# stately Documentation

***Release 1.1***

**Evan Hemsley**

**Sep 05, 2018**

# Contents

**Stately** is a simple, flexible, and readable state machine system for C#. It is ideal for constructing rigidly defined behaviors in objects for game engines such as Unity.

I hope you enjoy using **Stately** to build your applications.

# CHAPTER 1

# Read on...

## 1.1 Quickstart Guide

So you want to make a state machine. You've come to the right place.

Let's get started.

We are going to use Unity as our example here, but these concepts should be easily adaptable to any other game engine that uses C#.

First, let's include Stately and define a simple `GameObject` script. We'll need a top-level state. Let's call it `rootState`.

```
using Stately;

public class Cube : MonoBehaviour
{
  State rootState = new State("root");

  void Awake();
  {
    DefineStateMachine();
  }

  void Start()
  {
    rootState.Start();
  }

  public void DefineStateMachine()
  {

  }

  void Update()
```

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```
  {
    rootState.Update(Time.deltaTime);
  }
}
```

The designer says she wants the cube to jump when the player is on the ground and presses the jump button. A simple task, with the power of state machines!

```
State idleState = new State("idle");
State jumpState = new State("jump");

Transform transform;
Vector3 velocity = Vector3.Zero;

void Awake()
{
  transform = GetComponent<Transform>();
}

public void DefineStateMachine()
{
  rootState.StartAt(idleState);

  idleState.ChangeTo(jumpState).If(() => Input.GetButtonDown("Jump"));

  jumpState.OnEnter = delegate
  {
    velocity = new Vector3(0f, 5f, 0f);
  };

  jumpState.OnUpdate = (deltaTime) =>
  {
    velocity.y -= 0.5f * deltaTime;
  };

  jumpState.ChangeTo(idleState).If(() => transform.position.y <= 0f);
}

void Update()
{
  rootState.Update(Time.deltaTime);
  transform.position += velocity * Time.deltaTime;
}
```

Let's break down what's going on here.

### 1.1.1 State Behavior

```
rootState.StartAt(idleState);
```

*StartAt* tells a state to use a state as its starting substate. This sets up the state hierarchy. In this case, we wish `idleState` to be the starting state of the object.

```
jumpState.OnEnter = delegate
{
```

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```
  velocity = new Vector3(0f, 5f, 0f);
};
```

*OnEnter* is a callback which is called when the state is entered. Simple enough. In this case, when `jumpState` is entered, we want to set the object's `velocity` to `{0f, 5f, 0f}`.

```
jumpState.OnUpdate = (deltaTime) =>
{
  velocity.y -= 0.5f * deltaTime;
};
```

*OnUpdate* is, as you might expect, a callback which is called when the state is updated. It takes the time step as the sole argument. In this case, to simulate the effects of gravity, we want to decrease the object's `y` velocity by a factor of half the time step on each update tick.

For more information on defining State behavior, check the *State documentation*.

### 1.1.2 Transitions

```
idleState.ChangeTo(jumpState).If(() => Input.GetButtonDown("Jump"));
```

*ChangeTo* designates a transition between two states. In this case, `idleState.ChangeTo(jumpState)` sets up a transition from `idleState` to `jumpState`. Now, what's all that business past the *ChangeTo* call?

Each transition requires a condition that will trigger the transition. There are a few different condition methods that we can use, but the most basic one is *If*.

*If* takes a method which has zero arguments and returns a boolean. We can use C#'s convenient anonymous function syntax for readability.

So this snippet means that the transition will be executed when the jump button is pressed, changing the active substate of `rootState` from `idleState` to `jumpState`.

Now the designer wants to give the visuals a little oomph. She wants dust particles to appear when the cube jumps. No problem! We can accomplish this with a transition callback.

```
ParticleSystem dustParticleSystem;

void Awake()
{
  // ...

  dustParticleSystem = GetComponent<ParticleSystem>();
}

void DefineStateMachine()
{
  // ...

  idleState.ChangeTo(jumpState).If(() => Input.GetButtonDown("Jump")).ThenDo(() =>
  {
    dustParticleSystem.Emit(100);
  });

  // ...
}
```

*ThenDo* is used to specify a method which should be called when the transition is executed. It is executed after *OnExit* of the previous state and before *OnEnter* of the new state.

Why would you use *ThenDo* instead of *OnExit*? Simply, if you have one state that branches into two other states, you can define transition-specific behavior depending on which transition is executed.

For more information on defining Transitions, check the *Transition documentation*.

### 1.1.3 Inheritance

The designer wants a new type of Cube that has slightly different behavior. This cube should emit lots more dust when it jumps. No problem! Stately has functions to redefine state behavior so you can avoid duplicating code.

```
public class DustyCube : Cube
{
  override void DefineStateMachine()
  {
    base.DefineStateMachine();

    idleState.OnTransitionTo(jumpState).InsteadDo(() =>
    {
      dustParticleSystem.Emit(1000);
    });
  }
}
```

Now 10 times more dust particles will be emitted by the cube when it jumps! Wow!

The designer wants a different kind of cube now. This one should automatically jump two seconds after it touches the ground.

```
public class AutoJumpCube : Cube
{
  override void DefineStateMachine()
  {
    base.DefineStateMachine();

    idleState.ReplaceTransitionCondition(jumpState).With.After(2f);
  }
}
```

Now the cube will jump two seconds after entering the idle state! Easy!

This concludes the quickstart guide. You should have a good overview of the concepts you'll need to build state machines with Stately.

Please reference the class-specific documentation if you are in need of further clarification. I hope you enjoy building software with Stately!

## 1.2 State

A Stately state machine consists of a top-level state (known as the "root") and various substates which are defined using Transitions. You will never reference Transition except through methods provided by State.

A State consists of a name, various conditions for transitions between states, and callback functions to execute when states are entered, updated, or exited.

### 1.2.1 Methods

- *Start()*
- *StartAt(State otherState)*
- *Reset()*
- *Update(float deltaTime)*
- *FixedUpdate()*
- *ChangeTo(State otherState)*
- *ChangeToSubState(State otherState)*
- *SendSignal(string signal)*
- *OnTransitionTo(State otherState)*
- ReplaceTransitionCondition(State otherState) <ReplaceTransitionCondition()

### 1.2.2 Method Reference

**Start**()

The final step in initializing the state machine. Should be called once and only once on the root state before any updates are called.

**StartAt**(*State subState*)

**Parameters** **subState** (*State*) – The substate to begin at.

Sets the starting sub-state of a state. Essentially, you can think of this method as creating a sub-level of the state.

**Reset**()

Resets a state to its starting sub-state.

**Update**(*float deltaTime*)

**Parameters** **deltaTime** (*float*) – The change in time since the last call to Update.

Updates the state machine, checking for state transitions and updating timers. Should only be called on the root state.

**FixedUpdate**()

A convenience method intended for Unity. Allows for the OnFixedUpdate callback to be used. Should only be called on the root state.

**ChangeTo**(*State otherState*)

**Parameters** **otherState** (*State*) – The state to create a *Transition* to.

**Returns** The *Transition* object between the two states.

The bread and butter of Stately. Creates a *Transition* object from the calling state to the given state. *Transition* objects are never created or manipulated directly. Instead, use expressions on states to define transition conditions and callbacks.

**Examples**

```
idleState.ChangeTo(runningState).If(() => Input.GetButton("Run"));
```

The state will change from idleState to runningState if the Run button is down.

```
idleState.ChangeTo(jumpingState).If(() => Input.GetButton("Jump")).ThenDo(delegate {
  dustParticles.Emit(100);
});
```

The state will change from idleState to jumpingState if the Jump button is down, and then it will emit dust particles.

For a complete list of transition conditions and callback methods please refer to <transition>

**ChangeToSubState** (*State otherState*)

**Parameters** **otherState** (*State*) – The state to create an *AnyStateTransition* to.

**Returns** The *AnyStateTransition* to the substate.

Called from a higher-level state using a substate as a parameter. When the condition is met, it will transition from any substate into the given *otherState*. Useful when you have many substates that can change between each other.

States will not self-transition with this method.

**Example**

```
rootState = new State("root");

redState = new State("red");
blueState = new State("blue");
greenState = new State("green");
yellowState = new State("yellow");

rootState.ChangeToSubState(redState).IfSignalCaught("red");
rootState.ChangeToSubState(blueState).IfSignalCaught("blue");
rootState.ChangeToSubState(greenState).IfSignalCaught("green");
rootState.ChangeToSubState(yellowState).IfSignalCaught("yellow");

rootState.StartAt(redState);
```

Now, *redState*, *blueState*, *greenState*, and *yellowState* can all transition between each other, but we've narrowed this down to 4 transitions instead of 12. Nice!

**SendSignal** (*string signal*)

**Parameters** **signal** (*string*) – The signal to send to the state.

For use with the *IfSignalCaught* transition condition. This signal propagates recursively until a state with no substate is reached.

**OnTransitionTo** (*State otherState*)

**Parameters** **otherState** (*State*) – The other state.

**Returns** The already existing *Transition* object between these two states.

Used to redefine transition callbacks in conjunction with the *InsteadDo* and *AlsoDo* methods. Useful for extending or modifying transition behavior when inheriting classes that implement a state machine.

**Example**

```
idleState.OnTransitionTo(jumpingState).InsteadDo(delegate {
  dustParticles.Emit(500);
});
```

Jumping now emits 500 dust particles instead of 100!

**ReplaceTransitionCondition** (*State otherState*)

**Parameters** **otherState** (*State*) – The other state.

**Returns** The already existing *Transition* object between these two states.

This function is similar to *OnTransitionTo*, except that it erases the transition condition so it can be replaced. Useful for extending or modifying transition behavior when inheriting classes that implement a state machine.

**Example**

```
idleState.ReplaceTransitionCondition(jumpingState).With.After(2f);
```

Now the idle state will transition to the jumping state after 2 seconds instead of waiting for a button press.

### 1.2.3 Callback Reference

**OnEnter** Runs when the state is entered.

**OnUpdate** Runs on each update tick.

**OnFixedUpdate** Runs on each FixedUpdate tick (convenience method for Unity).

**OnExit** Runs when the state is exited.

### 1.2.4 Property Reference

**string Name**

**Returns** The name of the `State`.

**State CurrentState**

**Returns** The current substate of the `State`.

**State CurrentStateRecursive**

**Returns** The deepest substate of the `State`.

**string CurrentStatePath**

**Returns** A string concatenating the names of each active substate.

Useful for debug purposes.

**Example**

```
rootState = new State("root");
idleState = new State("idle");
animatingState = new State("animating");

rootState.StartAt(idleState);
idleState.StartAt(animatingState);
```

In this case, `rootState.CurrentStatePath` would return `"root.idle.animating"`.

## 1.3 Transition

Transitions should always be referenced through methods provided by State.

All Transition methods return the Transition object itself so that its methods can be chained.

### 1.3.1 Methods

- *If(System.Func<bool> condition)*
- *AndIf(System.Func<bool> condition)*
- *OrIf(System.Func<bool> condition)*
- *IfSignalCaught(string signal)*
- *AndIfSignalCaught(string signal)*
- *OrIfSignalCaught(string signal)*
- *After(float duration)*
- *AndAfter(float duration)*
- *OrAfter(float duration)*
- *AfterOneFrame()*
- *AfterNFrames(int n)*
- *ThenDo(System.Action onTransition)*
- *AlsoDo(System.Action onTransition)*
- *InsteadDo(System.Action onTransition)*

### 1.3.2 Method Reference

**If** (*System.Func<bool> condition*)

Defines an *If* transition between states. Performs the transition if the function given as argument returns true.

**AndIf** (*System.Func<bool> condition*)

Adds an additional condition to a transition. Performs the transition if the previous condition and the given function are both true.

**OrIf** (*System.Func<bool> condition*)

Adds an additional condition to a transition. Performs the transition if the previous condition or the given function returns true.

**IfSignalCaught** (*string signal*)

Defines an *IfSignalCaught* transition between states. Performs the transition if a matching signal is sent through the state machine.

**AndIfSignalCaught** (*string signal*)

Adds an additional condition to a transition. Performs the transition if the previous condition is true and a matching signal is sent through the state machine.

**OrIfSignalCaught** (*string signal*)

Adds an additional condition to a transition. Performs the transition if the previous condition is true or a matching signal is sent through the state machine.

**After** (*float duration*)

Defines an *After* transition between states. Performs the transition after the given amount of time (in seconds) has passed.

**AndAfter** (*float duration*)

Adds an additional condition to a transition. Performs the transition if the previous condition is true and the given amount of time (in seconds) has passed.

**OrAfter** (*float duration*)

Adds an additional condition to a transition. Performs the transition if the previous condition is true or the given amount of time (in seconds) has passed.

**AfterOneFrame** ()

Defines an *AfterOneFrame* transition. Performs the transition after a single Update has been completed.

**AfterNFrames** (*int n*)

Defines an *AfterNFrames* transition. Performs the transition after `n` updates have been completed.

**ThenDo** (*System.Action onTransition*)

Defines a *ThenDo* callback on the transition. Executes the given callback when the transition is performed. Executed between *OnExit* of the previous state and *OnEnter* of the new state.

**AlsoDo** (*System.Action onTransition*)

Adds an additional callback on the transition. Will be executed after the originally defined callback given by *ThenDo*.

**InsteadDo** (*System.Action onTransition*)

Overwrites the callback on the transition. This callback will be executed instead of the originally defined callback.

### 1.3.3 Property Reference

**Transition With**

**Returns** The Transition itself.

Used as part of the *ReplaceTransitionCondition* idiom.

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b) Convey the object code in, or embodied in, a physical product (including a physical distribution medium), accompanied by a written offer, valid for at least three years and valid for as long as you offer spare parts or customer support for that product model, to give anyone who possesses the object code either (1) a copy of the Corresponding Source for all the software in the product that is covered by this License, on a durable physical medium customarily used for software interchange, for a price no more than your reasonable cost of physically performing this conveying of source, or (2) access to copy the Corresponding Source from a network server at no charge.

c) Convey individual copies of the object code with a copy of the written offer to provide the Corresponding Source. This alternative is allowed only occasionally and noncommercially, and only if you received the object code with such an offer, in accord with subsection 6b.

d) Convey the object code by offering access from a designated place (gratis or for a charge), and offer equivalent access to the Corresponding Source in the same way through the same place at no further charge. You need not require recipients to copy the Corresponding Source along with the object code. If the place to copy the object code is a network server, the Corresponding Source may be on a different server (operated by you or a third party) that supports equivalent copying facilities, provided you maintain clear directions next to the object code saying where to find the Corresponding Source. Regardless of what server hosts the Corresponding Source, you remain obligated to ensure that it is available for as long as needed to satisfy these requirements.

e) Convey the object code using peer-to-peer transmission, provided you inform other peers where the object code and Corresponding Source of the work are being offered to the general public at no charge under subsection 6d.

A separable portion of the object code, whose source code is excluded from the Corresponding Source as a System Library, need not be included in conveying the object code work.

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CHAPTER 2

# Get Stately

You can view and download the source code on Gitlab: https://gitlab.com/ehemsley/stately

**Using git, you can clone the project by running:** git clone https://gitlab.com/ehemsley/stately

**This will allow you to get updates by running:** git pull

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