

5. A particle is traveling along a path in a vector field where the force F is applied in a circleshape. Which technique is inaccurate to solve the ODE?

Euler, Langrangian, Newtonian, Trapezoidal

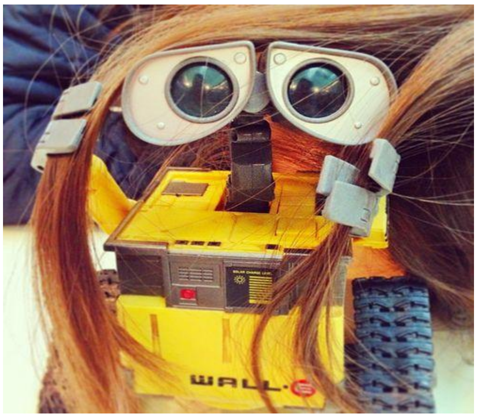
Euler's method is not accurate for a circle shape force because it can never tracks a circle and instead gradually travel on a spiral even if you take a very small step size, it's impossible to stick to the circle track

6. Back to your designed character by the beach, how can you add the hair blowing in wind? Use string-mass force and describe your system

Hair could be seen as a particle system. Each hair standed is a particle formed of more springs.

The string-mass force describes the forces in a rope or string when forces are acting upon it from either end. Force is computed using Hooke's law (see lecture video for more info on this). In this case gravity is going to pull the hair down and the hair will be kept in place by the scalp. Each hair stranded can be modelled by an N number of springs which will add the illusions of hair types.

The force that acts on a spring is the hair toughness/resistance. More springs will require more computation but will result in a more accurate model. Curly hair will have more resistant sprins.



7. What is the name of the force that opposes motion and defined as f = -dv for each particlei? (Hint: best to give a glue or honey look)
   Dampening force