Cocoa Tutorial

Advanced Tutorial for Cocoa

Welcome to the Advanced Tutorial for Cocoa!

This document will introduce you to Cocoa by having you build an Ocean Life world. This simulation of ocean life will show how animals are dependent on each other to survive. You'll create a food web, an important concept in understanding the balance of the earth's ecosystems.

You will create fish, get them to swim around and create food (shrimp) that give the fish energy. When fish run out of energy, they will die. The shrimp will reproduce and try to outlast the fish.

Then, you'll create seaweed that grows taller or is cut down when you click on it. Finally, you'll create a diver that you control with the keyboard to move through the water. By the end of this document, you will have seen the main features of Cocoa.

About this document. It is meant for adults or kids who can closely follow written directions. It is intended to give you the information you'll need to help others who don't understand the logic of building Cocoa worlds. It takes about an hour to go through it.

Your Goals:

 Start Cocoa: open the program.

 Goal 1: make a fish.

 Goal 2: make the fish move.

 Goal 3: save your work.

 Goal 4: make a left-facing appearance for the fish.

 Goal 5: make the fish turn to the left.

 Goal 6: make the fish move both ways.

 Goal 7: change the fish's behavior.

 Goal 8: make the fish swim randomly in both directions.

 Goal 9: make the fish swim regardless of its appearance.

 Goal 10: make the fish swim randomly in all directions.

 Goal 11: give the fish the concept of energy.

 Goal 12: write a rule which decreases the fish's energy by 1 on each clock tick.

 Goal 13: make fish die when they run out of energy.

 Goal 14: create shrimp for the fish to eat.

 Goal 15: make the fish eat the shrimp and gain energy.

 Goal 16: have the shrimp produce more shrimp.

 Goal 17: make seaweed that grows taller or gets cut down when you click on it.

 Goal 18: make a diver that you control with the keyboard.

Maintained by the Apple Cocoa DR Team. Last updated Fri, June 20 1997.
E-mail cocoa@apple.com with problems or questions.

Cocoa Tutorial

Here's what to look for as you go through these pages:

The main goals in building the Ocean Life world are marked with the Cocoa mascot.

Things for you to do are marked with a pointing finger.

Here we go. Have fun!

Start Cocoa

Double click on the Cocoa program icon.

Click on the "Create a New World" button. The Cocoa world opens with a blank board and Controls palette at the bottom.

This is where programming happens in Cocoa. You create "types" of "pieces" that live in your

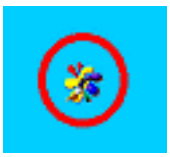
"world." You place pieces on the "board," and write "rules" to tell them what to do. Let's start creating an Ocean Life world by making a fish.

Goal 1: make a fish.

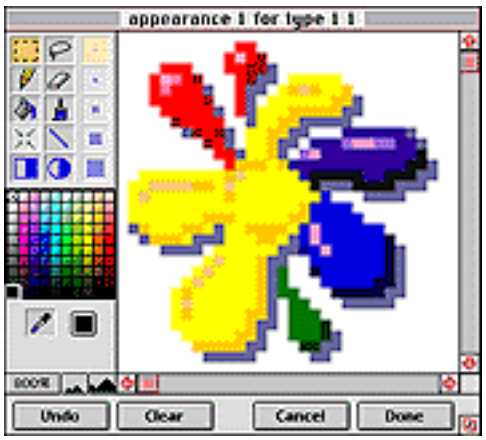
Steps involved: You will create a piece, and draw an appearance for it. Then you will name the type of piece and name its appearance.

 Click on the  Create tool. The cursor looks like the top of a tube of paint. Click anywhere on the board to create a new type of piece.

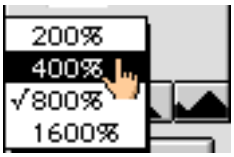
 Click on the  Painting tool. The cursor looks like a paintbrush. Click on the new piece with the Painting tool.



This opens the Appearance Editor. The drawing tools work much like the standard Macintosh drawing tools. The appearance looks like a splat of paint.



You can copy and paste between Cocoa and other graphics programs or the Scrapbook. This lets you use clip art pictures or scanned pictures for your appearances.

Change the magnification to 400%. 

The magnification bar 

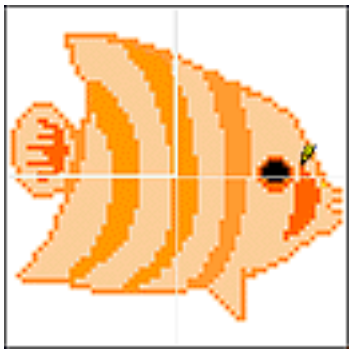
controls the degree of magnification of the drawing area. A magnification of 800% allows you to draw a piece of size 32x32 pixels. A magnification of 400% allows 64x64 pixels pieces. Notice the grid lines in the drawing area. They show you the grid lines that Cocoa uses. We'll talk about the grid later in this section.

You can draw up to 128x128 pixels pieces in the drawing area. We don't recommend larger appearances because it would make the world run too slowly. The piece on the board is at 100% or actual size.

Click on the 

Clear button. This erases the paint splat, leaving the drawing area blank.

Draw a fish appearance facing to the right.



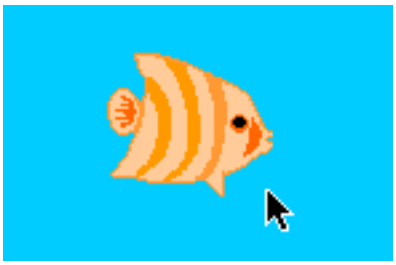
IMPORTANT

Notice that the grid lines in the drawing area are slightly thicker around the upper-left square. It is called the Home Square for this appearance. The size and shape of an appearance are important and they are based on the grid area that the appearance occupies around this Home Square. The rules for one size/shape won't work for other appearances that are a different size/shape, even if the rules don't check the appearance.

Click on the 

appearance Done button.

The Appearance Editor closes, and the piece now has the appearance that you drew.

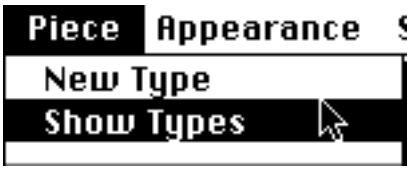


Now you can name the type of piece and its appearance. Names are important in building Cocoa worlds. The names of pieces and their appearances are checked when you write a rule. Naming things also makes it easier to tell who's who on the board.

Cocoa automatically creates names and uses consecutive numbers. It names types "type 1" then "type 2." It names pieces copied from the same type "type 1 1" then "type 1 2." It names multiple appearances for the same type "appearance 1" then "appearance 2."

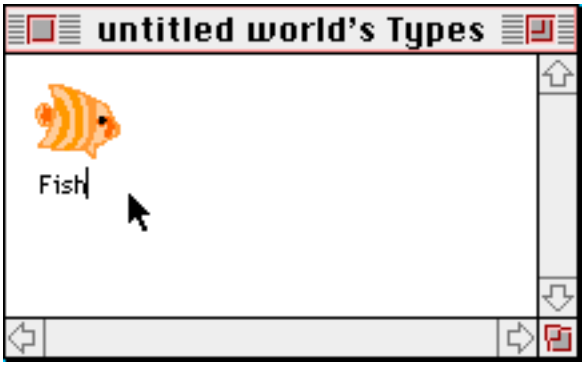
You need to plan ahead in order to avoid confusion later. Let's name the type of piece and its appearance.

First, click on the fish, then go to the PIECE menu and select Show Types.



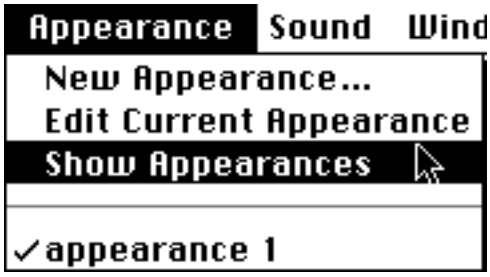
This opens a window that shows you that there's only one type of piece in this world. Name it "Fish."

Click on the name "type 1." Type in the name "Fish."



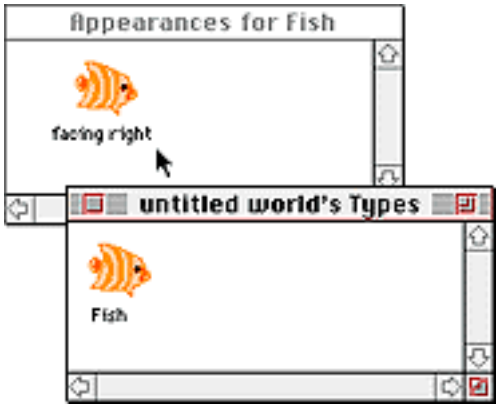
Now, we'll name the appearance.

Click on the fish to select it, then go to the APPEARANCE menu and select Show Appearances.



Click on the name "appearance 1." Type in the name "facing right."

If you've left both the Types and Appearances windows open, you'll see that the windows look alike except for the names underneath the pictures. They actually hold two very different kinds of objects.



When you have more types in the world or more appearances for a type, you'll be better able to tell which window you're viewing. It's important to look at the title bar of the window to check which window you're viewing.

Now let's see how the Ocean Life world is coming along.

Click on the close boxes for the windows.

Click on the 

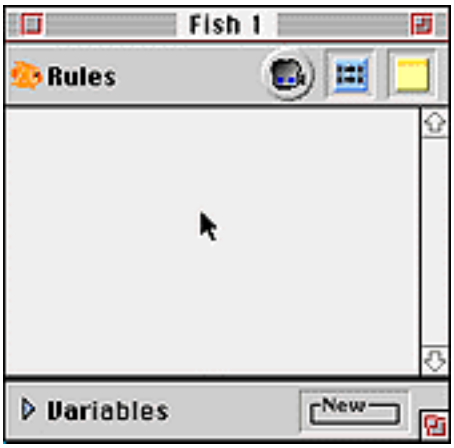
Run button in the Controls palette.

The world starts running. You can tell it's running because the hands of the clock in the Controls palette are going around. But nothing else is happening. That's because you haven't told the fish what to do yet.

Let's start by making the fish move to the right.

 Click on the  Stop button in the Controls palette.

 Double-click on the fish on the board. A Rules window displays the fish's rules. This contains everything that the fish knows.



Notice that the rule list is empty. This is why the fish doesn't do anything. We will change that.

Goal 2: make the fish move.

Steps involved: You will write a rule that moves the fish to the right. This illustrates the basic method of programming in Cocoa. You write a rule that tells the piece how it should behave when it is in a certain situation.

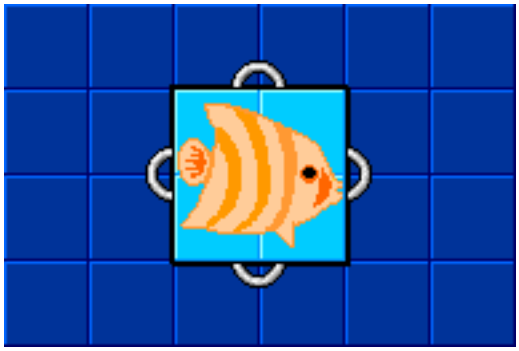
 Click on the  Rule-recording button at the top of the fish's Rules window.

Cocoa enters a special rule-recording mode in which it notices what you do and records it in a program. This is called "programming by demonstration." You demonstrate what you want to happen, and Cocoa writes the program to do it.

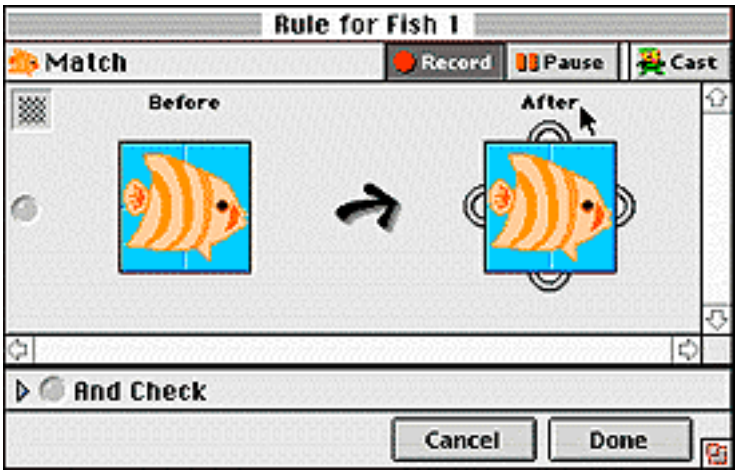
IMPORTANT

The board is actually divided up into a grid of squares. When Cocoa is in rule-recording mode, it

darkens the board and displays grid lines to show you the grid of squares.



A new window called the Rule Editor opens. It displays your rule as you write it.

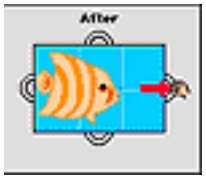


Rules are how you program in Cocoa. A rule says "take the area of the board that matches the Before side of the rule on the left and change it so that it looks like the After side of the rule on the right." Initially the Before and After sides are the same. The way you specify behavior is by modifying the After side so that it looks the way you want.

Cocoa displays a spotlight around the piece for which this rule is being recorded. Notice that our fish is larger than one square.

The spotlight displays the area of the board that your piece needs to notice. You can change the size of the spotlight by dragging the spotlight handles.

Open the spotlight one square to the right.

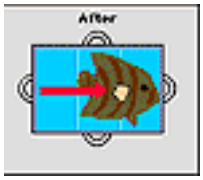


The Rule Editor reflects changes to the spotlight.

IMPORTANT

The spotlight should be kept as small as possible. A common mistake is to make it unnecessarily large. A large spotlight means that more squares have to match in order for the rule to excute. A rule with a small spotlight is more general than one with a large spotlight, since it will have fewer things to check and thus will match more situations.

Drag the fish one square to the right in the Rule Editor.

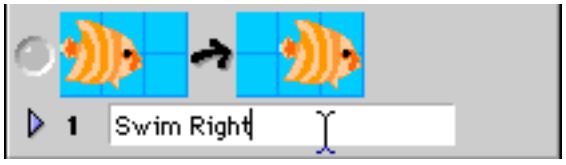


Doing things in After side of the Rule Editor is equivalent to doing them in the spotlight on the board. Anything you can do in one, you can do in the other. The After side of the rule even has size-changing handles like the spotlight on the board.

Since all we want this rule to do is make the fish move to the right, we're done.

Click on the Done rule Done button in the Rule Editor to close it.

Closing the Rule Editor tells Cocoa that you are finished with this rule. Cocoa takes the system out of rule-recording mode and displays a miniature picture of the rule in the fish's Rules window. You can name the rule here.



The fish now knows how to do one thing: swim to the right.

Click on the Run Run button to start the world.

The fish now goes swimming across the screen to the right. Click on the Stop Stop button when you've seen enough. You can make the clock go forward one tick at a time by clicking on the |> Step-forward button. This lets you examine a piece's behavior carefully. Finally, you can make a world play at a slower speed by using the clock's speed control bar Fast Med. Slow . Try it out.

This would be a good time to save your world. It's always smart to save your work on a regular basis.

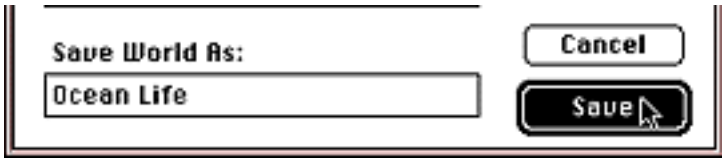
Goal 3: save your work.

Go the FILE menu and select Save World.

A dialog box appears asking you to name your world.

Type "Ocean Life" as the world name. Make certain that you notice and/or change the folder into which the world will be placed.

Click on the Save button.



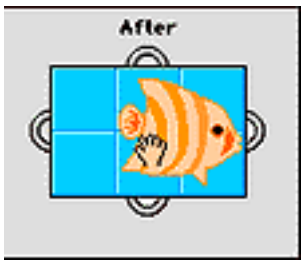
The saved world appears as an icon wherever you told it to go. The icon looks like a globe with the name "Ocean Life."

Now that we've got the fish moving to the right successfully, let's make it turn to the left.

MAKE A FISH MOVE TO THE LEFT

Click on the  Rule-recording button at the top of the fish's Rules window. (If you've closed the Rules window, you can open it by double-clicking on the fish.)

Open the spotlight to include 1 square to the LEFT.



But now we notice a problem. If we just drag the fish to the left, it will appear to be swimming backwards. It would be nice if it faced in the direction it was swimming. But the fish currently has only one appearance, facing to the right. So let's cancel this rule and make a new appearance for the fish.

Click on the 

Cancel button in the Rule Editor.

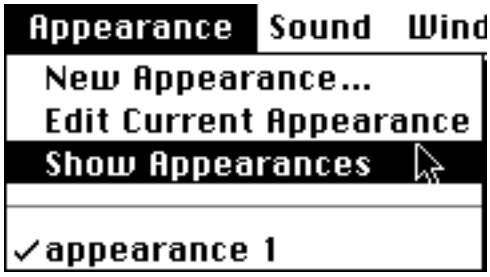
The Rule Editor closes, and Cocoa leaves rule-recording mode without changing anything.

Goal 4: make a left-facing appearance for the fish.

Steps involved: You will create a new appearance for the fish that faces to the left, and name the new appearance.

If you've closed the Rules window, you can open it by double-clicking on the fish.

With the fish's Rules window open, go to the APPEARANCE menu and select Show Appearances.



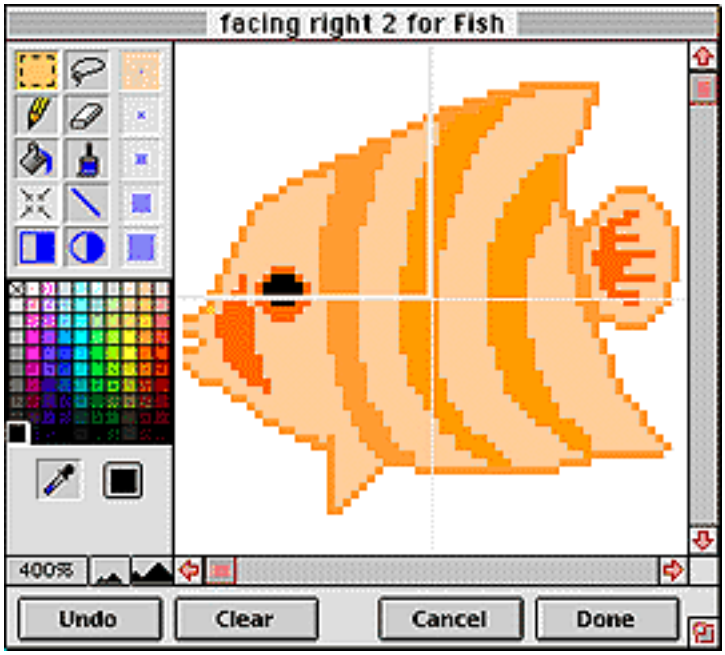
The Appearances window shows the one appearance for the fish. We want to create a second appearance.

Go back to the APPEARANCE menu and select New Appearance.

A copy of the "facing right" appearance is put into the Appearance Editor. We just have to flip it to make the fish face left. A new menu item called "Paint" gives you some editing options.

Go to the PAINT menu and select Flip Left-Right.

The fish appearance now is facing to the left.



Click on the  appearance Done button.

In the Appearances window, with the name "facing right 2" selected, rename the new appearance "facing left." Now you have 2 appearances for the fish.

Leave the Appearances window open. We can use the new appearance when we write the rule to turn the fish to the left.

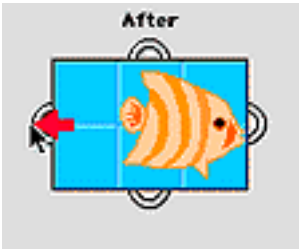
Now let's return to our previous goal.

Goal 5: make the fish turn to the left.

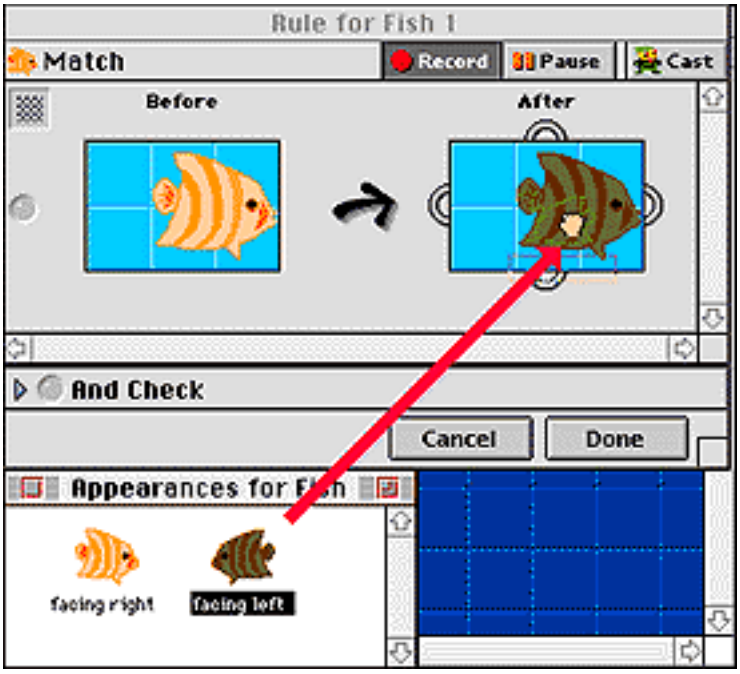
Steps involved: You will write a rule that first changes the fish's appearance and then moves it to the left.

Click on the  Rule-recording button at the top of the fish's Rules window.

Open the spotlight to include the empty space to the LEFT.



Click on the Appearances window to bring it to the front. It may be hidden by the Rules window. Drag the "facing left" appearance from the Appearances window ONTO THE FISH in the AFTER side of the Rule Editor.

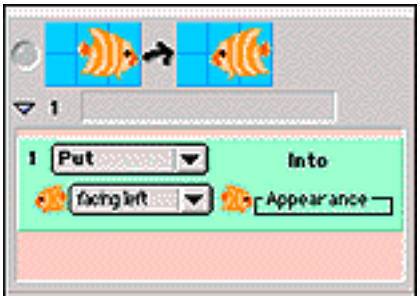


IMPORTANT

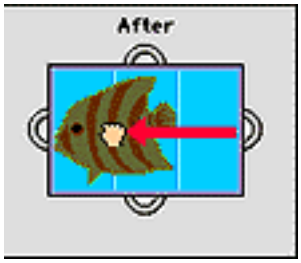
We're dragging from the **Appearances for Fish** window onto a **Fish.** If there were another type of piece, say a shark, on the board we could drag the fish's "facing right" appearance onto it, but a shark wouldn't change its appearance to look like a fish. Yet, if the shark, had a "facing right" appearance, it would change to it's own "facing right" appearance. This is another reason why the name of an appearance is important.

The fish now faces left. We can verify this by looking at the rule actions (in light green) in the Rules

window. They are listed here under the miniature picture of the rule.



Move the fish one square to the left.

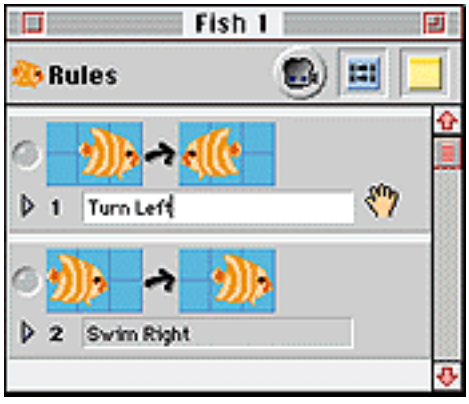


This gets recorded too. Look at the actions area to verify it.

Click on the 

rule Done button in the Rule Editor to close it.

Closing the Rule Editor tells Cocoa that you are finished with this rule. Cocoa takes the system out of rule-recording mode and second miniature rule is displayed in the fish's Rules window. The fish now knows how to do two things: turn left and swim right. To avoid confusion you can name the rules.



Click on the 

Run button to run the world.

The fish doesn't move when it's facing left. Why is this? The reason is the way Cocoa checks rules.

You haven't told the fish how to act when it's facing left. Also, we'll want the fish to turn to the right sometime. Let's write 2 more rules.

Goal 6: make the fish move both ways.

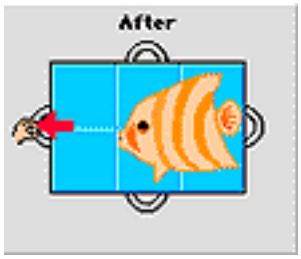
Steps involved: You will write a rule for the fish to Swim Left, then write a rule to Turn Right.

First, write a rule for the fish to swim left.

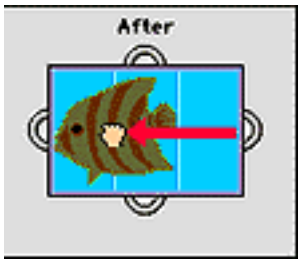
Move the fish to the middle of the board.

Click on the  Rule-recording button at the top of the fish's Rules window. (If you've closed the Rules window, you can open it by double-clicking on the fish.)

Open the spotlight to include the empty space to the left.



Drag the fish one square to the left.



Since all we want this rule to do is make the fish move to the left, we're done.

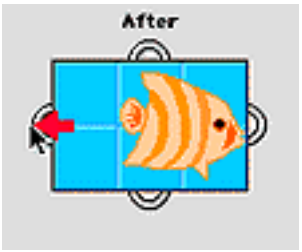
Click on the 

rule Done button in the Rule Editor to close it.

Now, write a rule for the fish to turn right.

Click on the  Rule-recording button at the top of the fish's Rules window. (If you've closed the Rules window, you can open it by double-clicking on the fish.)

Open the spotlight to include the empty space to the RIGHT.

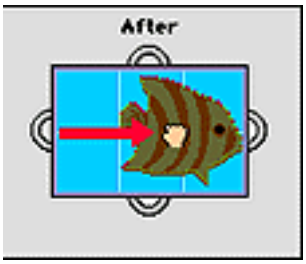


Here's another way to change the fish's appearance. This time we'll use the menu.

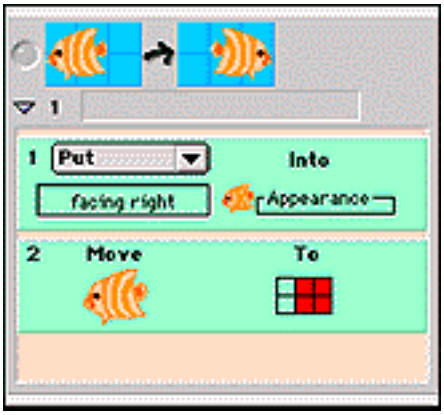
Click on the fish once to select it. Go to the APPEARANCE menu. Notice that "facing left" at the bottom of the menu is checked. Select the "facing right" option.

The fish now faces right again.

Drag the fish one square to the right.



We can verify what has been recorded by looking at the rule actions (in light green) in the Rules window. They are listed under the miniature picture of the rule.



Click on the Done rule Done button in the Rule Editor to close it.

You can name these 2 new rules "Turn Right" and Swim Left."

Save your world.

You can replace the existing "Ocean Life" world unless you want to keep the old one. In that case, you should give the new world a different name such as "Ocean Life 2."

Now we'll change how the fish uses these 4 rules.

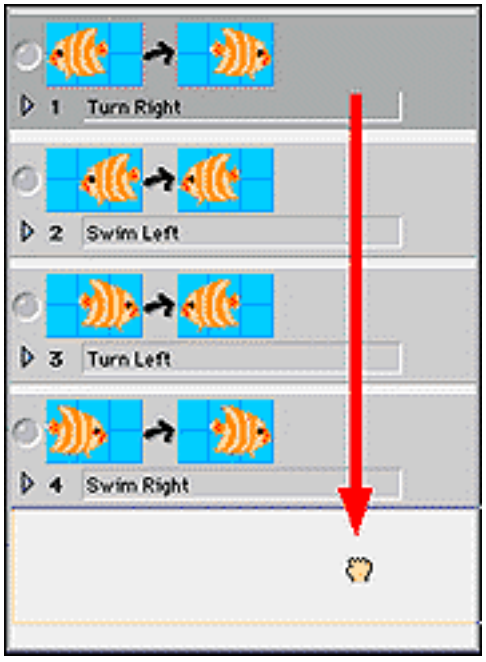
Goal 7: change the fish's behavior

Steps involved: Experiment with the rule order to see how changing the rule order changes how the fish behaves.

Move the Rules window as far off the board as you can and still see the rules listed. You can resize the window if you'd like.

Run the world.

Experiment with switching the order of the rules in the Rules window and see how it changes the fish's behavior on the board. Drag the top rule down to change the order. If it's moving too fast, adjust the speed control to "Med." or "Slow." The fish turns or moves in either direction depending on which rule executes first.



IMPORTANT

On each clock tick, Cocoa gives every piece on the board a chance to run. It starts at the TOP of the list of rules for that piece and tests each rule IN ORDER. As soon as Cocoa finds a rule that matches, it executes it. As soon as a rule executes, that piece's turn is over, and Cocoa proceeds to the next piece, if any. Thus the order of the rules matters in determining what a piece does.

The fish faces in the direction it is going in both cases. It's still unrealistic for a fish to swim in a straight line in one direction all the time. Let's make the fish behave more unpredictably.

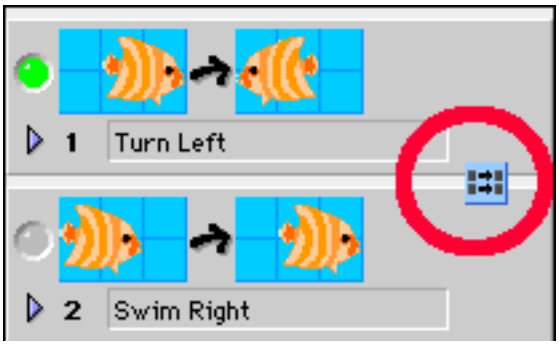
Stop the world.

Goal 8: make the fish swim randomly in both directions.

Steps involved: You will group the rules in a rule set, putting the two swim rules and the two turn rules into it. This introduces the concept of grouping rules into rule sets to modify the piece's behavior.

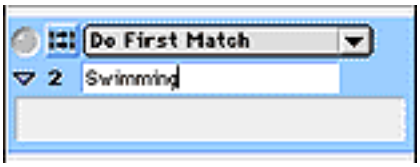
Click on the  Rule Set tool. The cursor becomes a "box of rules" icon.

Move the Rule Set tool over the white space between 2 rules in the Rules window. When the middle of the Rule Set tool is over the white space, click to place a rule set in the Rules window.



A rule set is a box of rules. It is similar to a folder in the Macintosh. It can hold any number of rules, it can be opened and closed, and it can be named. Let's give it a name.

Click in the text field and name this Rule Set "Swimming" because we will place all of the fish's swimming rules in it.



Hold the mouse button down over the rule set option menu.

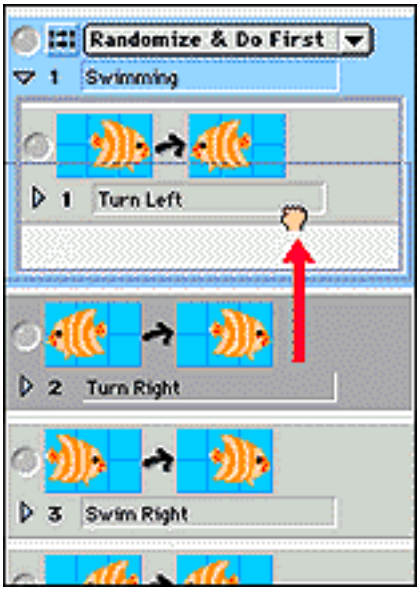
A pop-up menu of Rule Set options appears.

There are 3 options; the one we want is "Randomize & Do First." Every time a Randomize & Do First rule set is tested, it scrambles the order of the rules inside it. Thus if we place our rules in a Randomize & Do First rule set, they will be tried in a different order each time.

Select the "Randomize & Do First" option.

Scroll down to see the contents of the rule set. It's currently empty.

Drag all 4 rules into it.



Run the world.

The fish moves randomly left and right.

Close the fish's Rules window.

Worlds run faster with all the windows closed, since with them open Cocoa has to do a lot of work to update them. So open the Rules window when you want to examine the rule recording or execution, but close it when you just want to run the world. You can always open a piece's Rules window by double-clicking on the piece on the board.

Stop the world.

Goal 9: make the fish swim regardless of its appearance.

Steps involved: you'll write two additional rules to move up and down regardless of the direction the fish is facing.

IMPORTANT

When you write a rule, it automatically checks the piece's appearance. That's why it's so important to draw the appearance and name it before you write a rule. You do have the option of changing the way Cocoa checks a rule. You can change the name in the appearance check, or you can delete the

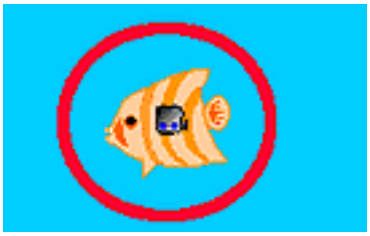
appearance check out of the checklist.

Here's how to make a rule that will work no matter what the appearance is.

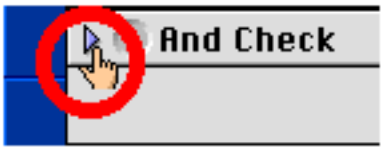
First, we'll write the "Move Up" rule.

Here's another way to write a rule. You can use the Rule-recording tool in the Controls palette.

Click on the  Rule-recording tool in the Controls palette and click on the fish.



We DON'T want to check what direction the fish is facing. We want to delete the appearance check in the check list.

Click on the 

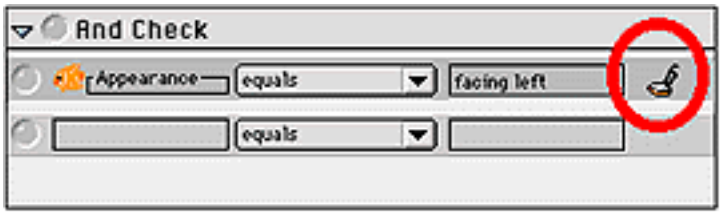
disclosure triangle next to title "And Check" to open the check list.

You'll see the appearance check that Cocoa automatically puts into the rule.

Click on the  Delete tool in the Controls palette.

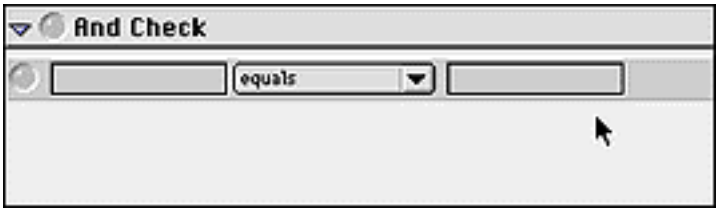
The cursor now looks like a vacuum.

Click on the appearance check in the check list with the Delete tool.



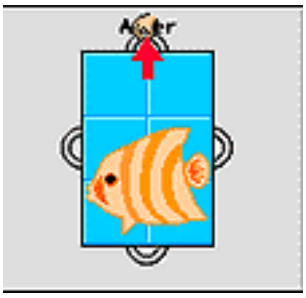
Now, the appearance will not be checked. This area is empty, so all the rule will check is what's on

the Before side of the Rule Editor.



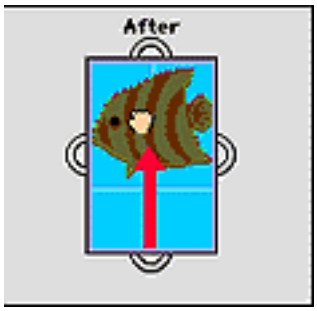
Now, we can move the fish up.

Open the spotlight to include the empty space ABOVE the fish.



This says we want to check that there's nothing in the space above the fish.

Drag the fish one square up.



Click on the 

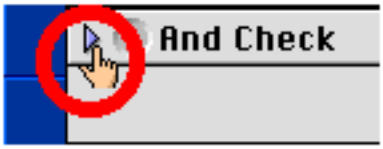
rule Done button in the Rule Editor to close it.

This rule will not check which direction the fish is facing, so the fish will move up if there is empty space above it.

Now, write the same kind of rule, but this time to move DOWN no matter what the appearance is.

Click on the  Rule-recording tool and click on the fish.

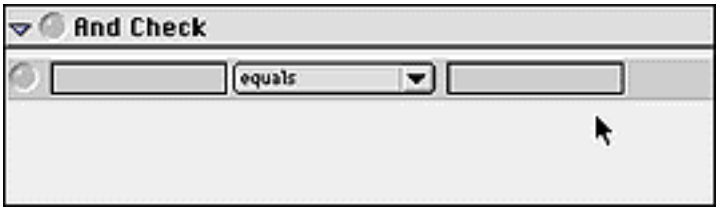
We want to delete the appearance check in the check list.

Click on the 

disclosure triangle next to title "And Check" to open the check list.

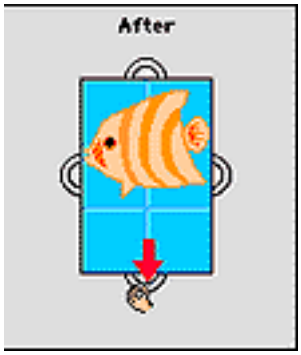
Click on the  Delete tool.

Click on the appearance check in the check list with the Delete tool to delete it from the check list.



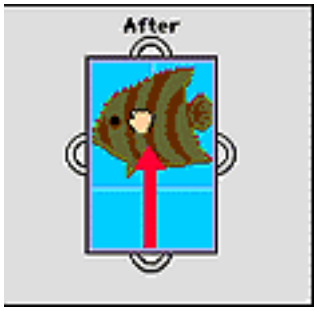
Now, we can move the fish down.

Open the spotlight to include the empty space BELOW the fish.



This says we want to check that there's nothing in the space below the fish.

Drag the fish one square down.

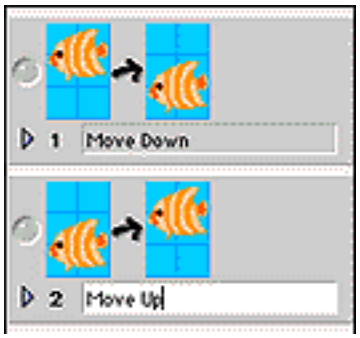


Click on the  rule Done button in the Rule Editor to close it.

To see the 2 rules you need to open the Rules window.

Double-click on the fish to open the Rules window.

Now you can name the 2 new rules: "Move Down" and "Move Up."

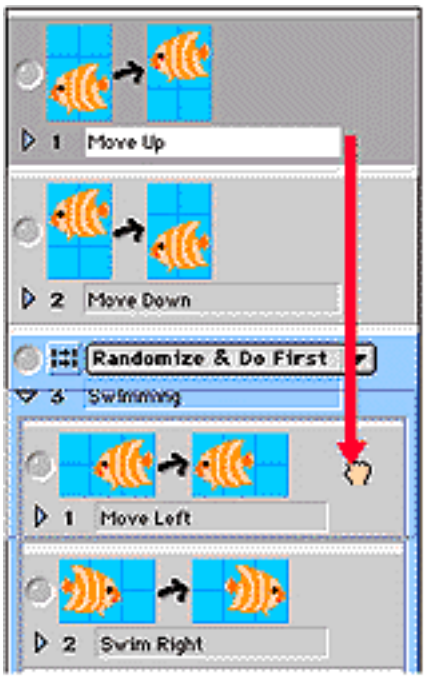


Goal 10: make the fish swim randomly in all directions.

Steps involved: you'll put the "Move Down" and "Move Up" rules to the "Swimming" rule set.

If you've closed the Rules window, you can open it by double-clicking on the fish.

Drag the two new rules into the "Swimming" Rule Set. Notice that the Rule Set has to be open before you can drag rules into it.



You can close the Rule Set to compact the rules list.

Close the Rule Set by clicking on the  disclosure triangle.

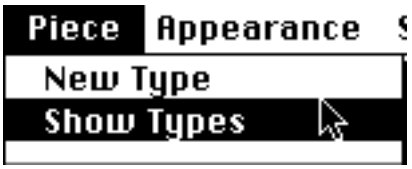
Click on the close box to close the Rules window.

Click on the  Run button to run the world.

The fish moves randomly in all directions.

Now that the fish is working the way we want, we can put out more fish to see how the Ocean Life world works.

Go to the PIECE menu and select Show Types.



Drag 2 more fish from the Types window onto the board.

They all start swimming around, each in its own individual way.

Congratulations! You have now created a simple Ocean Life world. It contains several fish of your own creation, and the fish swim around as you have taught them to do. You have programmed the fish.

Save your world.

IMPORTANT

The order you put new pieces onto the board is important. It determines the order in which the pieces act when the clock starts running. The first fish you put on the board gets to try its rules first, then the second fish you put on the board gets to try. If the third piece you put on the board was a different type of piece, say a shark, then the shark would try its rules after the two fish took their turns.

How can we make our Ocean Life world even more realistic?

In the next sections, we'll show the fish how to keep track of its energy. It takes energy to swim and when fish run out of energy, they die. But, if they eat food, they get more energy.

Goal 11: give the fish the concept of energy.

Steps involved: You will create a new variable for the fish and give it a name and value. Variables

are the information that a piece tracks and/or changes in a rule.

Open a fish's Rules window by double-clicking on one on the board.

IMPORTANT

It doesn't matter which fish you choose. Adding a rule or variable to one fish adds it to all copies of the fish. The fish on the board are all copies of the same type of piece in Cocoa.

Click on the 

disclosure triangle next to title "Variables."

The Rules and Variables share space in this window. The disclosure triangle will let you quickly open and close the Variables area. The thick black line between the 2 areas acts as a window splitter letting you adjust how much of each area you see. We'll use it later to see the rules.

Now, we'll create a new variable.

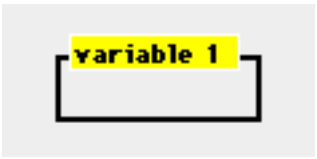
Click on the 

New Variable tool.

The cursor looks like a variable box.

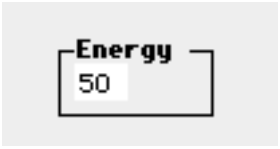
Click in the empty space of the fish's Variables area.

A new variable box is created.



Let's call it the fish's "Energy" and enter a value of "50."

Select the name "variable 1", type in the name "Energy", then hit the tab key, and enter "50."



50 is the initial value for the variable. 50 what? 50 anything. It doesn't matter what the units are. Variables have no meaning unless you use them in a rule. When you write a rule, you can have it

check and/or change the values of variables. Thus rules define the meanings of variables.

IMPORTANT

The initial value you give a variable for a type of piece is important. Any pieces on the board of the same type and any new pieces of the same type will have this initial value assigned to the variable. In this example, all fish on the board and any new fish will have their Energy value start at 50.

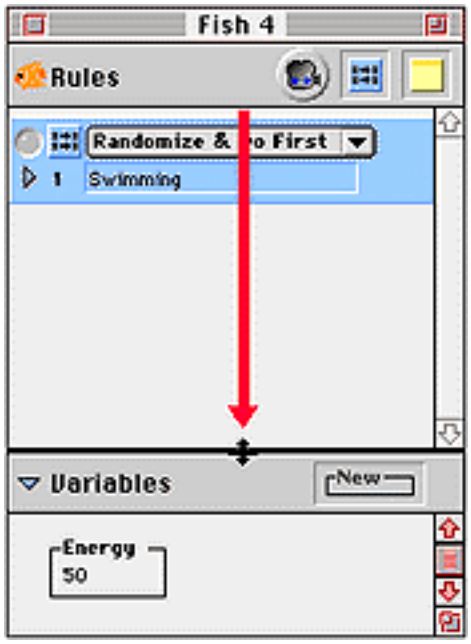
Let's make a fish's energy go down on every clock tick to show that it is using up energy as it swims. We could go back and modify all the swimming rules we've written to decrease the energy, but there's an easier way. We'll write a new rule to do it.

Goal 12: write a rule which decreases the fish's energy by 1 on each clock tick.

Steps involved: You will write a rule that changes the fish's Energy variable, and then create a "Do All & Continue" rule set for the rule.

Move the mouse over the black line between the Rules and Variables areas. The cursor turns into a window splitter.

Drag the splitter bar down to see the rule set at the top and the Energy variable at the bottom.

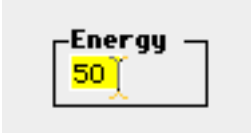


Now you can write the rule that changes the Energy variable.

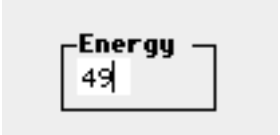
Click on the  Rule-recording button at the top of the fish's Rules window.

Leave the spotlight alone, since this rule is not going to change the fish's location. All we want to change is its energy. In rule-recording mode, any changes we make to a fish's variables are recorded. All we have to do is edit the fish's Energy variable to make it what we want it to be. Since it's 50 now, and we want it to go down by 1, we should make it 49.

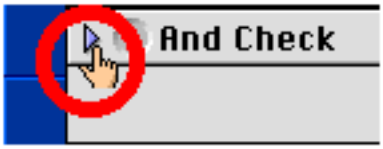
Select the value "50" in the Energy variable



Type in "49."



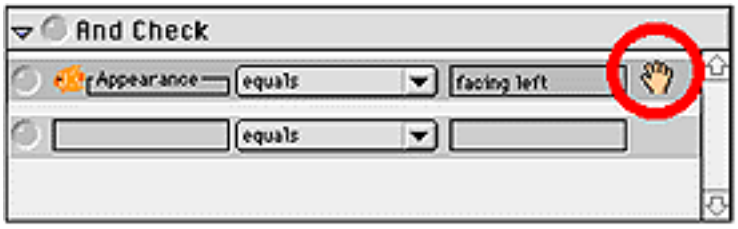
There's just one more thing to do. We DON'T want to check what direction the fish is facing.

Click on the 

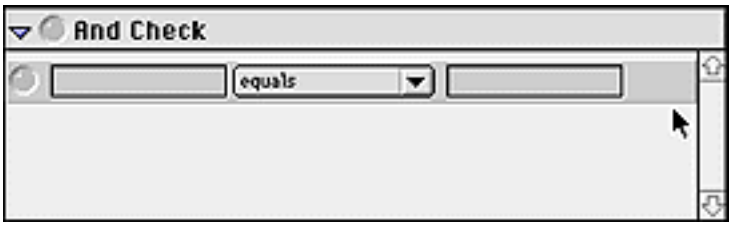
disclosure triangle next to title "And Check" to open the check list.

Here's another way to delete items in Cocoa.

Move the mouse over the appearance check in the check list and click on it to select it. You can tell it's selected because it's slightly darker.

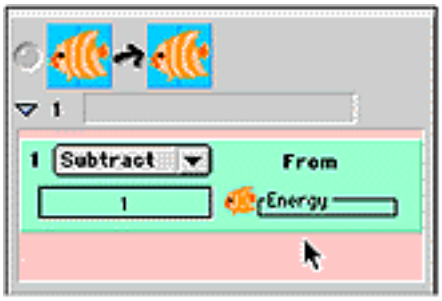


Hit the delete key on the keyboard.

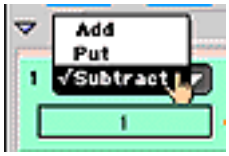


Now Cocoa will not check the appearance.

With programming by demonstration, you edit the screen to look the way you want it, and Cocoa does the rest. If you check what was recorded, you see the following action (in light-green).



Cocoa guesses that you meant to subtract 1 from the fish's energy, rather than setting it to 49, because adding or subtracting 1 is the most common arithmetic action. If this is wrong, you can change the recorded action with the pop-up menu supplied.



Click on the Done rule Done button in the Rule Editor to close it.

Name the rule "Use Energy."

Now we have a rule that does nothing but decrease a fish's energy.

Let's check how the rule works. Instead of running the world, we'll go forward one step at a time. This way we can carefully check the rule.

Click on the Step-forward button in the Controls palette.

Uh oh. All the fish stop moving. The only thing that happens now is the fish's energy goes down.

Why?

The reason is that the "Use Energy" rule, being the first rule in the list, is always executing. No other rule is getting a chance.

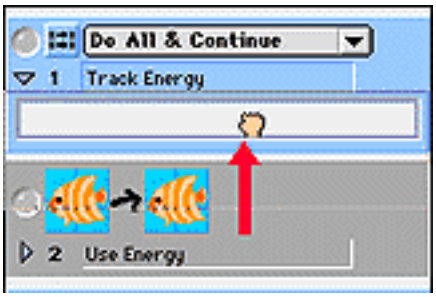
We could drag the "Use Energy" rule to below the Swimming rule set, but then the fish would swim and its energy would never go down. So that won't work.

Fortunately there is a solution.

One of the types of rule sets in Cocoa is a "Do all & Continue" rule set. Do all & Continue rule sets test all of the rules inside the set and execute all that match. Best of all, they allow more than one thing to happen on a clock tick. Cocoa continues testing the rules that are after a Do all & Continue rule set. Let's put the "Use Energy" rule in a Do all & Continue rule set.

Create a new rule set, name it "Track Energy", and change its type to "Do all & Continue."

Drag the "Use Energy" rule into the rule set.



Make certain the Do all & Continue rule set is at the TOP of the Rules window.

Step forward [I>] a few times.

Now the fish move again, and their energy goes down at the same time. Great! Just what we want. The fish are "getting tired" as they swim.

Let's see how this works.

Click the disclosure triangle next to the title "Variables" to close it. This way we can see more of the rules.

Open both rule sets. Click the disclosure triangle to open the rule set if it's closed.

Step forward [I>] ONE TIME.

Notice the red and green circles next to each rule and rule set as you step forward one step.

These are tracing lights that tell you what happened on the last clock tick. For rules, green  means that this rule's Before side DID match what was on the board and all the variables in the check list matched. All the actions that could be completed were completed. Red  means this rule was tested but did not execute because something DID NOT match. Clear  means this rule was not even tested because some other rule executed on that clock tick.

For rule sets, green means that at least one rule inside it executed on the last clock tick, red means that none of its rules executed, and clear means that none of its rules were even tested.

A good way to check the rules is to use the  step-forward button to make the clock go a single tick at a time. You can then examine what happens one step at a time.

If you run the world and try to watch the tracing lights, you'll have some trouble. The Rules window can't update fast enough when many actions are happening at once. It's best to use the step-forward button if you want to check the rules.

 Save your world.

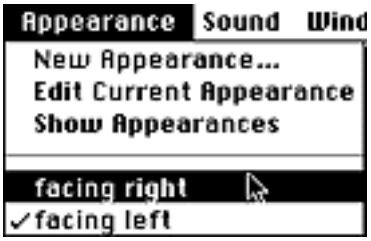
Goal 13: make fish die when they run out of energy.

Steps involved: You will create a "dead" appearance for the fish and write a rule that switches to it whenever the fish's energy level drops to zero. This illustrates how a rule can test the value of a variable.

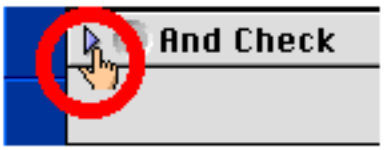
Create a dead appearance for fish. In the Show Appearances window, name it "dead."

Now write a rule that checks a fish's energy and makes it "die" (turn belly up) if it runs out of energy. To do this, we need to check the Energy variable in the "And Check" area of the Rule Editor.

If your fish now looks dead, change the appearance back to facing right before going on. Select the fish on the board, go back to the APPEARANCE menu and select the facing right appearance.

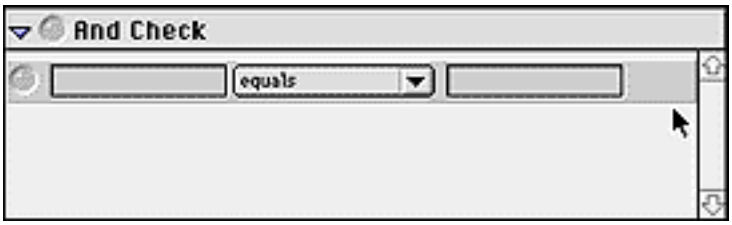


Click on the  Rule-recording button at the top of the fish's Rules window. (If you've closed the Rules window, you can open it by double-clicking on the fish.)

Click on the 

disclosure triangle next to title "And Check" to open the check list.

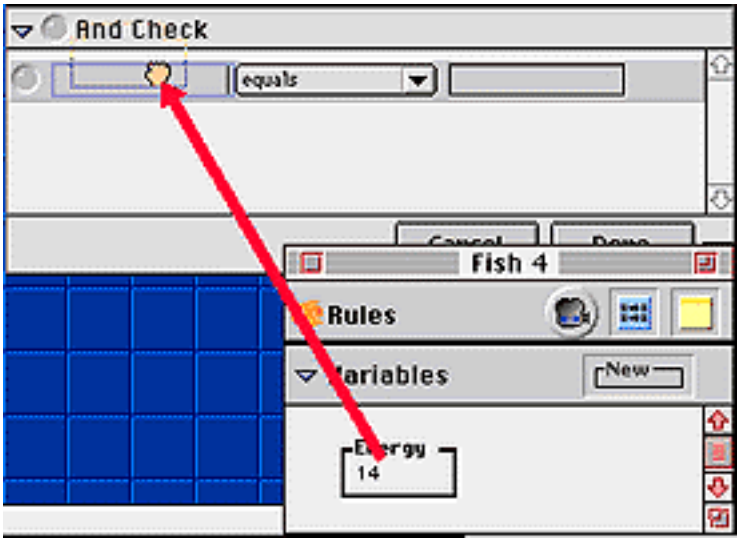
Select the appearance check in the check list and hit the delete key on the keyboard to delete the appearance check.



We want to make this rule check the fish's Energy variable value.

Open the Variables area by clicking on the disclosure triangle.

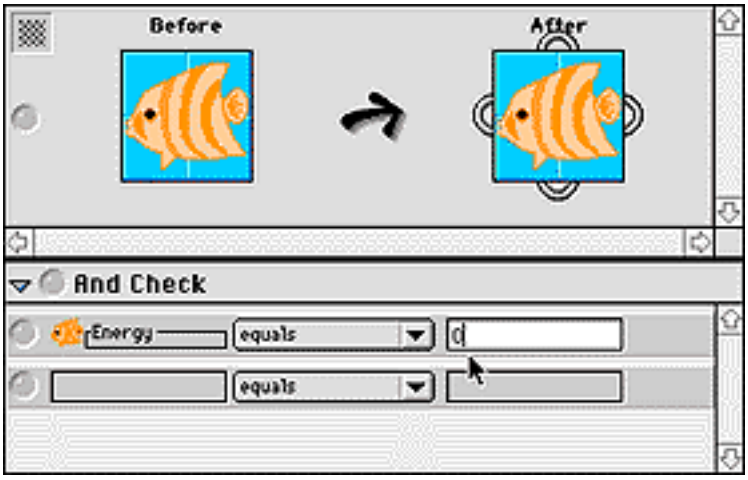
Drag the Energy variable from the fish's Rules window to the LEFT side of the variable test.



Cocoa guesses that the test should be that the variable equals its current value, 14. (Your value may be different.) But what we really want is to check if the energy equals zero. So we edit the RIGHT side of the check and change the value to 0.

Click on the value in the right side of the Energy check. Type "0" (zero).

You've now written a rule that says: "If my Energy equals zero, then..."



Now we have to tell the rule what to do. All we're going to do is change the fish's appearance to its dead appearance.

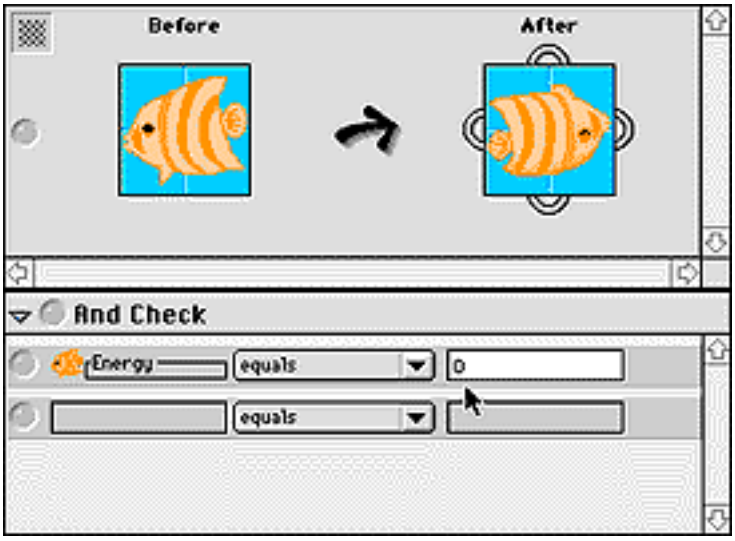
Here's another way to change the appearance.

Hold down the Command ⌘ key and mouse down on the fish in the After side of the Rule Editor. A picture pop-up menu lets you select from any of the fish's appearances.

With the mouse button down, move the pointer over the dead appearance and let go of the mouse button.

This action gets recorded. Here is our final rule.

"If my energy equals zero, then switch to my dead appearance."



That's all we want this rule to do.

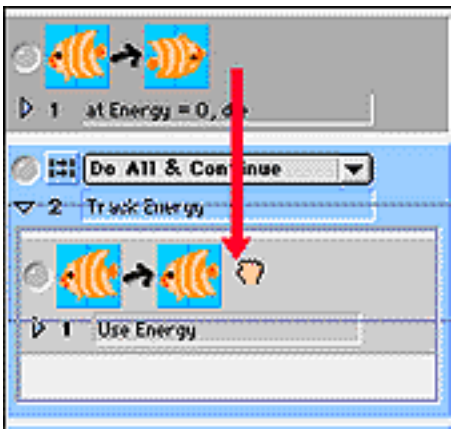
Click on the Done rule Done button in the Rule Editor to close it.

Name the rule "at Energy = 0, die"

Close the Variables area so you can see more rules.

We could leave this rule at the top of the rules list, but to keep the rules logically together, let's put this rule in the "Track Energy" Rule Set with the other rule that deals with Energy.

Open the "Track Energy" Rule Set and drag the "at Energy = 0, die" rule into the Rule Set.



Your fish now looks dead even though it probably still has energy. Change the appearance back to facing right before going on.

Hold down the Command ⌘ key and mouse down on the fish on the board. With the mouse button down, move the pointer over the facing right appearance and let go of the mouse button.

Now, let's see how the fish act.

Run the world.

Notice that eventually all the fish will die and only float up or down.

How can we prevent this?

Stop the world.

Click on the ◁| Step-backward button.

Step the clock backwards until all the fish come back to life.

If you need to back up a lot, you can also rewind the world by using the ◁◁ Rewind button in the Controls palette. But it goes quickly, so be prepared to stop fast.

If something happens during the running of a world that you don't like, you can "back up time" to undo it. Just run the clock backward to before that point, write a rule to change the outcome, and then run it forward again. Cocoa allows time to be backed up for quite a while.

But we still have the problem of keeping the fish alive. In the next section, we'll create shrimp for the fish to eat.

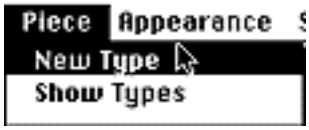
Save your world.

Goal 14: create shrimp for the fish to eat.

Steps involved: You will create a new piece, draw an appearance for it, give it a name, and make it swim randomly like the fish. No new concepts are introduced here; rather, this is a review of what you've learned so far.

Here's another way to make a new type of piece. This time we'll use the menu.

Go to the PIECE menu and select New Type.



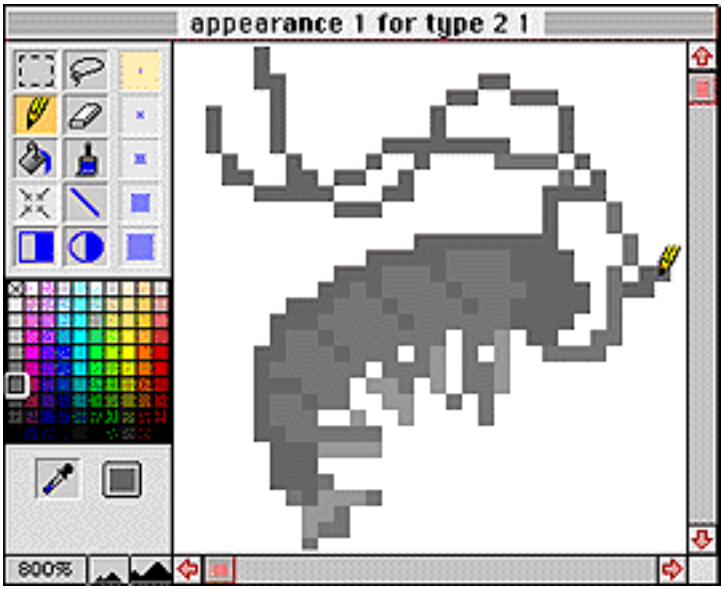
A paint splat appears on the board. It is dark because it is selected.

Here's another way to get to the Appearance Editor. This time we'll use the menu.

With the new piece selected, go to the APPEARANCE menu and select Edit Current Appearance.

Note that the magnification of the drawing area is at 800%.

Draw an appearance that looks like a shrimp.



Keep the appearance small occupying only one square.

Click on the 

appearance Done button.

The Appearance Editor closes, and the piece now has the appearance that you drew.

Now, we'll make the shrimp swim randomly, as we did with the fish.

Write 4 swim rules for the shrimp to swim up, down, left and right.

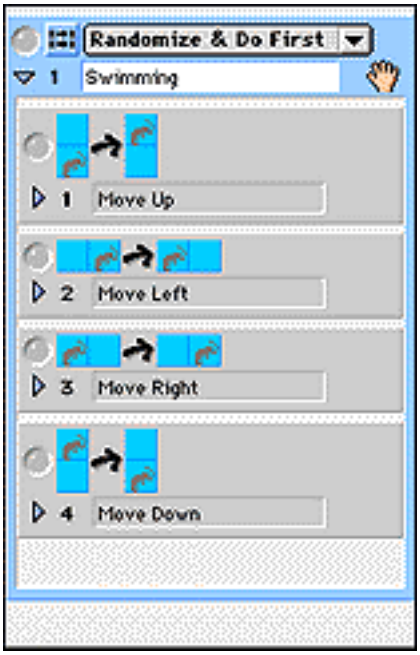
By now, you should be able to make these rules quickly. Don't bother making different appearances for the shrimp since we'll just use one.

To make the shrimp swim randomly, we'll put the shrimp's swimming rules in a Randomize & Do First rule set.

Here's another way to create a rule set. This time we'll use the menu.

Go to the PIECE menu and select New Rule Set.

Now, drag all the swimming rules into the rule set and select the Randomize & Do First option.



Now that we have the shrimp swimming, let's make fish eat them. First, make copies of the shrimp so you don't run out while writing the eating rules for the fish.

Here's an easy way to copy a piece.

Move the mouse over a shrimp on the board. Hold down the Option key and move the mouse. A copy of the shrimp will be left where you let up the mouse button. You can select many shrimp and copy a group of them this way.

Goal 15: make the fish eat the shrimp and gain energy.

Steps involved: You will write a rule that deletes a shrimp whenever its to the right of a fish, and the fish will make a sound when it eats. This rule will also add 50 to the fish's Energy. This illustrates how a rule can delete pieces, how it can change the value of a variable, and how it can be told to ignore certain squares.

Place a shrimp on the board to the right of a fish that's facing right.

Notice that the shrimp doesn't line up with the middle of the fish. That's because the fish occupies a 2x2 square area, while the shrimp occupies a single square. If you don't like the way this looks, you can make bigger shrimp. But it will help us illustrate a feature here, so let's continue.

Click on the fish on the board to select it.

Now we can record the sound the fish will say when it eats.

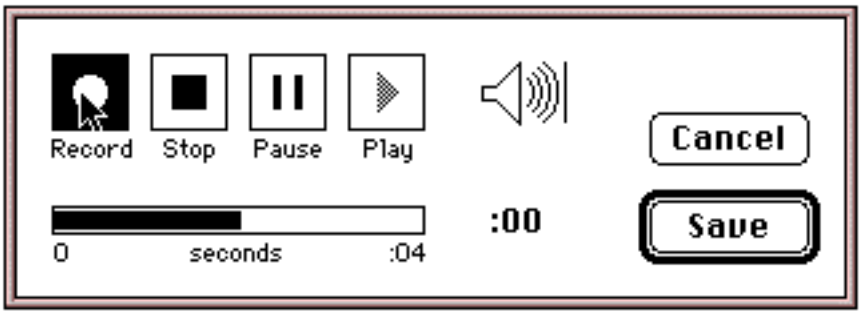
Go to the SOUND menu and select Show Sounds.

This window is empty because there are no sounds currently available for the fish.

Go to the SOUND menu and select New Sound.

This opens the Sound Editor where you can record up to 4 seconds of sound.

Record an eating sound for the fish. Click on **Play** to hear what was recorded.



Click on **Cancel** if you don't like what you recorded. You'll have to go back to the SOUND menu to record a new sound again.

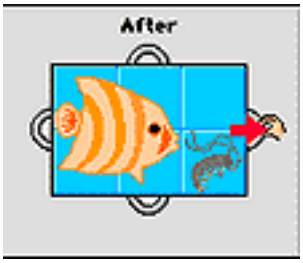
Click on **Save** when you're satisfied with the sound.

Name the sound "Eat."

Now you can write the rule for the fish to eat the shrimp.

Click on  Rule-recording tool and click on the fish.

Open the spotlight to include the shrimp on the right.



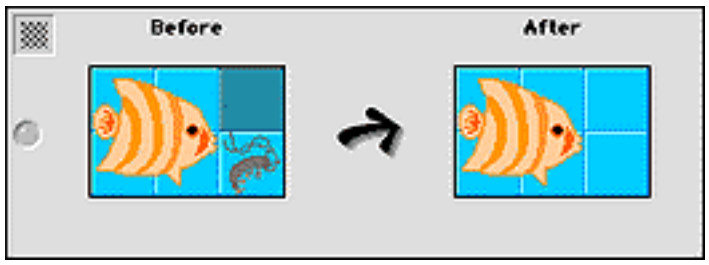
Since there are two squares to the right of the fish, and the shrimp is only in the lower one, we don't care what's in the upper square. Let's mark the upper square as a "don't care" square. With this feature, the fish will ignore what's in that square when it's checking if this rule will work.

Click the  Don't Care Square tool and click on the upper square.

This tells Cocoa to ignore what's in that square when trying to decide if this rule matches.

Select the shrimp and delete it.

Notice that there are now fewer pieces in the After side of the rule than in the Before side. Thus this rule deletes a piece every time it executes.



Now you can show that you want the fish to make the eating sound.

Click on the fish in the After side of the rule, go to the SOUND menu and select the "Eat" sound. (Or, drag the "Eat" sound from the Sounds window onto the fish in the After side of the Rule Editor.)

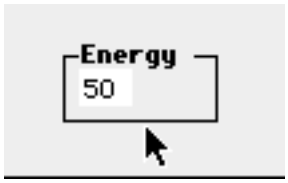
Since the purpose of eating is to get more energy, we need to tell the fish that it now has more energy.

Double-click on the fish to open its Rules window and make the Energy variable visible.

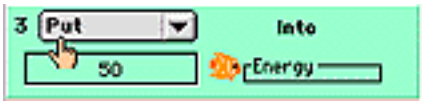
Adjust the window splitter so you can see the rule at the top and the Energy variable at the bottom.

We want the Energy value to go up by 50. To program this in Cocoa, just change the current value to 50.

Select the current value of the Energy variable and type "50."



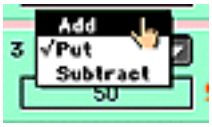
This action is recorded in the rule. Because this is a big value change, Cocoa doesn't know what you really mean when you put 50 in the Energy variable box. Look at the action that has been recorded.



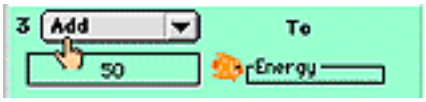
It says to **Put** 50 into the Energy variable. We actually want to **Add** 50. We can fix what has been recorded.

Move the mouse over **Put** option. Hold the mouse button down to display the pop-up menu.

Select the **Add** option.



The action now says that it adds 50 to the Energy value.



Click on the Done rule Done button in the Rule Editor to close it.

The fish now knows how to eat.

Run the world.

Try to write another rule, this time showing the fish how to eat when it's facing left.

The fish swim around and eat until eventually all the shrimp are gone. Then, the fish will die because they can't get any more energy.

This shows how animals are dependent on each other to survive. This kind of food web is an important concept in understanding the balance of the earth's ecosystems.

We need a way to balance this ecosystem. We'll make the shrimp multiply their population to try to maintain them as a food supply for the fish.

Save your world. See the options for saving your world. It shows 3 ways you can save your world.

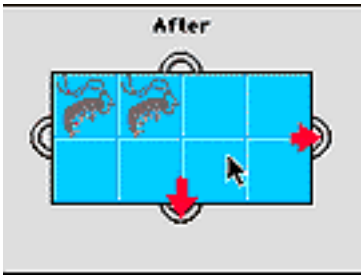
Goal 16: have shrimp produce more shrimp.

Steps involved: You will write a rule that creates a new shrimp whenever two shrimp are side-by-side. This illustrates how a rule can create pieces.

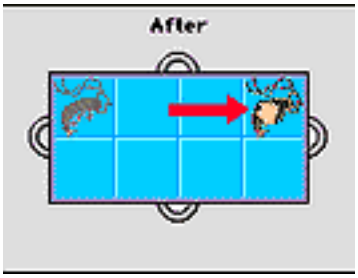
Place two shrimp together side-by-side on the board.

Click on  Rule-recording tool and click on the shrimp on the left.

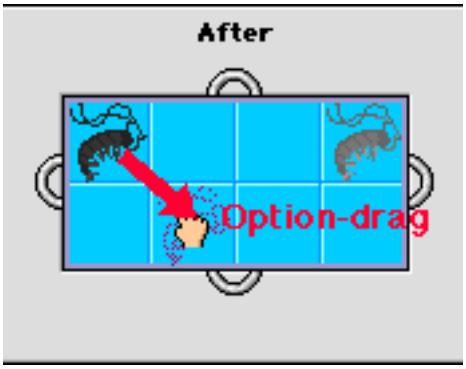
Open the spotlight to include the second shrimp to the right and some space around them.



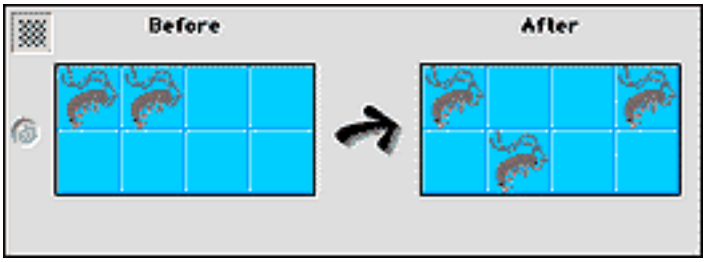
Move the second shrimp to the right to get it out of the way.



Option-drag one of the shrimp to make a copy of it in one of the empty spaces in the rule.



You can do this either in the spotlight on the board or in the After side of the Rule Editor. Both are updated. Notice that now there are more pieces in the After side of the rule than in the Before side. Thus this rule creates a new piece every time it executes.



Click on the 

rule Done button in the Rule Editor to close it.

Run the world.

Now it is unpredictable what will happen. Will the fish eat all the shrimp and then die? Or will the shrimp multiply out of control, filling up the screen with shrimp? Or will there be a stable state somewhere in between? It depends on how may fish and shrimp you start with.

Experiment with different initial numbers of fish and shrimp and observe what happens.

If the shrimp get out of control, you can make fish more voracious by adding rules that allow them to eat when a shrimp is above, below or in another square in front of them. Or you can put in a gestation period for shrimp, so that they don't reproduce right away but only after 50 clock ticks.

You can make the fish reproduce to have baby fish. Make the baby fish grow up and mature into adult fish. Create plants, other kinds of fish, sharks, etc., and work them into the Ocean Life world .

The idea is to experiment and have fun!

Save your world. See the options for saving your world. It shows 3 ways you can save your world.

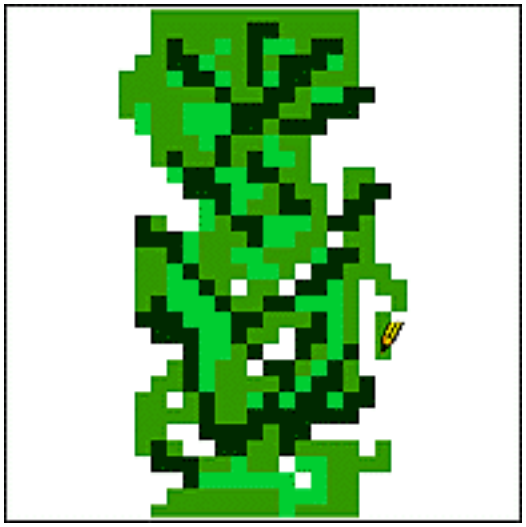
The next section will show you how to do Click and Key Responses in Cocoa. These features let you add interactivity to your worlds.

Goal 17: make seaweed that grows taller or gets cut shorter when you click on it.

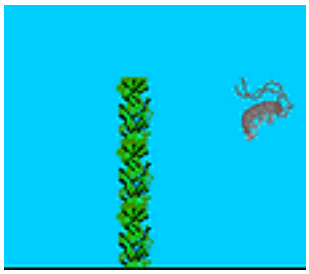
We'll add seaweed to the Ocean Life world to show how click responses work. You'll click on the top piece to make the seaweed grow taller, or click on the 2nd piece to make it shorter.

Create a new piece with an appearance that touches the top and bottom of the drawing area.

This way we can make the seaweed line up like one tall plant: the pieces will touch on the top and bottom sides.

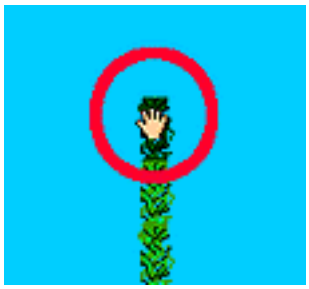


Hold down the option key and drag the seaweed on the board to make several copies one above the other. This looks like the seaweed is one tall plant.



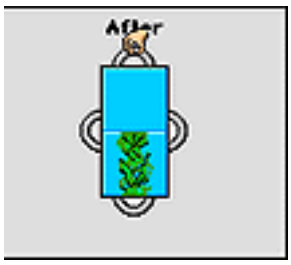
Now, write a Click Response rule on the top piece of seaweed to make it grow taller.

Select the top piece of seaweed.



Go to the PIECE menu and select New Click Response.

Open the spotlight to show the empty space above the seaweed.



Hold down the option key and drag the seaweed to create a copy of the seaweed in the space above.

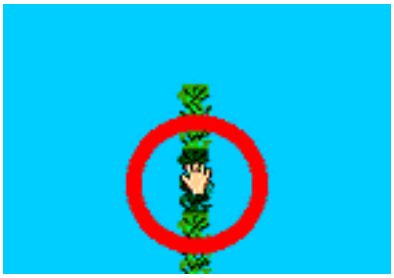
Click on the 

rule Done button in the Rule Editor to close it.

A new Click Response box appears in the Rules window. It holds the "Top Piece Grows" rule.

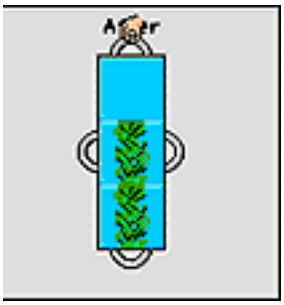
Now, you can write another click response rule. This time, we'll cut down the plant by clicking on the piece that's below the top piece.

Select the piece of seaweed that's below the top piece.



Go to the PIECE menu and select New Click Response.

Open the spotlight to show the empty space above the top piece of seaweed.



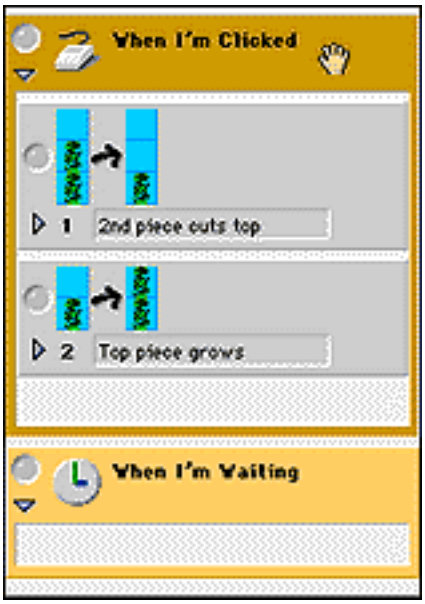
This shows that only the piece **below the top piece** can respond to a mouse click to make the seaweed plant shorter.

Select and delete the TOP piece of seaweed.

Click on the 

rule Done button in the Rule Editor to close it.

Two boxes are created in the Rules window. One holds the 2 rules you've written for the click responses. The other is empty now, but will hold any regular rules you write later. You can move any rule to and from the When I'm Clicked box and the When I'm Waiting box.



Run the world, and click on the top piece of seaweed to make it grow taller or click on the 2nd piece to make the seaweed shorter.

Goal 18: make a diver that you control with the keys to swim around the Ocean Life world.

IMPORTANT

Assigning a key to control your a piece in the world allows the viewer to interact with the world. Only ONE piece in your world can be controlled by the keyboard: it becomes the Main Character of the world.

Key responses allow the viewer to control part of the world. You can write any kind of rule as a key response rule, but the one most often used is a rule to move a piece around the board.

We'll create a piece as a diver in the Ocean Life world.

Create a new piece and make it look like a diver.

Now you can write a rule that moves the diver to the right when you click on the right-arrow key.

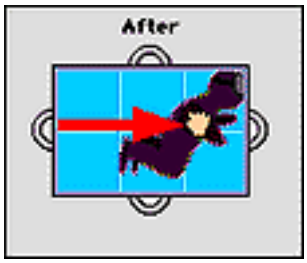
Click on the diver on the board to select it.

Go to the PIECE menu and select New Key Response.

The "Choose a Key" window lets you enter the key you want to use to control the diver.

Hit the "right-arrow" key on the keyboard to enter it in this field, then click on the Done button.

Open the spotlight to show the space to the right. Move the diver to the right.



Click on the 

rule Done button in the Rule Editor to close it.

Two boxes are created in the Rules window. One holds the "Move Right" rule you wrote for the right-arrow key response. The other is empty now, but will hold any regular rules you write. You can move any rule to and from the When Key is Pressed box and the When I'm Waiting box.

Now, when you run the world, you can hit the right-arrow key on the keyboard to move the diver to the right. The rule will only work if there's empty space to the right. The key response rules will let any viewer control one Main Character on the board. The Main Character will even respond to keyboard input when it is seen over the internet or in the auto-playing world that can be viewed on any Macintosh.

You can write key response rules for moving the diver up and down using the up-arrow and down-arrow keys. This will give the viewer more ways to move the diver around.

Save your world. See the options for saving your world. It shows 3 ways you can save your world.

Using Key Responses over the internet. If you "Save for Internet," the Netscape browser cannot detect key responses unless the viewer first clicks on the Cocoa world. We suggest you make multiple boards and instruct viewers to click somewhere on the first board to begin. You can also use the first board to introduce your world. Write a rule for that click on the first board to make the world go to a second board (select the second board from the BOARD menu when writing the rule.) Then, write your key response rules to add interaction on second board.

You can Download the Ocean Life world to see how the world was built by the Cocoa Team.