Robotic animation 'How-to'

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Robotics

Summary

Warning

The robot can fall

As you can imagine, the robot, like every living or static object on Earth, can fall. Gravity... You can play with it in 3D, cheat in stop-motion, but you have to deal with it with a real robot.

● Nao can fall hundreds of times without breaking himself thanks to the 'Fall Manager'. When it detects that the robot is going to fall, it sends a signal that puts Nao in a security position and then unstiffens the motors. But this 'Fall Manager' can make the robot fall on some special movements, especially when you are making an animation and you are trying to find a good pose. To avoid this, you can deactivate this option by first checking the box on the robot's web page and then launch the box 'Set Fall Manager' in Choregraphe. Don't forget to reactivate it when your animation is done.

Fall Manager reflex
If this option is enabled, it becomes possible to disable the Fall Manager reflex.

☑ Permit Deactivation of the Fall Manager reflex.

● The robot can fall on some extreme or fast movements. Even if you stabilize your animation on your robot, it can fall on another one because they are handcrafted and they are not all strictly similar. So test your animation on several robots if you can or give it to the community to have some feedbacks, but don't forget to tell them that it contains very unstable movements.

● Always have a hand on your robot. You have to be ready to catch him if he falls! But...

Watch your fingers!

On Nao, there are several parts where you can be pinched. Be even more careful with the following ones because of the power of the motors:

Joint of the knees

Gear of the hips
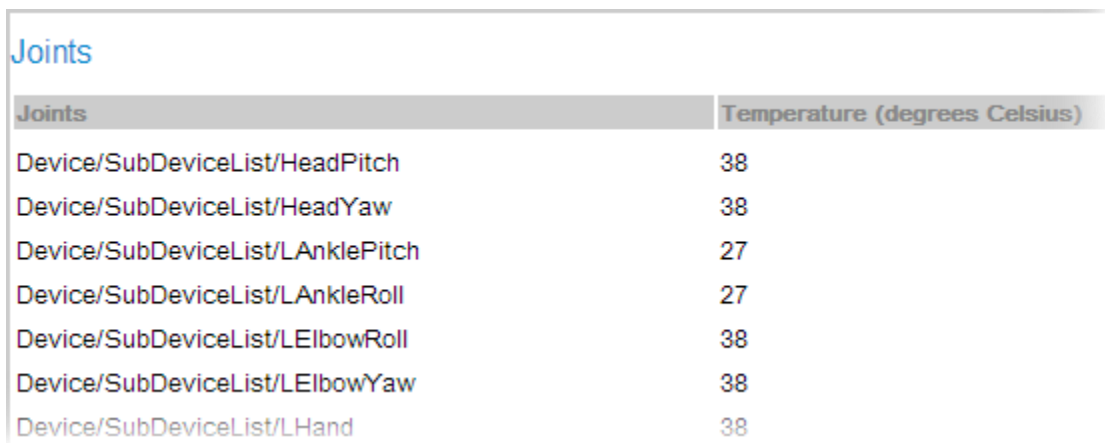

Between the hips
and the thigh

Under the knees

Regularly check the temperatures

Some motors can heat up very fast depending on the pose. If a motor heats over 75°C, the stiffness is going to decrease up to be removed completely at 80°C. So if you continue to animate when one or several motors are hot, your poses and then your animation can be biased.

To check the temperatures, go to the robot's web page into Advanced/Hardware and scroll down to

Joints

Joints	Temperature (degrees Celsius)
Device/SubDeviceList/HeadPitch	38
Device/SubDeviceList/HeadYaw	38
Device/SubDeviceList/LAnklePitch	27
Device/SubDeviceList/LAnkleRoll	27
Device/SubDeviceList/LElbowRoll	38
Device/SubDeviceList/LElbowYaw	38
Device/SubDeviceList/LHand	38

If you see that a motor is around 80°C, just remove the stiffness on all the motors and wait for the temperatures to cool down. Don't forget to click on the 'refresh' button to update the temperatures.

The battery is not infinite

Nao can be used during around 1 hour and 30 minutes on battery depending on what you do. If he moves a lot, it will be more around 1 hour but if he is unstiffnessed, it can be 2 hours and more.

It's better to keep the battery charging when you are animating the robot and then unplug it to test your animation so you will avoid to tangle the wire with the legs or to walk on it, it could make him fall.

You can see the battery level in the upper right hand corner of Choregraphe. It is displayed only when you are connected to a robot.

Wi-Fi or Ethernet

When you are creating an animation, you want your software to be responsive. If it takes one second between the moment when you move a joint and the moment when it really moves, you'll go crazy.

There are two ways to connect your robot to Choregraphe: Ethernet and Wi-Fi.

Obviously, it's more convenient to use a Wi-Fi connection because you will reduce the risk of falling, less wire is always better… But you will have a lot more latency than with an Ethernet connection.

The Wi-Fi can have a very inconstant bitrate unlike the Ethernet, so you can start by using the Wi-Fi then switch to the Ethernet if it's too slow before killing your robot, router, computer, cat, colleague…

You can configure your connection on the robot's web page, in Network.

Don'ts

In 2D or stop-motion animation, you have to draw or take a picture for every frame. You can do this in 3D even if the computer can calculate some interpolations. But in all these cases, you will put a keyframe on the first frame.

● On a real robot, never put a keyframe on the first frame as you can't know exactly in what position he will be before you play your animation.

If the robot is in this pose   and your first frame is
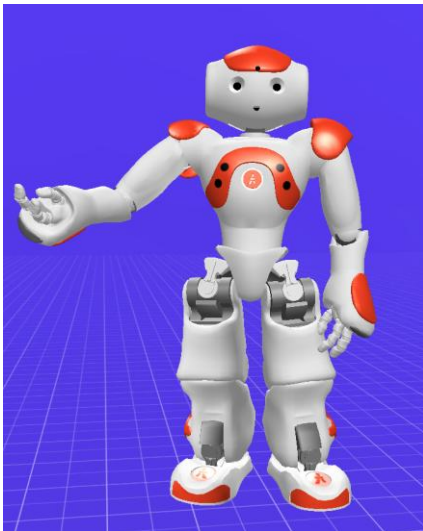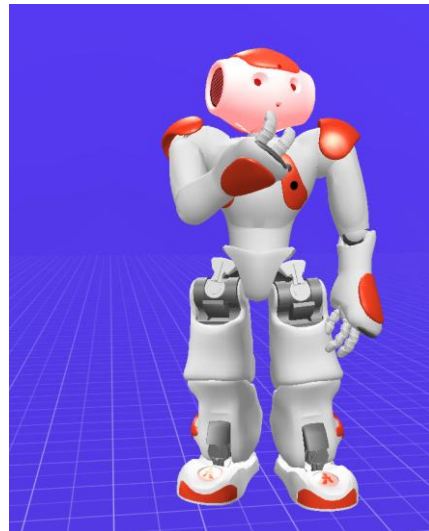
then you can damage the right arm because it will try to make a big movement in one frame.

● Also, for the same reason, don't put your keyframes too close. You can't make an animation frame by frame with a robot.
Here is a bad looking timeline

● One last thing you need to be careful about is not to make too big and too fast movements because you would make your robot very unstable and he would fall.

Choregraphe and the animation mode

I suppose that you know the basics of Choregraphe, if you don't, please read the documentation first. To start making an animation, you have to drop a Timeline box from the library to the workspace
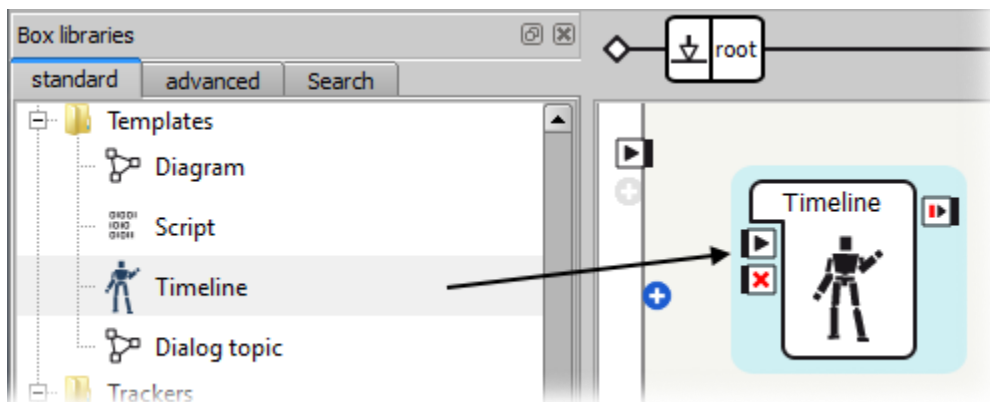
then double click on the box to edit the timeline. You will see a simple timeline with only one line and the behavior layers just below but we will talk about it later. The simple timeline is not really convenient to make an animation, so you have to click on the pencil icon to open an advanced timeline.
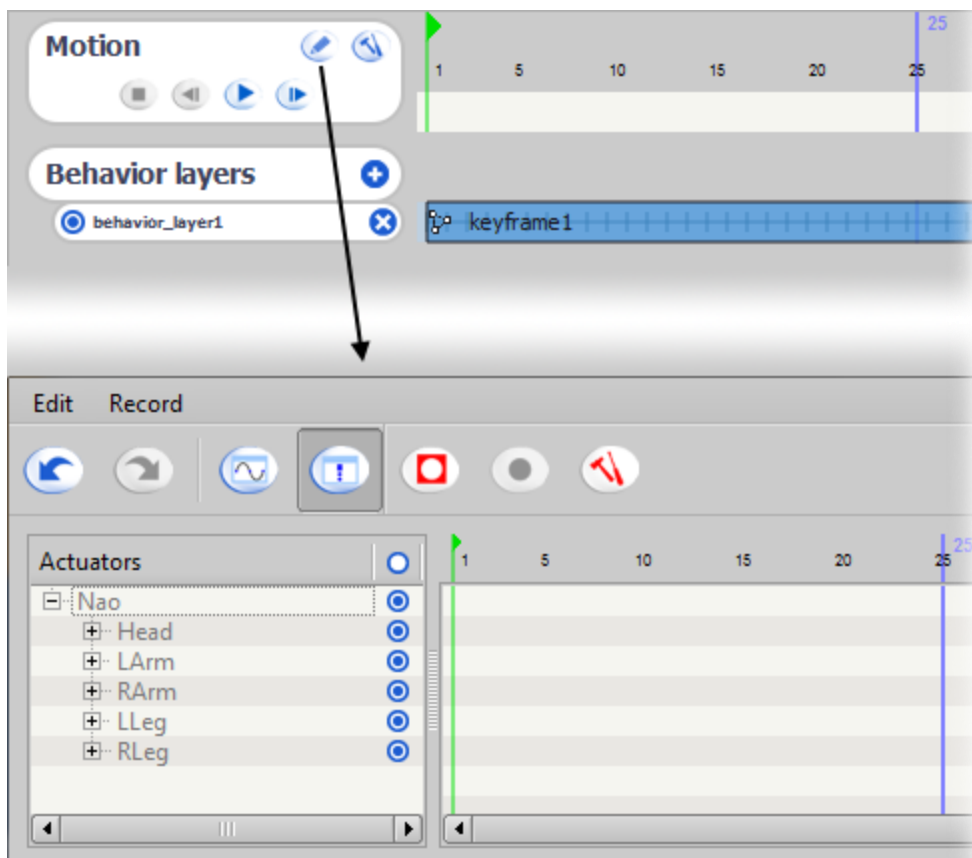
Now you can see each part of the robot so it will be easier to navigate in your animation. If you like to use the graph editor, just click on the 'Curves' icon.
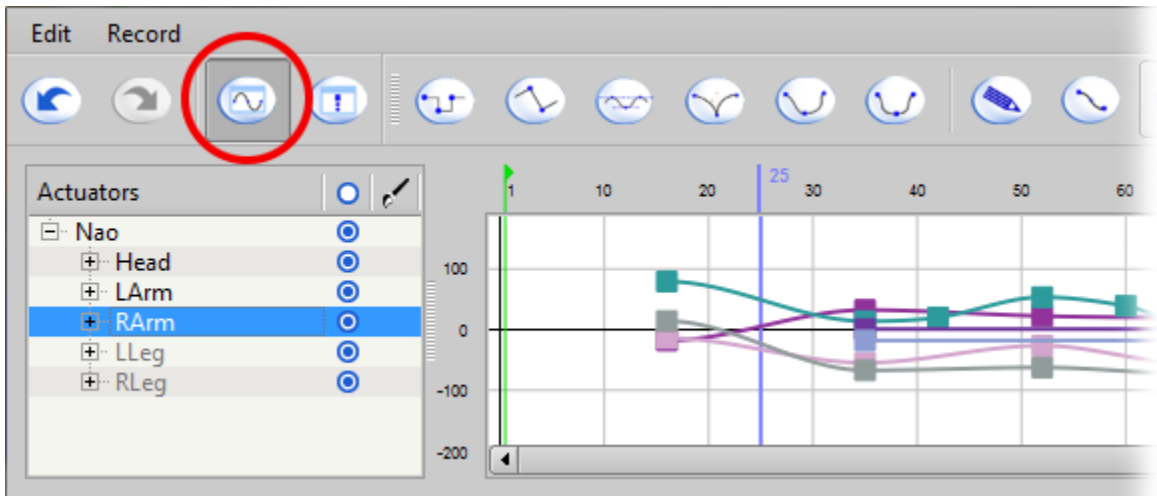
To save a pose, place your blue cursor where you want to put a key by clicking in the timeline and press F8 to store the whole body, F9 for the head, F10 for the arms and F11 for the legs. When you click in the area with the frame numbers, the robot doesn't move, when you click in the area with the keyframes, he moves, it depends on what you want to do.

You have different ways to give a pose to your robot.

● You can click on a member of the robot in the 3D view then unstiffness it by clicking on the 'Stiffen chain on/off', the red gears icon will become green and you will be able to move the member. This way is not very convenient because you have to hold the pose with one hand and click with the other.

● You can move each joint by selecting a member and then using the sliders in the 'Motion' window, the same where you have the 'Stiffen chain on/off' but you keep the stiffness on this time.

● And you have the 'Animation Mode'. You can activate it by clicking on the Da Vinci style icon near to the battery level.


In this mode, you can move your robot like a puppet thanks to the sensors. Touch a hand to move all the arm, press a bumper to move the leg (press it again to restiffen), touch the top of the head to move it. When you can move the member, a LED will become green, it's orange when you can't. For the legs, the LEDs are in the feet. For the head, it's the upper part of the eyes. For the right arm, it's the lower part of the right eye and for the left arm, the lower part of the left eye.

When you move the legs in this mode, I recommend that you move both at the same time so you can keep the feet flat on the floor and your animation will be much more stable.

Note that you can open the hand but you can't close it, you need to use the 'Motion' window to do it.

You will have to mix these different ways to create an animation.

When your animation is done, you will probably need to adjust your timings. There is a tool for this. Just click and drop in the frame numbers area. You should see this now
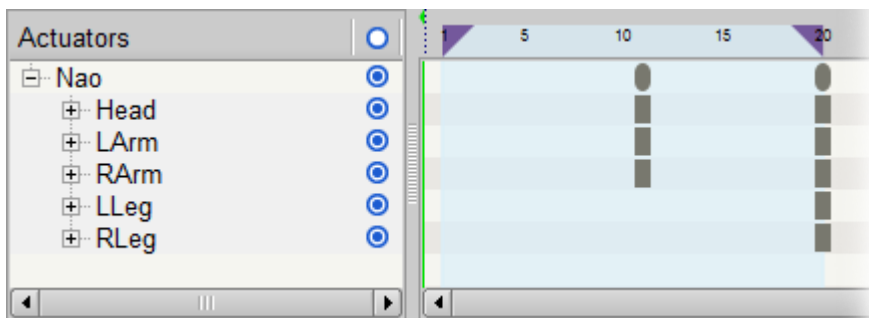
With the right handle, you can resize your animation while keeping the proportions between the keyframes.

The left handle has the same effect that a normal selection, you can move the keys without influencing the rest of your animation.
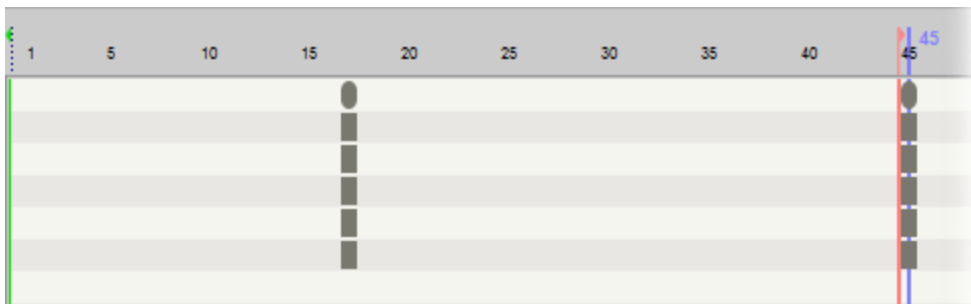
How to

Make an interval

If you put a keyframe on the whole body to make an interval, your movement will be very jerky. So you will create a keyframe only on the joints you need to move to have beautiful arcs and overlaps.

First, you need to create your key poses

then put the blue cursor somewhere between your two key poses. Now, in the 3D view, select the member for which you want to create an interval and in the 'Motion' window, move the appropriate cursors. It will automatically record a key but only for the joint you just moved.

As you can see here, my interval contains a key on the left shoulder roll and one on the left elbow roll.
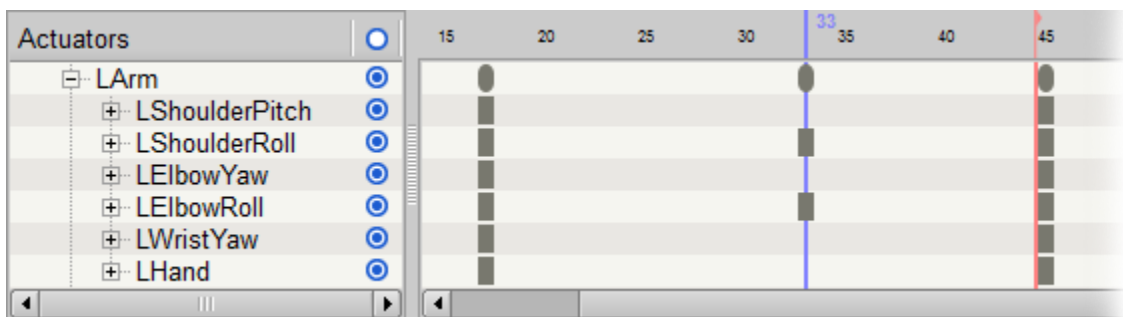
As I said before, never put a keyframe on the frame 1. But you will actually need one to make your interval between the unknown pose and the first keyframe. So just record a basic 'Stand' pose from the 'Pose library' (View/Pose library to display it) at the frame 1, make your interval in the same way that above and then delete the keyframe at 1. You will have a nice animation, no matter the starting pose.

Be less robotic

As we can't be as precise on a robot as in 3D, a good way to give a more natural impression is to shift the keys.
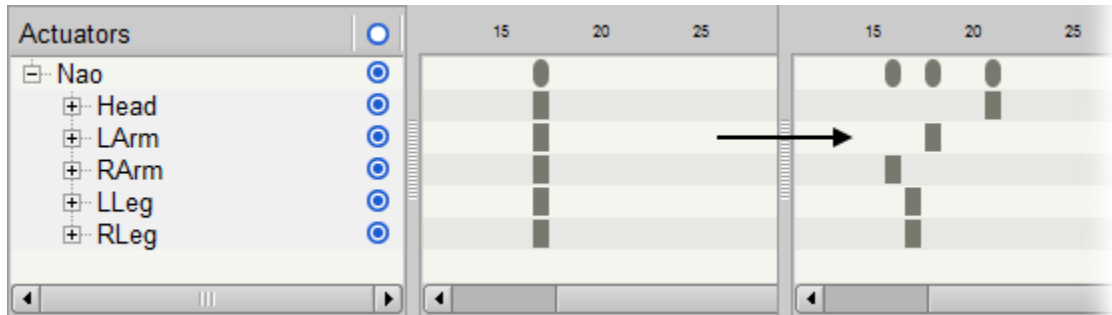
I don't like to do this in 3D because I find it a bit dirty but it's a very fast and easy way to make your movements more organic. It won't work for every kind of animation though. In an animation where the hands have to be in contact, an applause for exemple, it will look desynchronized.

I usually create my animation up to the end and then I shift the right arm one frame on the left, the left arm one frame on the right and the head 3 or 4 frames on the right, but there are no rules.

Never apply this method on the legs, it would make your robot fall.

Make facial expressions

… only with the LEDs of the eyes.

Well, it's not very intuitive for now. You will have to do some Python if you want to make you own LEDs animations but the animation we need the most is certainly the blink. You can find it in the standard Choregraphe library, in LEDs/Animations/Blink.

To use it in your animation, you have to create a new behavior layer by clicking on the "+" button
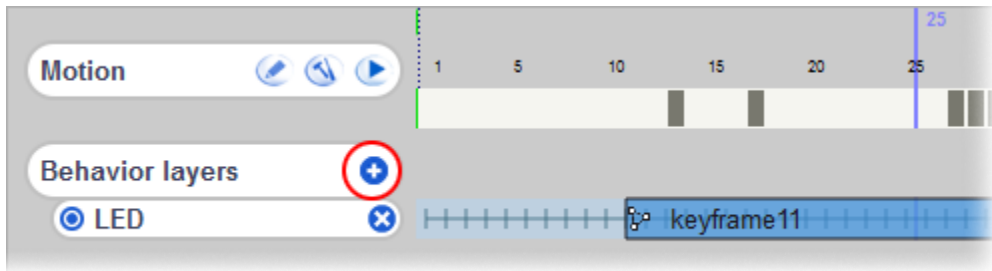
then rename it "LED" for exemple. It will automatically create a layer named "keyframe1", the number changes depending on the keyframe number where you put it. Drag the layer "keyframe1" to the part of your animation where you want a "blink" then drag and drop the "blink" box to your workspace with the layer selected. Finally, connect the "onStart" of the box to the "onLoad" of the layer.
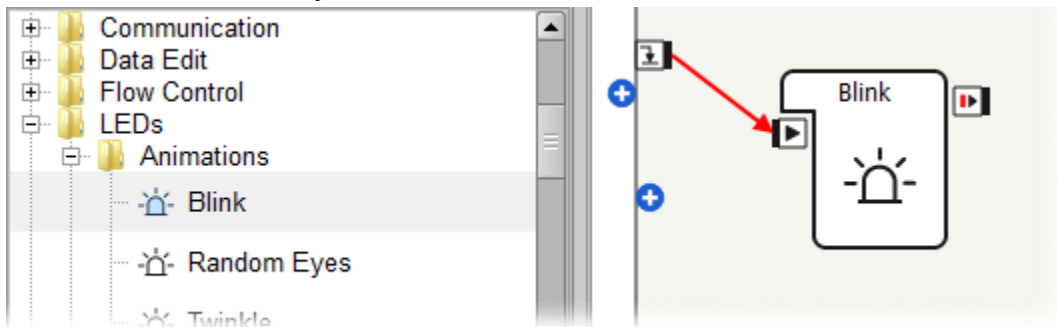
To put another blink, just do a right click where you want on the layer line and click on "Insert KeyFrame" then drag and connect the "blink" box again.

Interact with a human

If you want to make an animation where the robot is in contact with a human or with any interacting object or being, like another robot or an animal, you will have to take care of the motors. As your animation is not dynamic, if you catch the arm of your robot while he is moving, the motors will be overstrained and you can damage them.

To avoid this, you can set the stiffness of the arm that you need to catch to 20%. You will need some knowledge in Python.

In your animation, create a new behavior layer, call it Stiffness for example, and create a new empty box by right clicking on the workspace and "Add a new box". Be sure that the "Box type" is "Script". Now, double click on your box and replace this

```
def onInput_onStart(self):
    #~ self.onStopped() #~ activate output of the box
    pass
```

by this

```
def onInput_onStart(self):
    ALMotion.setStiffnesses( "LArm", 0.2 );
    self.onStopped()
```

"LArm" is for the left arm but you can put "RArm" for the right arm or "Arms" for both. The number is between 0 and 1, 0 is no stiffness, so here it's at 20%. Drag your layer to the moment where you need an interaction and connect your box to the onLoad. Don't forget to set the stiffness to 1 after this by creating a new layer on the same line and reusing your box, but with 1 instead of 0.2. If you don't, your movements will be very sluggish.

Make a speech

The most basic thing that you need to animate a speech is to display the waves of your sound. You can do it in all the good animation softwares, but not in Choregraphe yet. You know how to make a "blink", it's the same way to play a sound or to make the robot talk.

To make a speech, you have to drag a "Say" box in your layer. This box will transform your text into an audible speech, so all you write will be said by your robot with his own voice.

You have two parameters in this box
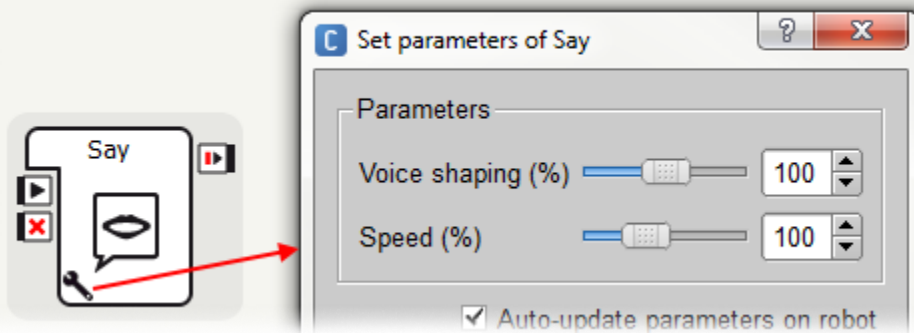
I recommend to set the "Speed" at 90% for a long speech, so it will be easier to understand what he says. Now, double click on your box to edit you text. Never copy/paste a text from a mail or anything, it could contain some unknown characters and make crash the text-to-speech.
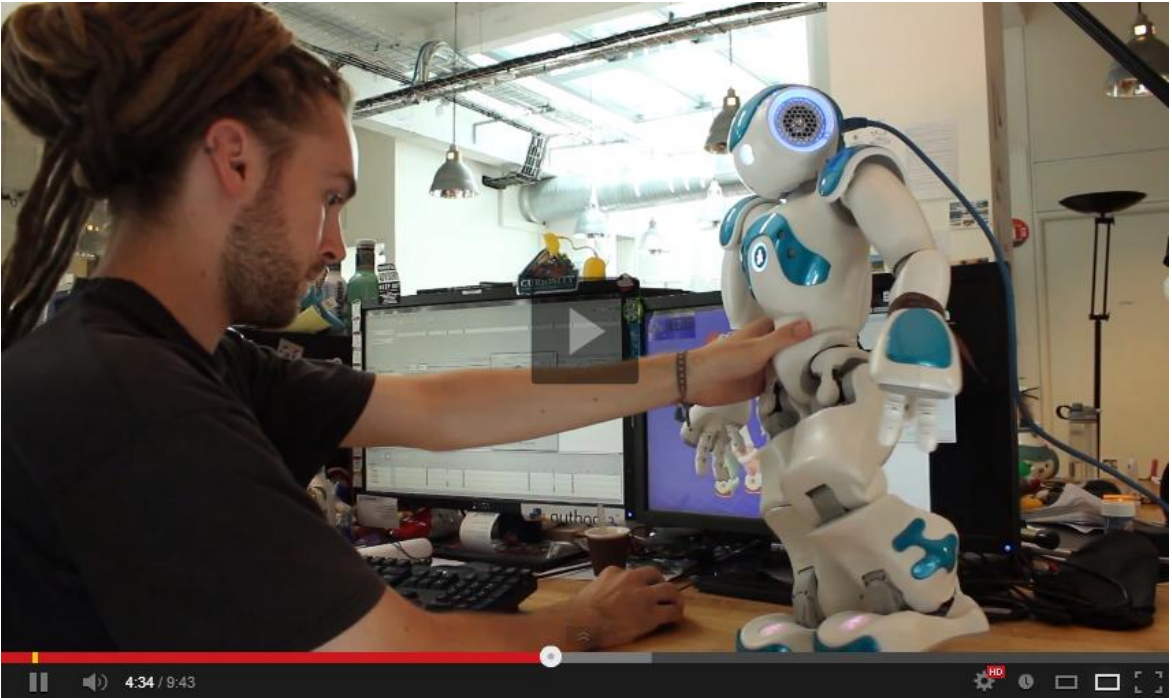
You can tweak you text if you think that the TTS is too fast on some part for exemple. In this text

```
Hi Po! You know, I'm not a panda \Pau=500\ but I can do kung fu
anyway! \RSPD=100\ Watch this!
```

`\Pau=500\` to make a pause of 500ms
`\RSPD=100\` to set the speed at 100%

When your text is good enough for you, start to animate it. Do it step by step, always play your animation from the beginning and be sure that it is synchronised with the speech.

Making of
an animation