Session 4 - Conservation planning

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In this session we are using the prioritizr package to create a set of conservation scenarios for protecting the future distribution of koalas in the SEQ region.

Table of contents

Optimiser installation

The prioritizr package requires that you download and install an optimiser - a commonly used one is Gurobi. You can obtain a free academic license for Gurobi here: https://www.gurobi.com/features/academic-named-user-license/.

Here is a guide to install Gurobi for R: https://docs.gurobi.com/projects/optimizer/en/current/reference/r/setup.html.

Alternatively, if you cannot obtain an academic licence there are other solvers available https://prioritizr.net/reference/solvers.html. We recommend installing the CBC solver: https://github.com/dirkschumacher/rcbc.

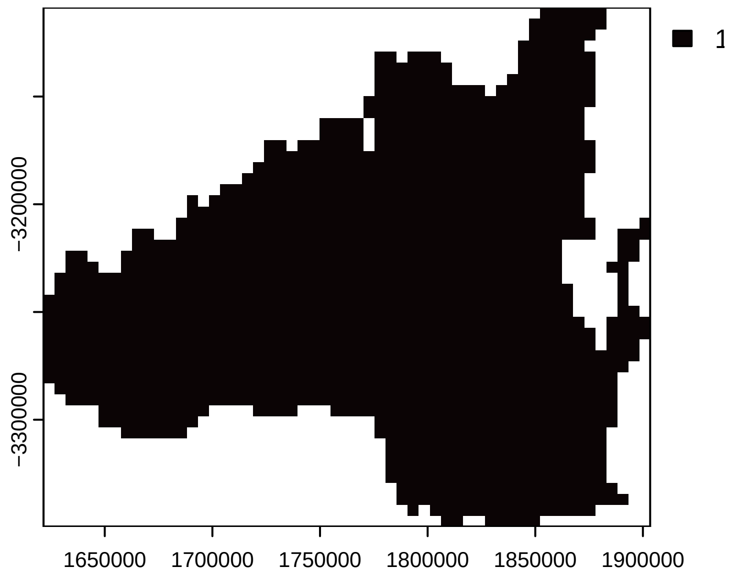
If you have issues with installing a solver, please let us know.

Install packages

```r
# Load required packages
library(terra)
library(viridisLite)
library(prioritizr)
library(raster)
```

Load Spatial Data

```r
# Load the Planning unit
PU <- terra::rast("data/otherdata/PlanningUnits.tif")
plot(PU, col = viridisLite::mako(n = 1))
```

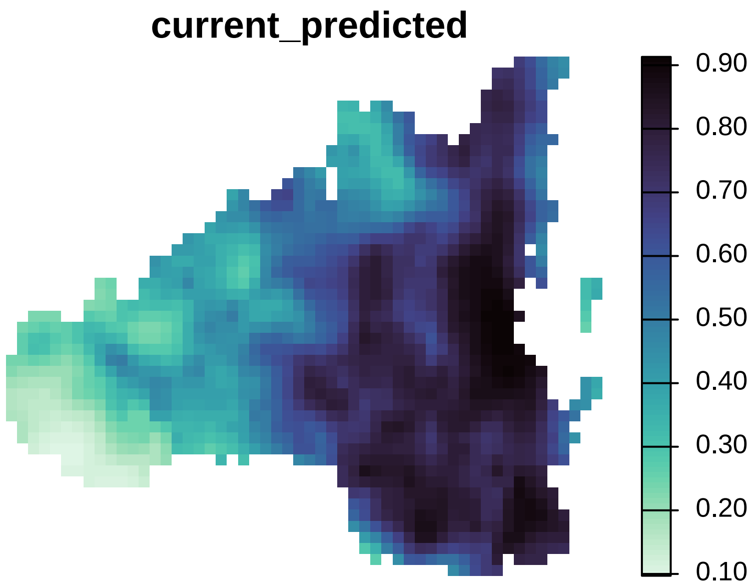


```r
# Get the file names of the testing data
spp.list <- list.files(path = "data/SpeciesDistributions/", full.names = TRUE, recursive = T
```

Load current species distribution

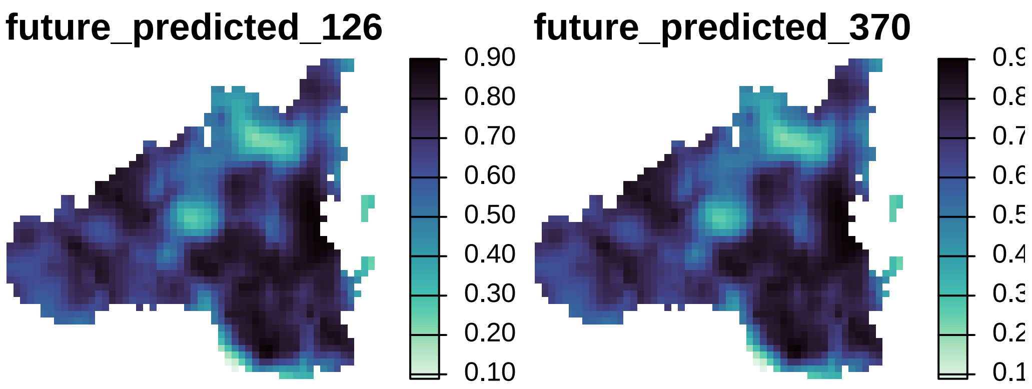
```r
# Load all files and rename them
spp <- rast(spp.list[grep("current", spp.list)])
# Get just the filenames (without full paths and extensions)
new_names <- tools::file_path_sans_ext(basename(spp.list[grep("current", spp.list)]))
```

```
# Load and assign names
spp <- rast(spp.list[grep("current", spp.list)])
names(spp) <- new_names
# Plot species distributions
plot(spp, axes = F,col = viridisLite::mako(n = 100, direction = -1), main = c(names(spp)))
```



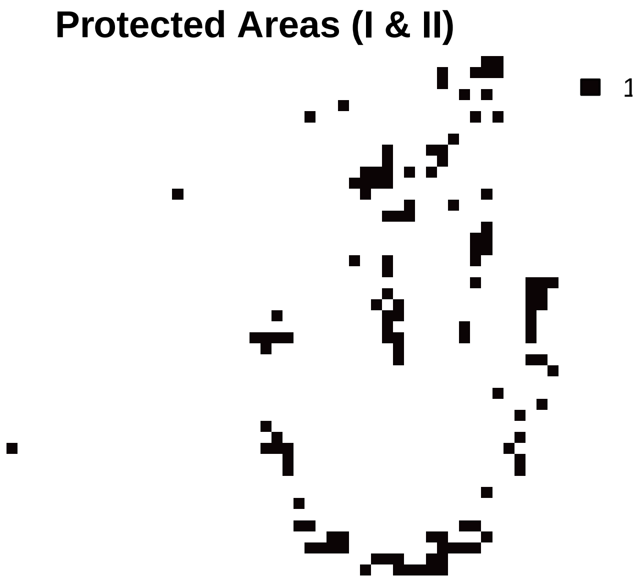
Load future species distribution

```
# Do the same for "future" rasters
spp <- rast(spp.list[grep("future", spp.list)])
# Get just the filenames (without full paths and extensions)
new_names <- tools::file_path_sans_ext(basename(spp.list[grep("future", spp.list)]))
# Load and assign names
spp <- rast(spp.list[grep("future", spp.list)])
names(spp) <- new_names
# Plot first four species distributions
plot(spp, axes = F,col = viridisLite::mako(n = 100, direction = -1), main = c(names(spp)))
```

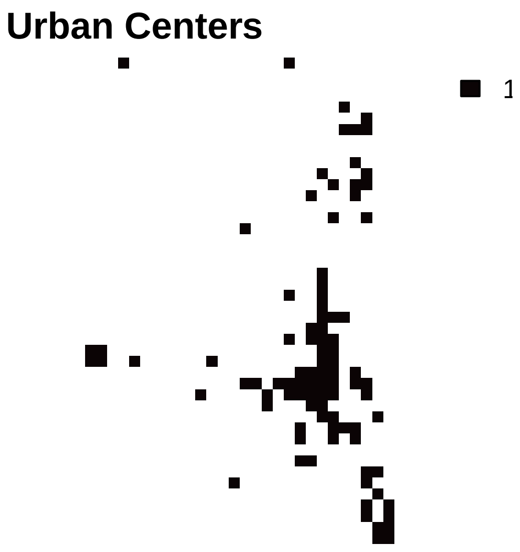


Load protected areas, urban centers, and cost layer

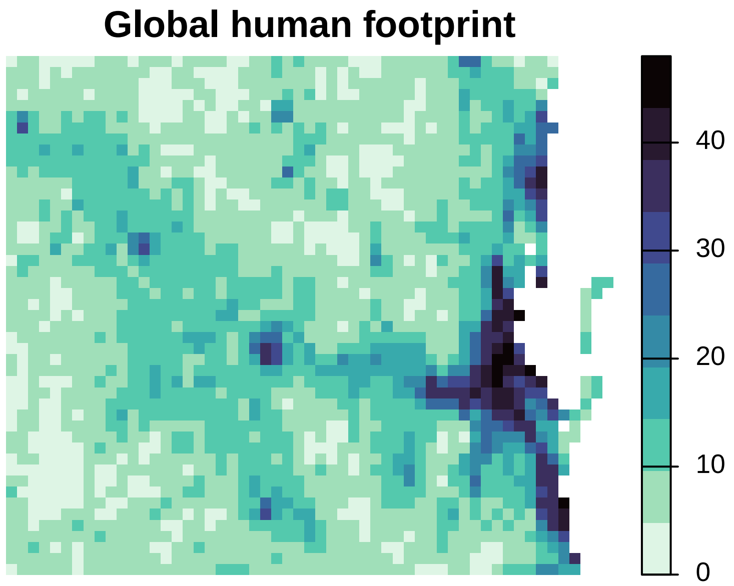
```
PA <- rast("data/otherdata/protected_areas.tif")
plot(PA, axes = FALSE, col = viridisLite::mako(n = 100, direction = -1), main = "Protected A
```



```
urban <- rast("data/otherdata/urban_centers.tif")
plot(urban, axes = FALSE, col = viridisLite::mako(n = 100, direction = -1), main = "Urban Ce
```



```
hfp <- rast("data/otherdata/cost_hfp2013.tif")
plot(hfp, axes = FALSE, col = viridisLite::mako(n = 10, direction = -1), main = "Global huma
```

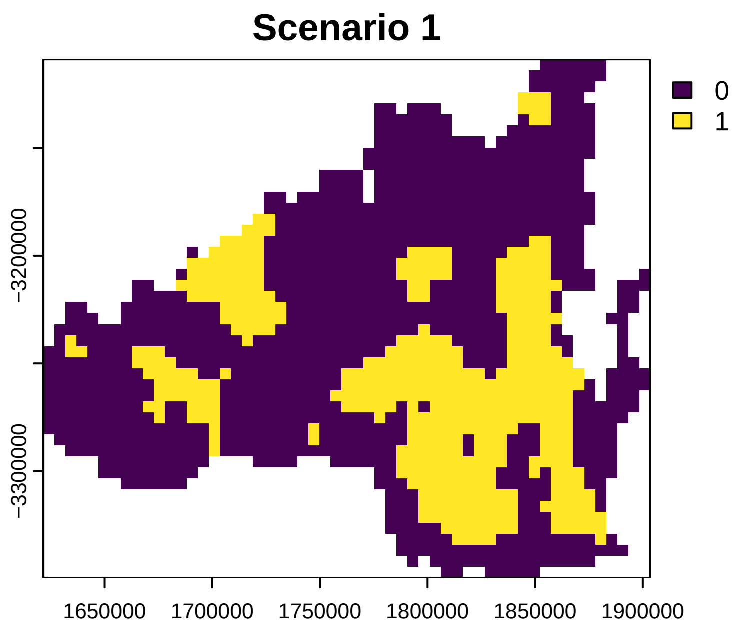


Define Budget

```
budget.area <- round(0.3 * length(cells(PU)))
```

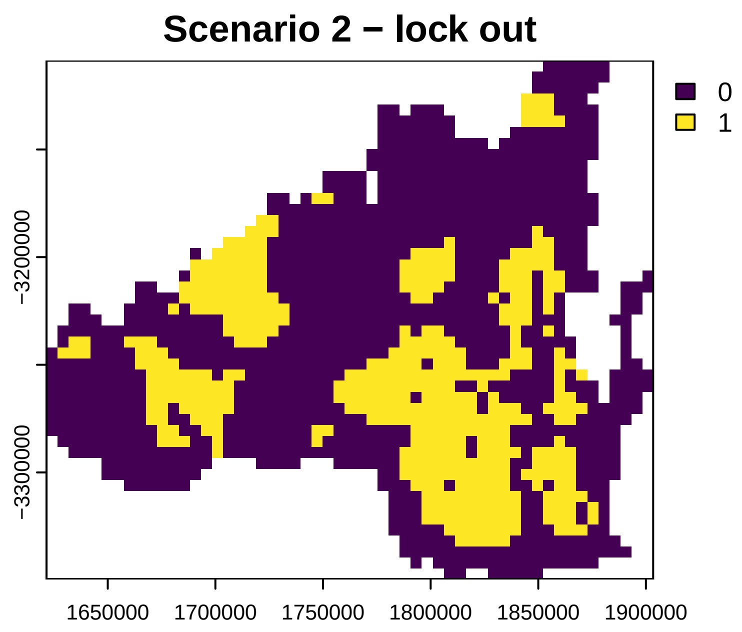
Scenario 1: Basic Shortfall Objective

```
p <- problem(PU, spp) %>%
  add_min_shortfall_objective(budget = budget.area) %>%
  add_relative_targets(targets = 1) %>%
  add_default_solver() %>%
  add_proportion_decisions()

s1 <- solve(p)
plot(s1, main = "Scenario 1")
```



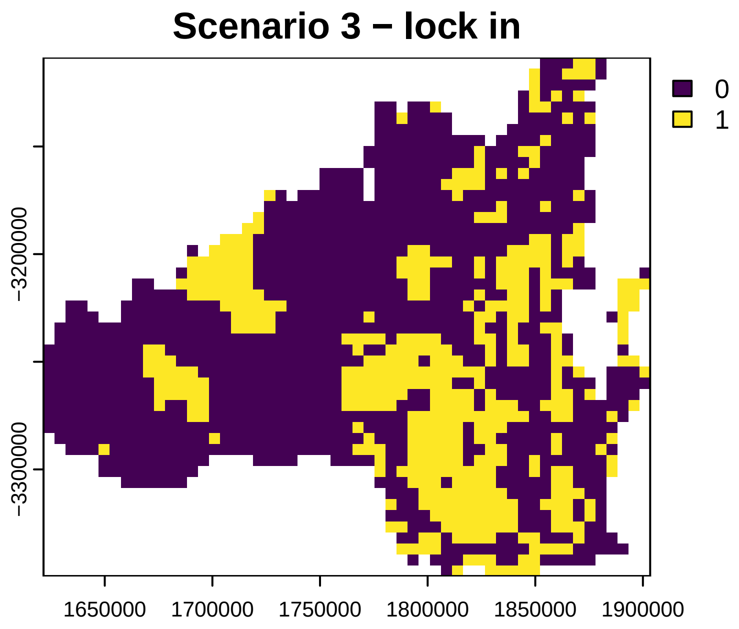
Scenario 2: Lock Out Urban Areas

```
p <- problem(PU, spp) %>%
  add_min_shortfall_objective(budget = budget.area) %>%
  add_relative_targets(targets = 1) %>%
  add_proportion_decisions() %>%
  add_locked_out_constraints(urban) %>%
  add_default_solver()

s2 <- solve(p)
plot(s2, main = "Scenario 2 - lock out")
```



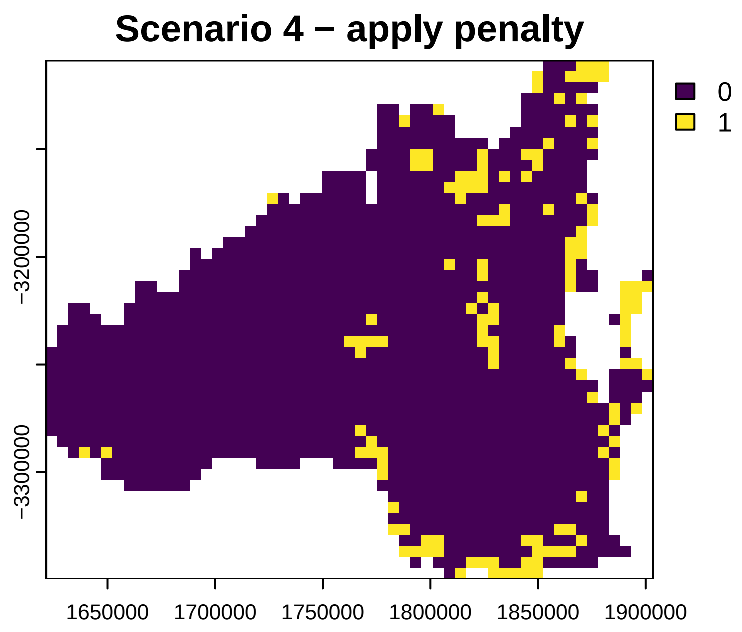
Scenario 3: Lock In Protected Areas

```r
p <- problem(PU, spp) %>%
  add_min_shortfall_objective(budget = budget.area) %>%
  add_relative_targets(targets = 1) %>%
  add_proportion_decisions() %>%
  add_locked_in_constraints(PA) %>%
  add_locked_out_constraints(urban) %>%
  add_default_solver()

s3 <- solve(p)
plot(s3, main = "Scenario 3 - lock in")
```



Scenario 4: Penalize Human Footprint

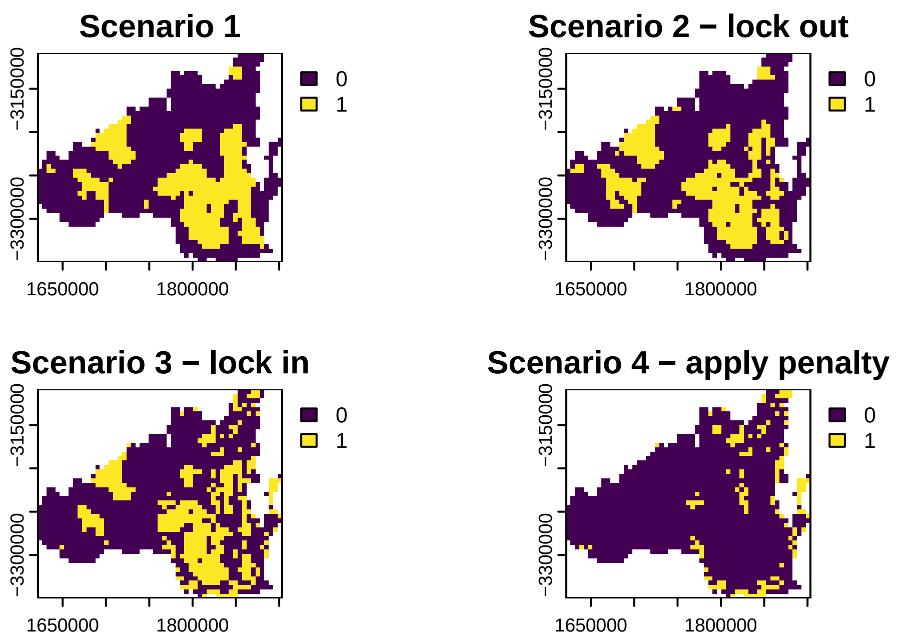
```r
p <- problem(PU, spp) %>%
  add_min_shortfall_objective(budget = budget.area) %>%
  add_relative_targets(targets = 1) %>%
  add_linear_penalties(penalty = 1, data = hfp) %>%
  add_proportion_decisions() %>%
  add_locked_in_constraints(PA) %>%
  add_locked_out_constraints(urban) %>%
  add_default_solver()

s4 <- solve(p)
plot(s4, main = "Scenario 4 - apply penalty")
```



```r
# Export to GeoTIFF
writeRaster(s4, "scenario_4.tif", overwrite = TRUE)
```

Plot All Scenarios Side by Side

```r
# Set plotting area to 1 row, 4 columns
par(mfrow = c(2, 2), mar = c(3, 3, 3, 1))

plot(s1, main = "Scenario 1")
plot(s2, main = "Scenario 2 - lock out")
plot(s3, main = "Scenario 3 - lock in")
plot(s4, main = "Scenario 4 - apply penalty")
```



```
# Reset plotting layout to default (optional)
par(mfrow = c(1, 1))
```

Calculate metrics

```
#Scenario 1
rpz_target_spp_s1 <- eval_target_coverage_summary(p, s1)
mean(rpz_target_spp_s1$relative_held)
```

```
[1] 0.3863076
```

```
mean(rpz_target_spp_s1$relative_shortfall)
```

```
[1] 0.6136924
```

```
#Scenario 2
rpz_target_spp_s2 <- eval_target_coverage_summary(p, s2)
mean(rpz_target_spp_s2$relative_held)
```

```
[1] 0.3801815
```

```r
mean(rpz_target_spp_s2$relative_shortfall)
```

```
[1] 0.6198185
```

```r
#Scenario 3
rpz_target_spp_s3 <- eval_target_coverage_summary(p, s3)
mean(rpz_target_spp_s3$relative_held)
```

```
[1] 0.3350504
```

```r
mean(rpz_target_spp_s3$relative_shortfall)
```

```
[1] 0.6649496
```

```r
#Scenario 4
rpz_target_spp_s4 <- eval_target_coverage_summary(p, s4)
mean(rpz_target_spp_s4$relative_held)
```

```
[1] 0.06277898
```

```r
mean(rpz_target_spp_s4$relative_shortfall)
```

```
[1] 0.937221
```