MSD 2019 Final Project

An extension (in sample testing) of Greed and Grievance in Civil War by Paul Collier and Anke Hoeffler, 2000

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Contents

Reading Data

```
setwd(".")
options(scipen = 100, digits = 4)

data <- read.dta("data/G&G.dta")
data <- data[!is.na(data$warsa), ]
```

Helper Functions

```
summarize_into_table <- function(summary_obj) {
    # takes summary object as input, and returns a DF
    # res.  to print res, use print(summ(obj), quote =
    # FALSE) is you don't want quotes

    options(digits = 4)
    res <- t(round(summary_obj$coefficients, digits = 4))
    z.values <- res[4, ]
    Signif <- symnum(z.values, corr = FALSE, na = FALSE,
        cutpoints = c(0, 0.01, 0.05, 0.1, 1), symbols = c("***",
            "**", "*", ""))
    res <- rbind(res, Signif)
    res <- t(res)
    res <- res[-1, ]
```

```
    res
}

comma_sep = function(x) {
    x = strsplit(x, "")
}
```

Free variables

```
all_tests <- matrix(data = 0, nrow = 15, ncol = 5)
colnames(all_tests) <- c("model", "sens", "spec", "auc",
    "accuracy")

thresholding_flag = TRUE
threshold_value = as.numeric(params$threshold)

sens_index <- 2
spec_index <- 3
auc_index <- 4
accuracy_index <- 5
```

Opportunity Models

Generating the various opportunity models

```
# Opportunity Models

filtering_columns_list <- list("warsa,sxp,sxp2,coldwar,secm,gy1,peace,prevwara,mount,geogia,frac,lnpop"
    "warsa,sxp,sxp2,coldwar,secm,gy1,peace,mount,geogia,frac,lnpop",
    "warsa,sxp,sxp2,coldwar,lngdp_,gy1,peace,mount,geogia,frac,lnpop",
    "warsa,sxp,sxp2,lngdp_,peace,lnpop,diaspeaa", "warsa,sxp,sxp2,lngdp_,peace,lnpop,difdpeaa,diahpeaa"

regression_formula_list <- list("warsa ~  sxp + sxp2 + coldwar + secm + gy1 + peace + prevwara + mount +
    "warsa ~  sxp + sxp2 + coldwar + secm + gy1 + peace + mount + geogia + frac + lnpop",
    "warsa ~  sxp + sxp2 + coldwar + lngdp_ + gy1 + peace + mount + geogia + frac + lnpop",
    "warsa ~  sxp + sxp2 + lngdp_ + peace + lnpop + diaspeaa",
    "warsa ~  sxp + sxp2 + lngdp_ + peace + lnpop + difdpeaa + diahpeaa")


for (i in c(1:5)) {

    filtering_columns <- strsplit(filtering_columns_list[[i]],
        ",")[[1]]

    opportunity.data <- data[, filtering_columns]

    testData <- opportunity.data
    trainData <- opportunity.data

    # trainData <- na.omit(trainData) testData <-
```

```
    # na.omit(testData)

    opportunity_fit <- glm(as.formula(regression_formula_list[[i]]),
        family = binomial(link = "logit"), data = trainData)

    opportunity_predict <- predict(opportunity_fit,
        newdata = testData, type = "response")

    opportunity_y.hat <- as.matrix(opportunity_predict)

    y <- as.matrix(testData$warsa)

    all_tests[i, 1] <- paste(c("opportunity", i), collapse = ".")

    if (thresholding_flag == TRUE) {

        opportunity_y.hat_normalized <- opportunity_y.hat

        opportunity_y.hat_normalized[opportunity_y.hat_normalized >=
            threshold_value] <- 1
        opportunity_y.hat_normalized[opportunity_y.hat_normalized <
            threshold_value] <- 0

        opp_predict_normalized <- prediction(opportunity_y.hat_normalized,
            y)

        len <- length(opp_predict_normalized@fp[[1]])
        fp <- as.numeric(opp_predict_normalized@fp[[1]][[len -
            1]])
        tp <- as.numeric(opp_predict_normalized@tp[[1]][[len -
            1]])
        fn <- as.numeric(opp_predict_normalized@fn[[1]][[len -
            1]])
        tn <- as.numeric(opp_predict_normalized@tn[[1]][[len -
            1]])

        all_tests[i, sens_index] <- tp/(tp + fn)
        all_tests[i, spec_index] <- tn/(tn + fp)

        all_tests[i, accuracy_index] <- (tp + tn)/(tp +
            tn + fp + fn)

        opp_predict <- prediction(opportunity_y.hat,
            y)
        opp_auc <- performance(opp_predict, measure = "auc")
        all_tests[i, auc_index] <- as.numeric(unlist(slot(opp_auc,
            "y.values")))

    } else {

        opp_predict <- prediction(opportunity_y.hat,
            y)
```

```
        opp_f <- performance(opp_predict, measure = "f")
        opp_where.F <- which.max(as.numeric(unlist(slot(opp_f,
            "y.values"))))
        opp_what.F <- performance(opp_predict, measure = "sens",
            x.measure = "spec")

        all_tests[i, sens_index] <- as.numeric(unlist(slot(opp_what.F,
            "y.values")))[opp_where.F]
        all_tests[i, spec_index] <- as.numeric(unlist(slot(opp_what.F,
            "x.values")))[opp_where.F]

        opp_auc <- performance(opp_predict, measure = "auc")
        all_tests[i, auc_index] <- as.numeric(unlist(slot(opp_auc,
            "y.values")))

    }

}
```

Grievance Models

Generating the various grievance models

```
# Grievance Models

filtering_columns_list <- list("warsa,elfo,rf,pol16,etdo4590,dem,peace,mount,geogia,lnpop",
    "warsa,elfo,rf,pol16,etdo4590,dem,peace,mount,geogia,lnpop,ygini",
    "warsa,elfo,rf,pol16,etdo4590,dem,peace,mount,geogia,lnpop,lgini")

regression_formula_list <- list("warsa ~  elfo + rf + pol16 + etdo4590 + dem + peace + mount + geogia +
    "warsa ~  elfo + rf + pol16 + etdo4590 + dem + peace + mount + geogia + lnpop + ygini",
    "warsa ~  elfo + rf + pol16 + etdo4590 + dem + peace + mount + geogia + lnpop + lgini")


for (i in c(1:3)) {

    filtering_columns <- strsplit(filtering_columns_list[[i]],
        ",")[[1]]

    grievance.data <- data[, filtering_columns]

    testData <- grievance.data
    trainData <- grievance.data

    # trainData <- na.omit(trainData) testData <-
    # na.omit(testData)

    grievance_fit <- glm(as.formula(regression_formula_list[[i]]),
        family = binomial(link = "logit"), data = trainData)

    grievance_predict <- predict(grievance_fit, newdata = testData,
        type = "response")
```

```
grievance_y.hat <- as.matrix(grievance_predict)

y <- as.matrix(testData$warsa)

all_tests[5 + i, 1] <- paste(c("grievance", i),
    collapse = ".")

if (thresholding_flag == TRUE) {
    grievance_y.hat_normalized <- grievance_y.hat

    grievance_y.hat_normalized[grievance_y.hat_normalized >=
        threshold_value] <- 1
    grievance_y.hat_normalized[grievance_y.hat_normalized <
        threshold_value] <- 0

    griev_predict_normalized <- prediction(grievance_y.hat_normalized,
        y)

    len <- length(griev_predict_normalized@fp[[1]])
    fp <- as.numeric(griev_predict_normalized@fp[[1]][[len -
        1]])
    tp <- as.numeric(griev_predict_normalized@tp[[1]][[len -
        1]])
    fn <- as.numeric(griev_predict_normalized@fn[[1]][[len -
        1]])
    tn <- as.numeric(griev_predict_normalized@tn[[1]][[len -
        1]])

    all_tests[5 + i, sens_index] <- tp/(tp + fn)
    all_tests[5 + i, spec_index] <- tn/(tn + fp)

    all_tests[5 + i, accuracy_index] <- (tp + tn)/(tp +
        tn + fp + fn)

    griev_predict <- prediction(grievance_y.hat,
        y)
    griev_auc <- performance(griev_predict, measure = "auc")
    all_tests[5 + i, auc_index] <- as.numeric(unlist(slot(griev_auc,
        "y.values")))

} else {

    griev_predict <- prediction(grievance_y.hat,
        y)

    griev_f <- performance(griev_predict, measure = "f")
    griev_where.F <- which.max(as.numeric(unlist(slot(griev_f,
        "y.values"))))
    griev_what.F <- performance(griev_predict,
        measure = "sens", x.measure = "spec")

    all_tests[5 + i, sens_index] <- as.numeric(unlist(slot(griev_what.F,
        "y.values")))[griev_where.F]
```

```
        all_tests[5 + i, spec_index] <- as.numeric(unlist(slot(griev_what.F,
            "x.values")))[griev_where.F]

        griev_auc <- performance(griev_predict, measure = "auc")
        all_tests[5 + i, auc_index] <- as.numeric(unlist(slot(griev_auc,
            "y.values")))

    }


}
```

Combined Model

Generating the combined opportunity and grievance models

```
# Combined Models

filtering_columns_list <- list("warsa,sxp,sxp2,coldwar,secm,gy1,peace,mount,geogia,lnpop,frac,grievxb",
    "warsa,peace,mount,geogia,lnpop,elfo,rf,pol16,etdo4590,dem,greedxb",
    "warsa,sxp,sxp2,coldwar,secm,gy1,peace,mount,geogia,lnpop,frac,elfo,rf,pol16,etdo4590,dem,ygini",
    "warsa,sxp,sxp2,coldwar,secm,gy1,peace,mount,geogia,lnpop,frac,elfo,rf,pol16,etdo4590,dem",
    "warsa,sxp,sxp2,secm,gy1,peace,geogia,lnpop,frac,etdo4590",
    "warsa,sxp,sxp2,lngdp_,gy1,peace,geogia,lnpop,frac,etdo4590",
    "warsa,sxp,sxp2,secm,gy1,peace,geogia,lnpop,frac,etdo4590,oilsxp,oilsxp2")

regression_formula_list <- list("warsa ~ sxp + sxp2 + coldwar + secm + gy1 + peace + mount + geogia + l
    "warsa ~  peace + mount + geogia + lnpop + elfo + rf + pol16 + etdo4590 + dem + greedxb",
    "warsa ~  sxp + sxp2 + coldwar + secm + gy1 + peace + mount + geogia + lnpop + frac + elfo + rf + p
    "warsa ~ sxp + sxp2 + coldwar + secm + gy1 + peace + mount + geogia + lnpop + frac + elfo + rf + pol
    "warsa ~  sxp + sxp2 + secm + gy1 + peace + geogia + lnpop + frac + etdo4590",
    "warsa ~  sxp + sxp2 + lngdp_ + gy1 + peace + geogia + lnpop + frac + etdo4590",
    "warsa ~  sxp + sxp2 + secm + gy1 + peace + geogia + lnpop + frac + etdo4590 +  oilsxp + oilsxp2")


for (i in c(1:7)) {

    filtering_columns <- strsplit(filtering_columns_list[[i]],
        ",")[[1]]

    combined.data <- data[, filtering_columns]

    testData <- combined.data
    trainData <- combined.data

    # trainData <- na.omit(trainData) testData <-
    # na.omit(testData)

    combined_fit <- glm(as.formula(regression_formula_list[[i]]),
        family = binomial(link = "logit"), data = trainData)

    combined_predict <- predict(combined_fit, newdata = testData,
```

```
    type = "response")

combined_y.hat <- as.matrix(combined_predict)

y <- as.matrix(testData$warsa)

all_tests[(5 + 3) + i, 1] <- paste(c("combined",
    i), collapse = ".")

if (thresholding_flag == TRUE) {
    combined_y.hat_normalized <- combined_y.hat

    combined_y.hat_normalized[combined_y.hat_normalized >=
        threshold_value] <- 1
    combined_y.hat_normalized[combined_y.hat_normalized <
        threshold_value] <- 0

    comb_predict_normalized <- prediction(combined_y.hat_normalized,
        y)

    len <- length(comb_predict_normalized@fp[[1]])
    fp <- as.numeric(comb_predict_normalized@fp[[1]][[len -
        1]])
    tp <- as.numeric(comb_predict_normalized@tp[[1]][[len -
        1]])
    fn <- as.numeric(comb_predict_normalized@fn[[1]][[len -
        1]])
    tn <- as.numeric(comb_predict_normalized@tn[[1]][[len -
        1]])

    all_tests[(5 + 3) + i, sens_index] <- tp/(tp +
        fn)
    all_tests[(5 + 3) + i, spec_index] <- tn/(tn +
        fp)

    all_tests[(5 + 3) + i, accuracy_index] <- (tp +
        tn)/(tp + tn + fp + fn)

    comb_predict <- prediction(combined_y.hat,
        y)
    comb_auc <- performance(comb_predict, measure = "auc")
    all_tests[(5 + 3) + i, auc_index] <- as.numeric(unlist(slot(comb_auc,
        "y.values")))

} else {

    comb_predict <- prediction(combined_y.hat,
        y)

    comb_f <- performance(comb_predict, measure = "f")
    comb_where.F <- which.max(as.numeric(unlist(slot(comb_f,
        "y.values"))))
    comb_what.F <- performance(comb_predict, measure = "sens",
```

```
            x.measure = "spec")

        all_tests[(5 + 3) + i, sens_index] <- as.numeric(unlist(slot(comb_what.F,
            "y.values")))[comb_where.F]
        all_tests[(5 + 3) + i, spec_index] <- as.numeric(unlist(slot(comb_what.F,
            "x.values")))[comb_where.F]

        comb_auc <- performance(comb_predict, measure = "auc")
        all_tests[(5 + 3) + i, auc_index] <- as.numeric(unlist(slot(comb_auc,
            "y.values")))

    }

}
```

Converting Results into DataFrame

```
model_names <- all_tests[, 1]

invisible(apply(all_tests, 2, as.numeric))
invisible(sapply(all_tests, as.numeric))
class(all_tests) <- "numeric"
storage.mode(all_tests) <- "numeric"

all_tests <- as.data.frame(all_tests)

all_tests[, 1] <- model_names

result <- all_tests

print(result)
```

```
##            model    sens   spec    auc accuracy
## 1  opportunity.1 0.06522 0.9953 0.8540   0.9331
## 2  opportunity.2 0.06522 0.9953 0.8558   0.9331
## 3  opportunity.3 0.07692 0.9957 0.8360   0.9320
## 4  opportunity.4 0.06250 0.9982 0.8610   0.9479
## 5  opportunity.5 0.09375 0.9982 0.8610   0.9496
## 6    grievance.1 0.00000 1.0000 0.7774   0.9306
## 7    grievance.2 0.00000 1.0000 0.7593   0.9321
## 8    grievance.3 0.00000 1.0000 0.8065   0.9370
## 9     combined.1 0.08696 0.9952 0.8573   0.9323
## 10    combined.2 0.08696 0.9935 0.8602   0.9308
## 11    combined.3 0.03125 1.0000 0.8498   0.9353
## 12    combined.4 0.08696 0.9919 0.8614   0.9293
## 13    combined.5 0.06522 0.9922 0.8598   0.9302
## 14    combined.6 0.07692 0.9957 0.8358   0.9320
## 15    combined.7 0.08889 0.9885 0.8943   0.9266
```

```
write.csv(result, file = paste0("Project_Extension_1_Threshold_",
    params$threshold, ".csv"))
```

The following is a list of all packages used to generate these results. (Leave at very end of file.)

```
sessionInfo()
```

```
## R version 3.5.2 (2018-12-20)
## Platform: x86_64-apple-darwin17.7.0 (64-bit)
## Running under: macOS High Sierra 10.13.6
##
## Matrix products: default
## BLAS/LAPACK: /usr/local/Cellar/openblas/0.3.5/lib/libopenblasp-r0.3.5.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] ROCR_1.0-7        gplots_3.0.1.1    lme4_1.1-21
##  [4] Matrix_1.2-15     DescTools_0.99.28 foreign_0.8-71
##  [7] forcats_0.3.0     stringr_1.4.0     dplyr_0.8.0
## [10] purrr_0.3.0       readr_1.3.1       tidyr_0.8.2
## [13] tibble_2.0.1      ggplot2_3.1.0     tidyverse_1.2.1
## [16] scales_1.0.0      here_0.1
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_1.0.0         lubridate_1.7.4    mvtnorm_1.0-10
##  [4] lattice_0.20-38    gtools_3.8.1       assertthat_0.2.0
##  [7] rprojroot_1.3-2    digest_0.6.18      R6_2.4.0
## [10] cellranger_1.1.0   plyr_1.8.4         backports_1.1.3
## [13] evaluate_0.13      httr_1.4.0         pillar_1.3.1
## [16] rlang_0.3.1        lazyeval_0.2.1     readxl_1.3.0
## [19] rstudioapi_0.9.0   minqa_1.2.4        gdata_2.18.0
## [22] nloptr_1.2.1       rmarkdown_1.11     splines_3.5.2
## [25] munsell_0.5.0      broom_0.5.1        compiler_3.5.2
## [28] modelr_0.1.3       xfun_0.4           pkgconfig_2.0.2
## [31] manipulate_1.0.1   htmltools_0.3.6    tidyselect_0.2.5
## [34] expm_0.999-4       crayon_1.3.4       withr_2.1.2
## [37] MASS_7.3-51.1      bitops_1.0-6       grid_3.5.2
## [40] nlme_3.1-137       jsonlite_1.6       gtable_0.2.0
## [43] formatR_1.6        magrittr_1.5       KernSmooth_2.23-15
## [46] cli_1.0.1          stringi_1.3.1      xml2_1.2.0
## [49] generics_0.0.2     boot_1.3-20        tools_3.5.2
## [52] glue_1.3.0         hms_0.4.2          yaml_2.2.0
## [55] colorspace_1.4-0   caTools_1.17.1.2   rvest_0.3.2
## [58] knitr_1.21         haven_2.0.0
```