MaxEntAnalysisLooped

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This R Markdown Script can be used to take the MaxEnt outputs and perform spatial and statistical analyses on the files for visualization in ArcGIS. The only variable you have to change is the scenario to the current scope of analysis being run. The script then for loops through all the current and projected climate file outputs for the scenario and performs the specified analyses for each and writes the appropriate raster tiff files to the correct folders. The entire process is automated so that a new scenario can be inputted and the all the same calculations and rasters can be created rapidly. Then the files can just be visualized in ArcGIS using predesigned templates for each analysis type that we created.

##############################################################################  
#Change the Scenario and the run the analysis  
  
scenario<-"allislands\_270m"  
  
#Options:  
#allislands\_270m  
#ni\_270m  
#sca\_270m  
#sca\_int\_270m  
#scr\_270m  
#sri\_270m  
#sri\_adultyoung\_270m  
#sri\_seedsap\_270m  
#scr\_foginc\_270m  
#scr\_fogdec\_270m  
#sri\_foginc\_270m  
#sri\_fogdec\_270m  
#scr\_fogelev\_270m  
#sri\_fogelev\_270m  
#scr\_fogconstant\_270m  
#sri\_fogconstant\_270m  
#MainlandCA  
  
#Filename options:  
filename<-"final2"  
  
#Packages  
library(tidyverse)#data rearrangement

## -- Attaching packages ----------------------------------------------------------- tidyverse 1.2.1 --

## v ggplot2 3.0.0 v purrr 0.2.5  
## v tibble 1.4.2 v dplyr 0.7.6  
## v tidyr 0.8.1 v stringr 1.3.1  
## v readr 1.1.1 v forcats 0.3.0

## -- Conflicts -------------------------------------------------------------- tidyverse\_conflicts() --  
## x dplyr::filter() masks stats::filter()  
## x dplyr::lag() masks stats::lag()

library(raster)#rasters

## Loading required package: sp

##   
## Attaching package: 'raster'

## The following object is masked from 'package:dplyr':  
##   
## select

## The following object is masked from 'package:tidyr':  
##   
## extract

#Note that rasters will overwrite themselves so run with caution or code them out  
##############################################################################  
  
#Grab model statistic values: Get AUC value from each climate run, but get threshold value from historic only  
  
#Read in the csvs with the model statistics for that scenario for all climate projections  
historic<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/historic/final2/maxentResults.csv"))  
hist\_2150<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/historic\_1921\_1950/final2/maxentResults.csv"))  
hist\_5180<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/historic\_1951\_1980/final2/maxentResults.csv"))  
  
mpi45\_1039<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/MPI\_rcp45\_2010\_2039/final2/maxentResults.csv"))  
mpi45\_4069<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/MPI\_rcp45\_2040\_2069/final2/maxentResults.csv"))  
mpi45\_7099<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/MPI\_rcp45\_2070\_2099/final2/maxentResults.csv"))  
  
ccsm485\_1039<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/CCSM4\_rcp85\_2010\_2039/final2/maxentResults.csv"))  
ccsm485\_4069<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/CCSM4\_rcp85\_2040\_2069/final2/maxentResults.csv"))  
ccsm485\_7099<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/CCSM4\_rcp85\_2070\_2099/final2/maxentResults.csv"))  
  
miroc45\_1039<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/MIROC\_rcp45\_2010\_2039/final2/maxentResults.csv"))  
miroc45\_4069<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/MIROC\_rcp45\_2040\_2069/final2/maxentResults.csv"))  
miroc45\_7099<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/MIROC\_rcp45\_2070\_2099/final2/maxentResults.csv"))  
  
miroc85\_1039<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/MIROC\_rcp85\_2010\_2039/final2/maxentResults.csv"))  
miroc85\_4069<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/MIROC\_rcp85\_2040\_2069/final2/maxentResults.csv"))  
miroc85\_7099<-read.csv(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/MIROC\_rcp85\_2070\_2099/final2/maxentResults.csv"))  
  
#Select AUC values  
hist\_auc<-historic[101,] %>%   
 dplyr::select(Test.AUC)  
hist\_2150\_auc<-hist\_2150[101,] %>%   
 dplyr::select(Test.AUC)  
hist\_5180\_auc<-hist\_5180[101,] %>%   
 dplyr::select(Test.AUC)  
  
mpi45\_1039\_auc<-mpi45\_1039[101,] %>%   
 dplyr::select(Test.AUC)  
mpi45\_4069\_auc<-mpi45\_4069[101,] %>%   
 dplyr::select(Test.AUC)  
mpi45\_7099\_auc<-mpi45\_7099[101,] %>%   
 dplyr::select(Test.AUC)  
  
ccsm485\_1039\_auc<-ccsm485\_1039[101,] %>%   
 dplyr::select(Test.AUC)  
ccsm485\_4069\_auc<-ccsm485\_4069[101,] %>%   
 dplyr::select(Test.AUC)  
ccsm485\_7099\_auc<-ccsm485\_7099[101,] %>%   
 dplyr::select(Test.AUC)  
  
miroc45\_1039\_auc<-miroc45\_1039[101,] %>%   
 dplyr::select(Test.AUC)  
miroc45\_4069\_auc<-miroc45\_4069[101,] %>%   
 dplyr::select(Test.AUC)  
miroc45\_7099\_auc<-miroc45\_7099[101,] %>%   
 dplyr::select(Test.AUC)  
  
miroc85\_1039\_auc<-miroc85\_1039[101,] %>%   
 dplyr::select(Test.AUC)  
miroc85\_4069\_auc<-miroc85\_4069[101,] %>%   
 dplyr::select(Test.AUC)  
miroc85\_7099\_auc<-miroc85\_7099[101,] %>%   
 dplyr::select(Test.AUC)  
  
#AUC Values for scenario  
histTestAUC<-rbind(hist\_auc, hist\_2150\_auc,hist\_5180\_auc) %>%   
 mutate(Projection=c("Historic", "Historic 1921\_1950", "Historic 1951\_1980")) %>%   
 dplyr::select(Projection, everything())  
  
projTestAUC<-rbind(mpi45\_1039\_auc,mpi45\_4069\_auc,mpi45\_7099\_auc,  
 ccsm485\_1039\_auc,ccsm485\_4069\_auc,ccsm485\_7099\_auc,  
 miroc45\_1039\_auc,miroc45\_4069\_auc,miroc45\_7099\_auc,  
 miroc85\_1039\_auc,miroc85\_4069\_auc,miroc85\_7099\_auc) %>%   
 mutate(Projection=c("MPI 4.5 2010-2039", "MPI 4.5 2040-2069", "MPI 4.5 2070-2099",  
 "CCSM4 8.5 2010-2039", "CCSM4 8.5 2040-2069", "CCSM4 8.5 2070-2099",  
 "MIROC 4.5 2010-2039", "MIROC 4.5 2040-2069", "MIROC 4.5 2070-2099",  
 "MIROC 8.5 2010-2039", "MIROC 8.5 2040-2069", "MIROC 8.5 2070-2099")) %>%   
 dplyr::select(Projection, everything())  
  
#Threshold value for scenario  
#Threshold is the Binary threshold values:#Reclassify matrix based on 5 replicates average of the maximum training sensitivity + specifitiy (Liu 2013)  
threshold<-historic[101,] %>%   
 dplyr::select(Maximum.training.sensitivity.plus.specificity.logistic.threshold)  
threshold<-as.double(threshold)  
  
#All statistic values gathered  
  
########################################################  
########################################################  
########################################################  
#Run the Analysis (should run smoothly based on inputs above)  
  
#############################################################  
#First part of analysis focused on raster analysis between historic and future projections  
#############################################################  
rclmat<-c(-Inf,threshold,0, threshold,1,1)#Actual reclassify matrix based on threshold  
rclmat\_grad<-c(-Inf,threshold,0)#Actual reclassify matrix based on threshold  
  
#Run analysis on historic projections  
historics<-c("historic", "historic\_1921\_1950", "historic\_1951\_1980")  
histhighmat<-NULL  
phistsuitmat<-NULL  
  
for (h in historics){  
 #Read in historic information  
if (scenario=="MainlandCA"){  
 hist<-raster(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/", h, "/", filename,"/Quercus\_tomentella.asc"))  
}else  
 hist<-raster(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/", h, "/", filename,"/Quercus\_tomentella\_avg.asc"))  
  
  
proj4string(hist) <- CRS("+proj=aea +lat\_1=34 +lat\_2=40.5 +lat\_0=0 +lon\_0=-120 +x\_0=0 +y\_0=-4000000 +ellps=GRS80 +datum=NAD83 +units=m +no\_defs")   
writeRaster(hist, filename = paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/", h, ".tif"), format="GTiff", overwrite=TRUE)  
histhigh<-cellStats(hist, max)  
histhighmat<-rbind(histhighmat,histhigh)  
histrc <- reclassify(hist, rclmat) #Threshold used here  
writeRaster(histrc, filename = paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/", h, ".tif"), format="GTiff", overwrite=TRUE, datatype="INT1U")  
histrc\_grad <- reclassify(hist, rclmat\_grad) #Threshold used here  
writeRaster(histrc\_grad, filename = paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary\_gradient/", h, ".tif"), format="GTiff", overwrite=TRUE)  
histfq<-as.data.frame(freq(histrc, 1))  
histsuit<-histfq[2,2]  
histnosuit<-histfq[1,2]  
phistsuit<-histsuit/(histsuit+histnosuit)  
phistsuitmat<-rbind(phistsuitmat, phistsuit)  
} #end historic for loop  
  
###Create historic summary table  
histhighsuit<-as.data.frame(histhighmat,row.names = FALSE)  
perchistsuit<-as.data.frame(phistsuitmat,row.names = FALSE)  
histtable<-cbind(histTestAUC, histhighsuit, perchistsuit)  
colnames(histtable)<-c("Projections", "Avg Test AUC", "Highest Present Suitability", "Percent Suitable Area")  
  
  
#Run analysis on future projections  
#Set historic for comparison code  
if (scenario=="MainlandCA"){  
 histpr<-raster(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/historic/", filename,"/Quercus\_tomentella.asc"))  
}else  
 histpr<-raster(paste0("G:/data/tools/MaxEnt/Output/", scenario, "/historic/", filename,"/Quercus\_tomentella\_avg.asc"))  
  
proj4string(histpr) <- CRS("+proj=aea +lat\_1=34 +lat\_2=40.5 +lat\_0=0 +lon\_0=-120 +x\_0=0 +y\_0=-4000000 +ellps=GRS80 +datum=NAD83 +units=m +no\_defs")   
histprrc <- reclassify(histpr, rclmat) #Threshold used here  
histfq<-as.data.frame(freq(histprrc, 1))  
histsuit<-histfq[2,2]  
histnosuit<-histfq[1,2]  
  
  
  
proj\_nam<-as.matrix(c("MPI\_rcp45\_2010\_2039", "MPI\_rcp45\_2040\_2069", "MPI\_rcp45\_2070\_2099","CCSM4\_rcp85\_2010\_2039", "CCSM4\_rcp85\_2040\_2069", "CCSM4\_rcp85\_2070\_2099", "MIROC\_rcp45\_2010\_2039", "MIROC\_rcp45\_2040\_2069", "MIROC\_rcp45\_2070\_2099", "MIROC\_rcp85\_2010\_2039", "MIROC\_rcp85\_2040\_2069", "MIROC\_rcp85\_2070\_2099"))  
  
highmat<-NULL  
diffmeanmat<-NULL  
diffmaxmat<-NULL  
diffminmat<-NULL  
pcsuitmat<-NULL  
percsuitmat<-NULL  
  
for (p in proj\_nam){  
print (p)  
if (scenario=="MainlandCA"){  
 proj<-raster(paste0("G:/data/tools/MaxEnt/Output/",scenario,"/",p,"/",filename,"/Quercus\_tomentella\_layers.asc"))  
}else  
 proj<-raster(paste0("G:/data/tools/MaxEnt/Output/",scenario,"/",p,"/",filename,"/Quercus\_tomentella\_layers\_avg.asc"))  
   
  
proj4string(proj) <- CRS("+proj=aea +lat\_1=34 +lat\_2=40.5 +lat\_0=0 +lon\_0=-120 +x\_0=0 +y\_0=-4000000 +ellps=GRS80 +datum=NAD83 +units=m +no\_defs")   
writeRaster(proj, filename = paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/", p, ".tif"), format="GTiff", overwrite=TRUE)  
high<-cellStats(proj, max)  
highmat<-rbind(highmat,high)  
diff<-proj-histpr  
writeRaster(diff, filename=paste0("G:/data/tools/MaxEnt/Analysis/", scenario, "/", p, ".tif"), format="GTiff", overwrite=TRUE)  
diffmean<-cellStats(diff, mean)  
diffmeanmat<-rbind(diffmeanmat, diffmean)  
diffmax<-cellStats(diff, max)  
diffmaxmat<-rbind(diffmaxmat, diffmax)  
diffmin<-cellStats(diff, min)  
diffminmat<-rbind(diffminmat, diffmin)  
projrc <- reclassify(proj, rclmat) #Threshold value used here  
writeRaster(projrc, filename=paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/", p, ".tif"), format="GTiff", overwrite=TRUE, datatype="INT1U")  
projrc\_grad <- reclassify(proj, rclmat\_grad) #Threshold value used here  
writeRaster(projrc\_grad, filename=paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary\_gradient/", p, ".tif"), format="GTiff", overwrite=TRUE)  
projfq<-as.data.frame(freq(projrc, 1))  
projnosuit<-projfq[1,2]  
  
if (nrow(projfq)==2){  
 projsuit<-0  
}else  
 projsuit<-projfq[2,2]  
  
###  
pcsuit<-(projsuit-histsuit)/histsuit  
pcsuitmat<-rbind(pcsuitmat, pcsuit)  
percsuit<-projsuit/(projsuit+projnosuit)  
percsuitmat<-rbind(percsuitmat, percsuit)  
  
  
}#End proj names for loop

## [1] "MPI\_rcp45\_2010\_2039"  
## [1] "MPI\_rcp45\_2040\_2069"  
## [1] "MPI\_rcp45\_2070\_2099"  
## [1] "CCSM4\_rcp85\_2010\_2039"  
## [1] "CCSM4\_rcp85\_2040\_2069"  
## [1] "CCSM4\_rcp85\_2070\_2099"  
## [1] "MIROC\_rcp45\_2010\_2039"  
## [1] "MIROC\_rcp45\_2040\_2069"  
## [1] "MIROC\_rcp45\_2070\_2099"  
## [1] "MIROC\_rcp85\_2010\_2039"  
## [1] "MIROC\_rcp85\_2040\_2069"  
## [1] "MIROC\_rcp85\_2070\_2099"

#Create projected summary table  
highsuitdf<-as.data.frame(highmat,row.names = FALSE)  
meandiffdf<-as.data.frame(diffmeanmat,row.names = FALSE)  
gaindf<-as.data.frame(diffmaxmat,row.names = FALSE)  
lossdf<-as.data.frame(diffminmat,row.names = FALSE)  
pcsuitdf<-as.data.frame(pcsuitmat, row.names = FALSE)  
percsuitdf<-as.data.frame(percsuitmat, row.names = FALSE)  
  
projtable<-cbind(projTestAUC, highsuitdf, meandiffdf, gaindf, lossdf, percsuitdf, pcsuitdf)  
colnames(projtable)<-c("Projections", "Avg Test AUC", "Highest Future Suitability", "Mean Change in Suitability", "Highest Gain", "Highest Loss","Percent Suitable Area", "Overall Percent Change of Suitable Area")  
  
  
#Export tables for histtable and projtable  
write.csv(histtable,file=paste0("G:/data/tools/MaxEnt/Analysis/", scenario, "/summarytables/historicsummarytable.csv"),row.names = FALSE)  
write.csv(projtable,file=paste0("G:/data/tools/MaxEnt/Analysis/", scenario, "/summarytables/projectionssummarytable.csv"),row.names = FALSE)  
  
#############################################################  
#Second part of analysis focused on raster analysis between all stacked rasters  
#############################################################  
  
#Read in all rasters and create summed raster (ignoring other historic options here)  
histrc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/historic.tif"))  
projA1rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/MPI\_rcp45\_2010\_2039.tif"))  
projA2rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/MPI\_rcp45\_2040\_2069.tif"))  
projA3rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/MPI\_rcp45\_2070\_2099.tif"))  
projB1rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/CCSM4\_rcp85\_2010\_2039.tif"))  
projB2rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/CCSM4\_rcp85\_2040\_2069.tif"))  
projB3rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/CCSM4\_rcp85\_2070\_2099.tif"))  
projC1rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/MIROC\_rcp45\_2010\_2039.tif"))  
projC2rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/MIROC\_rcp45\_2040\_2069.tif"))  
projC3rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/MIROC\_rcp45\_2070\_2099.tif"))  
projD1rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/MIROC\_rcp85\_2010\_2039.tif"))  
projD2rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/MIROC\_rcp85\_2040\_2069.tif"))  
projD3rc<-raster(paste0("G:/data/tools/MaxEnt/Output\_tiff/", scenario, "/binary/MIROC\_rcp85\_2070\_2099.tif"))  
  
 #Sum across scenarios and write raster  
Asum<-sum(histrc, projA1rc, projA2rc, projA3rc)  
writeRaster(Asum, filename=paste0("G:/data/tools/MaxEnt/Analysis/", scenario, "/percentchange/MPI\_rcp45.tif"), format="GTiff", overwrite=TRUE)  
Bsum<-sum(histrc, projB1rc, projB2rc, projB3rc)  
writeRaster(Bsum, filename=paste0("G:/data/tools/MaxEnt/Analysis/", scenario, "/percentchange/CCSM4\_rcp85.tif"), format="GTiff", overwrite=TRUE)  
Csum<-sum(histrc, projC1rc, projC2rc, projC3rc)  
writeRaster(Csum, filename=paste0("G:/data/tools/MaxEnt/Analysis/", scenario, "/percentchange/MIROC\_rcp45.tif"), format="GTiff", overwrite=TRUE)  
Dsum<-sum(histrc, projD1rc, projD2rc, projD3rc)  
writeRaster(Dsum, filename=paste0("G:/data/tools/MaxEnt/Analysis/", scenario, "/percentchange/MIROC\_rcp85.tif"), format="GTiff", overwrite=TRUE)  
  
#Sum all and write raster  
Allsum<-sum(histrc, projA1rc, projA2rc, projA3rc, projB1rc, projB2rc, projB3rc, projC1rc, projC2rc, projC3rc, projD1rc, projD2rc, projD3rc)  
writeRaster(Allsum, filename=paste0("G:/data/tools/MaxEnt/Analysis/", scenario, "/percentchange/ALLScenarios.tif"), format="GTiff", overwrite=TRUE)