

```
In [1]: using Pkg
        Pkg.add(["POMDPs", "POMDPTools", "POMDPModels", "Random", "Distributions", "POMDPSimu
```

```
Updating registry at `C:\Users\delete\.julia\registries\General`
Updating git-repo `https://github.com/JuliaRegistries/General.git`
Updating registry at `C:\Users\delete\.julia\registries\JuliaPOMDP`
Updating git-repo `https://github.com/JuliaPOMDP/Registry`
Resolving package versions...
No Changes to `C:\Users\delete\.julia\environments\v1.8\Project.toml`
No Changes to `C:\Users\delete\.julia\environments\v1.8\Manifest.toml`
```

```
In [2]: using POMDPs, POMDPTools, POMDPModels, Random, Distributions, POMDPSimulators, BasicF
```

```
In [3]: Pkg.activate(; temp=true)
        Pkg.add("ARDESPOT")
        using ARDESPOT
```

```

Activating new project at `C:\Users\delete\AppData\Local\Temp\jl_dMEI75`
Resolving package versions...
Updating `C:\Users\delete\AppData\Local\Temp\jl_dMEI75\Project.toml`
[d96c9ae4] + ARDESPOT v0.3.5
Updating `C:\Users\delete\AppData\Local\Temp\jl_dMEI75\Manifest.toml`
[d96c9ae4] + ARDESPOT v0.3.5
[1520ce14] + AbstractTrees v0.4.4
[79e6a3ab] + Adapt v3.6.1
[ec485272] + ArnoldiMethod v0.2.0
[d721219e] + BasicPOMCP v0.3.9
[8bb6e9a1] + BeliefUpdaters v0.2.3
[d1d4a3ce] + BitFlags v0.1.7
[fa961155] + CEnum v0.4.2
[a9c8d775] + CPUTime v1.0.0
[49dc2e85] + Calculus v0.5.1
[d360d2e6] + ChainRulesCore v1.15.7
[9e997f8a] + ChangesOfVariables v0.1.6
[944b1d66] + CodecZlib v0.7.1
[3da002f7] + ColorTypes v0.11.4
[c3611d14] + ColorVectorSpace v0.9.10
[5ae59095] + Colors v0.12.10
[d842c3ba] + CommonRLInterface v0.3.1
[34da2185] + Compat v4.6.1
[187b0558] + ConstructionBase v1.5.1
x [d38c429a] + Contour v0.5.7
[a8cc5b0e] + Crayons v4.1.1
[e3df1716] + D3Trees v0.3.3
[9a962f9c] + DataAPI v1.14.0
[a93c6f00] + DataFrames v1.5.0
[864edb3b] + DataStructures v0.18.13
[e2d170a0] + DataValueInterfaces v1.0.0
[b429d917] + DensityInterface v0.4.0
[31c24e10] + Distributions v0.25.87
[ffbed154] + DocStringExtensions v0.9.3
[fa6b7ba4] + DualNumbers v0.6.8
[411431e0] + Extents v0.1.1
[5789e2e9] + FileIO v1.16.0
[1a297f60] + FillArrays v1.0.0
[53c48c17] + FixedPointNumbers v0.8.4
[59287772] + Formatting v0.4.2
[b38be410] + FreeType v4.0.0
x [663a7486] + FreeTypeAbstraction v0.9.9
[46192b85] + GPUArraysCore v0.1.4
[cf35fbd7] + GeoInterface v1.3.0
[5c1252a2] + GeometryBasics v0.4.6
[86223c79] + Graphs v1.8.0
[cd3eb016] + HTTP v1.7.4
[34004b35] + HypergeometricFunctions v0.3.15
[d25df0c9] + Inflate v0.1.3
[83e8ac13] + IniFile v0.5.1
[842dd82b] + InlineStrings v1.4.0
[3587e190] + InverseFunctions v0.1.8
[41ab1584] + InvertedIndices v1.3.0
[92d709cd] + IrrationalConstants v0.2.2
[c8e1da08] + IterTools v1.4.0
[82899510] + IteratorInterfaceExtensions v1.0.0
[692b3bcd] + JLLWrappers v1.4.1
[682c06a0] + JSON v0.21.4
[b964fa9f] + LaTeXStrings v1.3.0
[8cdb02fc] + LazyModules v0.3.1

```

```
[2ab3a3ac] + LogExpFunctions v0.3.23
[e6f89c97] + LoggingExtras v1.0.0
[e12ccd36] + MCTS v0.5.1
[1914dd2f] + MacroTools v0.5.10
[299715c1] + MarchingCubes v0.1.7
[739be429] + MbedTLS v1.1.7
[e1d29d7a] + Missings v1.1.0
[77ba4419] + NaNMath v1.0.2
[d9ec5142] + NamedTupleTools v0.14.3
[4d8831e6] + OpenSSL v1.3.5
[bac558e1] + OrderedCollections v1.6.0
[90014a1f] + PDMats v0.11.17
[f3bd98c0] + POMDPLinter v0.1.1
[08074719] + POMDPMModelTools v0.3.13
[7588e00f] + POMDPTools v0.1.3
[a93abf59] + POMDPs v0.9.5
[d96e819e] + Parameters v0.12.3
[69de0a69] + Parsers v2.5.8
[c8b314e2] + ParticleFilters v0.5.5
[2dfb63ee] + PooledArrays v1.4.2
[21216c6a] + Preferences v1.3.0
[08abe8d2] + PrettyTables v2.2.3
[92933f4c] + ProgressMeter v1.7.2
[1fd47b50] + QuadGK v2.8.2
[189a3867] + Reexport v1.2.2
[ae029012] + Requires v1.3.0
[79098fc4] + Rmath v0.7.1
[91c51154] + SentinelArrays v1.3.18
[777ac1f9] + SimpleBufferStream v1.1.0
[699a6c99] + SimpleTraits v0.9.4
[66db9d55] + SnoopPrecompile v1.0.3
[a2af1166] + SortingAlgorithms v1.1.0
[276daf66] + SpecialFunctions v2.2.0
[90137ffa] + StaticArrays v1.5.21
[1e83bf80] + StaticArraysCore v1.4.0
[82ae8749] + StatsAPI v1.6.0
[2913bbd2] + StatsBase v0.33.21
[4c63d2b9] + StatsFuns v1.3.0
[892a3eda] + StringManipulation v0.3.0
[09ab397b] + StructArrays v0.6.15
[3783bdb8] + TableTraits v1.0.1
[bd369af6] + Tables v1.10.1
[62fd8b95] + TensorCore v0.1.1
[3bb67fe8] + TranscodingStreams v0.9.12
[410a4b4d] + Tricks v0.1.7
[5c2747f8] + URIs v1.4.2
[3a884ed6] + UnPack v1.0.2
⌵ [b8865327] + UnicodePlots v2.12.4
[1986cc42] + Unitful v1.13.1
[6e34b625] + Bzip2_jll v1.0.8+0
[5ae413db] + EarCut_jll v2.2.4+0
[d7e528f0] + FreeType2_jll v2.10.4+0
⌵ [458c3c95] + OpenSSL_jll v1.1.20+0
[efe28fd5] + OpenSpecFun_jll v0.5.5+0
[f50d1b31] + Rmath_jll v0.4.0+0
[0dad84c5] + ArgTools v1.1.1
[56f22d72] + Artifacts
[2a0f44e3] + Base64
[ade2ca70] + Dates
[8ba89e20] + Distributed
```

```

[f43a241f] + Downloads v1.6.0
[7b1f6079] + FileWatching
[9fa8497b] + Future
[b77e0a4c] + InteractiveUtils
[b27032c2] + LibCURL v0.6.3
[76f85450] + LibGit2
[8f399da3] + Libdl
[37e2e46d] + LinearAlgebra
[56ddb016] + Logging
[d6f4376e] + Markdown
[a63ad114] + Mmap
[ca575930] + NetworkOptions v1.2.0
[44cfe95a] + Pkg v1.8.0
[de0858da] + Printf
[3fa0cd96] + REPL
[9a3f8284] + Random
[ea8e919c] + SHA v0.7.0
[9e88b42a] + Serialization
[1a1011a3] + SharedArrays
[6462fe0b] + Sockets
[2f01184e] + SparseArrays
[10745b16] + Statistics
[4607b0f0] + SuiteSparse
[fa267f1f] + TOML v1.0.0
[a4e569a6] + Tar v1.10.1
[8dfed614] + Test
[cf7118a7] + UUIDs
[4ec0a83e] + Unicode
[e66e0078] + CompilerSupportLibraries_jll v1.0.1+0
[deac9b47] + LibCURL_jll v7.84.0+0
[29816b5a] + LibSSH2_jll v1.10.2+0
[c8ffd9c3] + MbedTLS_jll v2.28.0+0
[14a3606d] + MozillaCACerts_jll v2022.2.1
[4536629a] + OpenBLAS_jll v0.3.20+0
[05823500] + OpenLibm_jll v0.8.1+0
[83775a58] + Zlib_jll v1.2.12+3
[8e850b90] + libblastrampoline_jll v5.1.1+0
[8e850ede] + nghttp2_jll v1.48.0+0
[3f19e933] + p7zip_jll v17.4.0+0

```

Info Packages marked with α have new versions available but compatibility constraints restrict them from upgrading. To see why use ``status --outdated -m``

```

In [4]: mutable struct PipeCS <: POMDPs.POMDP{Float64,Int,Int}
        discount_factor::Float64
    end
PipeCS() = PipeCS(0.90)
POMDPs.discount(p::PipeCS) = p.discount_factor
isterminal(::PipeCS, sp::Float64) = sp == 0.95

```

```

Out[4]: isterminal (generic function with 1 method)

```

```

In [6]: POMDPs.states(::PipeCS) = (0.00:0.95)

```

```

In [7]: POMDPs.actions(::PipeCS) = [1, 2, 3, 4]

POMDPs.initialstate(m::PipeCS) = Normal(0.05, 0.03);

```

```

In [28]: function POMDPs.transition(m::PipeCS, s::Float64, a::Int64, rng::AbstractRNG)
        if s > 0.00 && s <= 0.15

```

```

    if a == 2
        sp = (0.25 - 0.1) * rand(rng) + 0.1
    elseif a == 4
        sp = (0.1) * rand(rng)
    else
        sp = 0.6 * rand(rng)
    end
elseif s > 0.15 && s <= 0.35
    if a == 2
        sp = (0.35 - 0.15) * rand(rng) + 0.15
    elseif a == 4
        sp = (0.1) * rand(rng)
    else
        sp = 0.85 * rand(rng) + 0.15
    end
elseif s > 0.35 && s <= 0.60
    if a == 2
        sp = (0.40 - 0.20) * rand(rng) + 0.2
    elseif a == 3
        sp = (0.35 - 0.15) * rand(rng) + 0.15
    elseif a == 4
        sp = (0.1) * rand(rng)
    else
        sp = 0.95 * rand(rng) + 0.35
    end
elseif s > 0.60 && s <= 0.85
    if a == 3
        sp = (0.90 - 0.5) * rand(rng) + 0.5
    elseif a == 4
        sp = (0.1) * rand(rng)
    else
        sp = (0.95 - 0.60) * rand(rng) + 0.6
    end
else
    sp = (0.95 - 0.90) * rand(rng) + 0.9
end
end
end

```

```

In [21]: function POMDPs.observation(m::PipeCS, a::Int, sp::Float64)
    n = 15
    distort = rand(rng, -n:n)
    if sp + (distort/100) <= 0
        o = 0
    elseif sp + (distort/100) >= 0.95
        o = 95
    else
        o = round(Int, (sp*100)) + distort
    end
end
end

```

```

In [22]: function POMDPs.reward(m::PipeCS, s::Float64, a::Int)
    if s > 0.00 && s <= 0.15
        if a == 1
            r = -200
        elseif a == 2
            r = -400
        elseif a == 3
            r = -5700
        else

```

```
        r = -5700
    end
elseif s > 0.15 && s <= 0.35
    if a == 1
        r = -2600
    elseif a == 2
        r = -2550
    elseif a == 3
        r = -7700
    else
        r = -7700
    end
elseif s > 0.35 && s <= 0.60
    if a == 1
        r = -4200
    elseif a == 2
        r = -9200
    elseif a == 3
        r = -4100
    else
        r = -8200
    end
elseif s > 0.60 && s <= 0.85
    if a == 1
        r = -6700
    elseif a == 2
        r = -11600
    elseif a == 3
        r = -6550
    else
        r = -8100
    end
else
    if a == 1
        r = -7930
    elseif a == 2
        r = -12730
    elseif a == 3
        r = -7730
    else
        r = -7980
    end
end
end
```

```
In [29]: pomdp = PipeCS()

solver = DESPOTSolver(bounds=(0.0, 0.95))
planner = solve(solver, pomdp)
```

```

Out[29]: DESPOTPlanner{PipeCS, Tuple{Float64, Float64}, MemorizingSource{MersenneTwister}, Mer
senneTwister}(DESPOTSolver
  epsilon_0: Float64 0.0
  xi: Float64 0.95
  K: Int64 500
  D: Int64 90
  lambda: Float64 0.01
  T_max: Float64 1.0
  max_trials: Int64 9223372036854775807
  bounds: Tuple{Float64, Float64}
  default_action: ExceptionRethrow ExceptionRethrow()
  rng: MersenneTwister
  random_source: MemorizingSource{MersenneTwister}
  bounds_warnings: Bool true
  tree_in_info: Bool false
, PipeCS(0.9), (0.0, 0.95), MemorizingSource{MersenneTwister}(MersenneTwister(2653968
764), Float64[], MemorizingRNG{MemorizingSource{MersenneTwister}}[MemorizingRNG{Memor
izingSource{MersenneTwister}}(Float64[], 1, 0, 0, MemorizingSource{MersenneTwister}(#
= circular reference @-2 =#)) MemorizingRNG{MemorizingSource{MersenneTwister}}(Float6
4[], 1, 0, 0, MemorizingSource{MersenneTwister}(#= circular reference @-2 =#)) ... Memo
rizingRNG{MemorizingSource{MersenneTwister}}(Float64[], 1, 0, 0, MemorizingSource{Mer
senneTwister}(#= circular reference @-2 =#)) MemorizingRNG{MemorizingSource{MersenneT
wister}}(Float64[], 1, 0, 0, MemorizingSource{MersenneTwister}(#= circular reference
@-2 =#)); MemorizingRNG{MemorizingSource{MersenneTwister}}(Float64[], 1, 0, 0, Memori
zingSource{MersenneTwister}(#= circular reference @-2 =#)) MemorizingRNG{MemorizingSou
rce{MersenneTwister}}(Float64[], 1, 0, 0, MemorizingSource{MersenneTwister}(#= circu
lar reference @-2 =#)) ... MemorizingRNG{MemorizingSource{MersenneTwister}}(Float64[],
1, 0, 0, MemorizingSource{MersenneTwister}(#= circular reference @-2 =#)) MemorizingR
NG{MemorizingSource{MersenneTwister}}(Float64[], 1, 0, 0, MemorizingSource{MersenneTw
ister}(#= circular reference @-2 =#)); ... ; MemorizingRNG{MemorizingSource{MersenneTwi
ster}}(Float64[], 1, 0, 0, MemorizingSource{MersenneTwister}(#= circular reference @-
2 =#)) MemorizingRNG{MemorizingSource{MersenneTwister}}(Float64[], 1, 0, 0, MemORIZIN
gSource{MersenneTwister}(#= circular reference @-2 =#)) ... MemorizingRNG{MemorizingSou
rce{MersenneTwister}}(Float64[], 1, 0, 0, MemorizingSource{MersenneTwister}(#= circula
r reference @-2 =#)) MemorizingRNG{MemorizingSource{MersenneTwister}}(Float64[], 1,
0, 0, MemorizingSource{MersenneTwister}(#= circular reference @-2 =#)); MemorizingRNG
{MemorizingSource{MersenneTwister}}(Float64[], 1, 0, 0, MemorizingSource{MersenneTwi
ster}(#= circular reference @-2 =#)) MemorizingRNG{MemorizingSource{MersenneTwister}}
(Float64[], 1, 0, 0, MemorizingSource{MersenneTwister}(#= circular reference @-2 =#))
... MemorizingRNG{MemorizingSource{MersenneTwister}}(Float64[], 1, 0, 0, MemorizingSou
rce{MersenneTwister}(#= circular reference @-2 =#)) MemorizingRNG{MemorizingSource{Mer
senneTwister}}(Float64[], 1, 0, 0, MemorizingSource{MersenneTwister}(#= circular refe
rence @-2 =#))], 0, 0, true, 0, true), MersenneTwister(2673288260, (0, 1002, 0, 1))

```

```

In [30]: for (s,a,r,sp,o) in stepthrough(pomdp, planner, "s,a,r,sp,o", max_steps=50)
          @show (s,a,r,sp,o)
end

```

```

MethodError: no method matching transition(::PipeCS, ::Float64, ::Int64)
Closest candidates are:
  transition(::PipeCS, ::Float64, ::Int64, ::AbstractRNG) at In[28]:1
  transition(::FullyObservablePOMDP, ::Any, ::Any) at C:\Users\delete\.julia\packages\
POMDPTools\Dhp8w\src\ModelTools\fully_observable_pomdp.jl:34
  transition(::UnderlyingMDP{P, S, A}, ::S, ::A) where {P, S, A} at C:\Users\delete\.
julia\packages\POMDPTools\Dhp8w\src\ModelTools\underlying_mdp.jl:21
  ...

Stacktrace:
 [1] macro expansion
   @ C:\Users\delete\.julia\packages\POMDPS\XBTe5\src\gen_impl.jl:39 [inlined]
 [2] genout(v::DDNOut{(:sp, :o, :r)}, m::PipeCS, s::Float64, a::Int64, rng::Memorizi
ngRNG{MemorizingSource{MersenneTwister}})
   @ POMDPS C:\Users\delete\.julia\packages\POMDPS\XBTe5\src\gen_impl.jl:19
 [3] (::ARDESPOT.var"#157#f#30")(m::PipeCS, s::Float64, a::Int64, rng::MemorizingRNG
{MemorizingSource{MersenneTwister}})
   @ ARDESPOT C:\Users\delete\.julia\packages\POMDPS\XBTe5\src\generative.jl:65
 [4] expand!(D::ARDESPOT.DESPOT{Float64, Int64, Int64}, b::Int64, p::DESPOTPlanner{P
ipeCS, Tuple{Float64, Float64}, MemorizingSource{MersenneTwister}, MersenneTwister})
   @ ARDESPOT C:\Users\delete\.julia\packages\ARDESPOT\l9sbg\src\tree.jl:70
 [5] explore!(D::ARDESPOT.DESPOT{Float64, Int64, Int64}, b::Int64, p::DESPOTPlanner
{PipeCS, Tuple{Float64, Float64}, MemorizingSource{MersenneTwister}, MersenneTwiste
r})
   @ ARDESPOT C:\Users\delete\.julia\packages\ARDESPOT\l9sbg\src\planner.jl:24
 [6] build_despot(p::DESPOTPlanner{PipeCS, Tuple{Float64, Float64}, MemorizingSource
{MersenneTwister}, MersenneTwister}, b_0::ParticleFilters.ParticleCollection{Float6
4})
   @ ARDESPOT C:\Users\delete\.julia\packages\ARDESPOT\l9sbg\src\planner.jl:10
 [7] action_info(p::DESPOTPlanner{PipeCS, Tuple{Float64, Float64}, MemorizingSource
{MersenneTwister}, MersenneTwister}, b::ParticleFilters.ParticleCollection{Float64})
   @ ARDESPOT C:\Users\delete\.julia\packages\ARDESPOT\l9sbg\src\pomdps_glue.jl:8
 [8] iterate
   @ C:\Users\delete\.julia\packages\POMDPTools\Dhp8w\src\Simulators\stepthrough.jl:
91 [inlined]
 [9] iterate(it::POMDPTools.Simulators.POMDPSimIterator{(:s, :a, :r, :sp, :o), PipeC
S, DESPOTPlanner{PipeCS, Tuple{Float64, Float64}, MemorizingSource{MersenneTwister},
MersenneTwister}, ParticleFilters.BasicParticleFilter{PipeCS, PipeCS, ParticleFilter
s.LowVarianceResampler, MersenneTwister, Vector{Float64}}, Random._GLOBAL_RNG, Partic
leFilters.ParticleCollection{Float64}, Float64})
   @ POMDPTools.Simulators C:\Users\delete\.julia\packages\POMDPTools\Dhp8w\src\Simu
lators\stepthrough.jl:85
 [10] top-level scope
   @ .\In[30]:1

```