

Tower of Hanoi Puzzle Creator

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The puzzle

The Tower of Hanoi is a puzzle which consists of three rods and a number of disks of different sizes that can slide onto the rods. The puzzle starts with the disks in a neat stack in ascending order of size on one rod.

The objective is to move the entire stack to another rod, obeying three simple rules:

1. Only one disk can be moved at a time.
2. No disk may be placed on top of a smaller disk.
3. Each move consists of moving the uppermost disk from one stack to another.

Asset overview

The *Tower of Hanoi Puzzle Creator* allows you to create Tower of Hanoi puzzles with different number of disks and tower geometries. This is done in a similar manner as the standard *Tree* game object (created by clicking at *Create/3D Object/Tree*). When a Tree is created, a new prefab is created inside the assets folder and an instance of it is placed in the current scene. When you modify the tree instance, from the tree component inspector, you'll actually be modifying the *Mesh* and *Tree Data* bundled inside the prefab. The same thing will happen when you create a new Tower of Hanoi, by clicking at *Create/3D Object/Tower of Hanoi*, and modify its instance via the *Tower of Hanoi Creator* script component.

Beyond the procedural editing of the number of disks and tower geometry, the asset also allows you to configure:

- Sounds played when a rod is selected/deselected.
- Animation the disks perform going from one rod to another.
- The way a rod selection is highlighted – by using what we called *Magic Particles*.
- Actions triggered when the puzzle is solved or disks start/finish moving.

Below we will cover the main parts of the tower creation and configuration.

Creating a new tower

There are two ways to create a new tower:

1. Click at *Create/3D Object/Tower of Hanoi*. If you've imported all of the package assets, and did not change the "Tower of Hanoi Puzzle Creator" folder and its sub-folders structure and names, the newly created tower will be automatically configured with sounds, magic particles and disks animations. Otherwise, if the default assets are not found, you'll just get a bare tower, with no animations or sounds.
2. Duplicate one of the tower prefabs which came with the package and edit the copy.

Editing the tower geometry

The geometry of the tower can be tweaked by changing the sliders in the *Tower of Hanoi Creator* script inspector. Editing is very simple and the best way to understand what each slider does is simply to play around with them.

One thing to keep in mind when you change one slider is that it might affect the minimum or maximum values for another one. For example, the radius of the smallest disk can't be smaller than the radius of the rods. So, if you have made the rods as large as possible and now you want to decrease the radius of the smallest disk, you'll first have to decrease the radius of the rods.

Another thing to remember is that only changes in the mesh of the tower are reflected to its prefab. Colors, sounds, materials, animations, are kept individually for each of the instances – unless you click *Apply* (as is the usual behavior for prefabs).

A nice tip if you want more freedom in creating towers

Tip: if no tower shape suits your needs, you can still create a minimal tower geometry, give it a transparent material, and use only the disks and the animation logic. Place it over your own tower model (possibly created with an external 3D modeling tool) and you are ready to go! That's the purpose of the "Only Disks Tower" prefab!

Creating a new Magic Particle

A *Magic Particle* is any game object you want to fly around a selected rod to highlight that it has been selected. All you need to do is to attach a *Magic Particle* script to it and save as a prefab. Then assign the prefab to the *Particle* field in the *Tower of Hanoi* script inspector under the Magic Particles section.

Configuring a Magic Particle

Magic particles are created with random speeds and fade in/out times to give them a more organic feel. The ranges of these values can be configured at the *Magic Particle* script inspector. The other properties in this script are:

- *Radius offset*: The orbiting radius of a magic particle is the *radius of the stack* + *radius offset*. So, a zero value for the *radius offset* means that the particle will orbit tangentially to the rods and disks.
- *Rod change acceleration*: when a magic particle flies to another rod, it does so with a constant acceleration all the way.
- *Fading Value Changed* event: every time a magic particles fade in/out this event is triggered. The fading parameter varies from 0 to 1, with 0 meaning the particle is not visible. You can listen to this event to implement fancy appearances/animations for the magic particles.
- *Fade Scale* checkbox: if checked, the magic particle scale will vary accordingly to the fading value.
- *Fade Trail Renderer* checkbox: if checked and if the magic particle has a Trail Renderer component, the trail will be scaled accordingly to the fading value.

Disk animations

The disks animations can be configured at the *Tower of Hanoi* script inspector, under the *Disk Animations* section. The disks animations have two main parts: sliding in/out of a rod, and flying from the tip of one rod to the tip of another one.

To adjust the in/out motion, setup the fields:

- *Speed*: maximum speed the disks can reach while sliding the rods.
- *Acceleration*: acceleration towards the maximum speed.

The *Framerate Multiplier* field controls the animation speed of the two main parts of the animation. For example, a value of 3 makes everything goes three times as fast.

The *flying from one rod to another* part is controlled by sampling two animation clips:

- *Near Animation*: disks animation between adjacent rods.
- *Far Animation*: disks animation between the far left and far right rods.

Creating a disk Near/Far Animation

If you want to create your own disks animations, do the following:

1. Create a new cylinder.
2. Place it at the origin (represents the tip of the starting rod), with no rotation, and scale it to have the appearance of a disk.
3. Open the Animation window and create a new animation for the disk.
4. Record the animation, make any moves you want, but make sure that it ends with:
 1. Position = (positive value, 0, 0) /* Represents the tip of the target rod */
 2. Rotation = Identity /* No rotation */

Only the position and rotation fields of the animation clips are used. Also, they are scaled such that the end position matches the tip of the target rod – this way you don't have to redo your animation each time you change the distance between rods.

Rod selection system

The default rod selection system is composed by box colliders created at the start of the game. These colliders listen to mouse click events and send them to the *Tower of Hanoi* script, thus controlling which rod is selected/deselected. If you want to implement a different system, uncheck the checkbox *Default Selection* at the of the *Events* section at the *Tower of Hanoi* script inspector. The way you would then select the rods is by calling the `ClickRod(rod)` method of the *Tower of Hanoi* script.

Puzzle complexity

For a tower with N disks, the number of moves required to solve the puzzle is $(2^N - 1)$. Therefore, if you make a tower with too many disks, it might become impossible for the player to solve the puzzle.

WARNING!

If you create a tower with 64 disks and press play with *AutoSolve* turned on, when all the disks move to another stack, the whole universe will collapse. At least that's the legend. So remember: with great power comes... mehh. Just do it ;)

To create a tower with 64 disks, first click at the *Show Ranges* checkbox, in the *Tower of Hanoi Creator* script, and change the *Max* limit of disks' number to 64, then increase the number of disks. The auto solve feature can be found in the *Tower of Hanoi* script inspector. To make the doomsday come earlier, you might want to decrease the *Rod Selection Delay* for the auto solve feature, and also to increase the *Framerate Multiplier* at the *Disks Animations* section. Good luck!