///////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////加vif

library(readxl) # 讀取 Excel

library(lme4) # 建立混合模型

library(openxlsx) # 輸出 Excel（可寫多個工作表）

library(broom.mixed) # 整理 lmer 模型（tidy）

library(broom) # 整理 lm 模型（tidy）

library(dplyr) # 資料處理

library(car) # 計算 VIF（適用於 lm 和 lmer 模型）

library(lmerTest) # 計算 p value

# 2. 讀入資料（請修改為你的實際資料路徑）

home\_data <- read\_excel("C:/Users/User/OneDrive/Desktop/作業資料(高中)/個研資料/家養犬\_填補後資料062301.xlsx")

shelter\_data<- read\_excel("C:/Users/User/OneDrive/Desktop/作業資料(高中)/個研資料/收容犬\_填補後資料062501.xlsx")

# 3. 資料前處理

home\_data[home\_data == "N"] <- NA

shelter\_data[shelter\_data == "N"] <- NA

# 因子/數值轉換範例 註 餵食次數主要為1、2我認為影響非線性，故用類別

home\_factor\_vars <- c("home\_alone\_situation", "if\_else\_pet","people\_group", "people\_where", "people\_sex", "dog\_sex", "ligation", "species","feed\_times","when\_feed", "feed\_what")

home\_numeric\_vars<- c("how\_long\_feed", "walk\_dog\_per\_week","people\_age", "dog\_weight", "dog\_age")

home\_data[home\_factor\_vars] <- lapply(home\_data[home\_factor\_vars], as.factor)

home\_data[home\_numeric\_vars] <- lapply(home\_data[home\_numeric\_vars], as.numeric)

shelter\_factor\_vars <- c("move\_size","clean\_frequent","people\_where","people\_group", "people\_sex", "dog\_sex", "ligation", "species","feed\_times","when\_feed", "feed\_what")

shelter\_numeric\_vars<-c("how\_long\_here","social\_with\_human","social\_with\_dog","how\_many\_roommate","people\_age", "dog\_weight", "dog\_age")

shelter\_data[shelter\_factor\_vars] <- lapply(shelter\_data[shelter\_factor\_vars], as.factor)

shelter\_data[shelter\_numeric\_vars] <- lapply(shelter\_data[shelter\_numeric\_vars], as.numeric)

# 4. 定義函式：對單一行為建立三套模型並回傳整理結果（含樣本數與隨機效應變異）

analyze\_behavior <- function(behavior) {

cat("\n--- 開始處理行為：", behavior, "---\n")

# 初始化所有結果變數，即使模型不運行，它們也是空的，避免後續bind\_rows報錯

co2 <- co3 <- NULL

n2 <- n3 <- NA

vc3 <- NULL

vf2\_df <- vf3\_df <- NULL

mod2\_success <- FALSE

mod3\_success <- FALSE

tryCatch({ # 外層 tryCatch 捕捉 analyze\_behavior 函數中的一般性錯誤

# 2) 家養犬 lm 模型

home\_data[[behavior]] <- as.numeric(home\_data[[behavior]])

home\_model\_vars <- c(behavior, "home\_alone\_situation", "if\_else\_pet","people\_group", "people\_where", "people\_sex", "dog\_sex", "species","feed\_times","when\_feed", "feed\_what","how\_long\_feed", "walk\_dog\_per\_week","people\_age", "dog\_weight", "dog\_age")

dat2 <- na.omit(home\_data[, intersect(colnames(home\_data), home\_model\_vars)])

cat(" 模型 2 (home\_data): na.omit 後的樣本數 =", nrow(dat2), "\n")

if (nrow(dat2) < 10) {

cat(" 模型 2 (home\_data): 樣本不足 (<10)，跳過。\n")

} else {

fixed\_effects\_mod2\_potential <- c( "home\_alone\_situation", "if\_else\_pet","people\_group", "people\_sex", "dog\_sex", "species", "feed\_what", "walk\_dog\_per\_week","people\_age", "dog\_weight")

valid\_fixed\_effects\_mod2 <- c()

for (fe in fixed\_effects\_mod2\_potential) {

if (fe %in% colnames(dat2)) {

if (is.numeric(dat2[[fe]])) {

if (sd(dat2[[fe]], na.rm = TRUE) > 1e-6) {

valid\_fixed\_effects\_mod2 <- c(valid\_fixed\_effects\_mod2, fe)

}

} else if (is.factor(dat2[[fe]])) {

if (length(levels(factor(dat2[[fe]]))) > 1) {

valid\_fixed\_effects\_mod2 <- c(valid\_fixed\_effects\_mod2, fe)

}

}

}

}

if (length(valid\_fixed\_effects\_mod2) == 0) {

cat(" 模型 2 (home\_data): 沒有足夠的有效固定效應預測變數來建立模型，跳過。\n")

} else {

mod2 <- tryCatch({

formula\_str\_mod2 <- paste0(behavior, " ~ ", paste(valid\_fixed\_effects\_mod2, collapse = " + "))

lm(as.formula(formula\_str\_mod2), data = dat2)

}, error = function(e) {

cat(" !!! 模型 2 (home\_data) 建立失敗: ", e$message, "\n")

return(NULL)

})

if (!is.null(mod2)) {

cat(" [診斷] 模型 2 建立成功，開始分析 model.matrix...\n")

X\_mat2 <- tryCatch({

model.matrix(formula(mod2), data = dat2)

}, error = function(e) {

cat(" !!! model.matrix 建立失敗: ", e$message, "\n")

return(NULL)

})

if (!is.null(X\_mat2)) {

na\_cols <- which(colSums(is.na(X\_mat2)) > 0)

zero\_cols <- which(apply(X\_mat2, 2, function(col) all(col == 0)))

if (length(na\_cols) > 0) {

cat(" ⚠️ 設計矩陣中有 NA 欄位: ", paste(colnames(X\_mat2)[na\_cols], collapse = ", "), "\n")

}

if (length(zero\_cols) > 0) {

cat(" ⚠️ 設計矩陣中有全為 0 的欄位: ", paste(colnames(X\_mat2)[zero\_cols], collapse = ", "), "\n")

}

}

}

if (!is.null(mod2)) {

mod2\_success <- TRUE

co2 <- tryCatch({

broom::tidy(mod2) %>% mutate(model = "home\_data (lm)")

}, error = function(e) {

cat(" !!! 提取模型 2 (home\_data) 固定效應結果失敗: ", e$message, "\n")

return(NULL)

})

n2 <- nobs(mod2)

if (length(valid\_fixed\_effects\_mod2) > 1) {

vf2\_df <- tryCatch({

cat(" [VIF DEBUG] 模型 2 行為：", behavior, "\n")

cat(" [VIF DEBUG] 模型 2 類型：", class(mod2), "\n")

X\_mat <- model.matrix(mod2)

cat(" [VIF DEBUG] model.matrix 維度：", paste(dim(X\_mat), collapse = " x "), "\n")

if (ncol(X\_mat) <= 1) {

stop("模型 2 的設計矩陣沒有足夠的變數，僅包含截距")

}

vf2 <- car::vif(mod2)

data.frame(term = names(vf2), VIF = as.numeric(vf2), model = "home\_data (lm)")

}, error = function(e) {

cat(" !!! 計算模型 2 (home\_data) VIF 失敗: ", e$message, "\n")

return(NULL)

})

} else {

cat(" 模型 2 (home\_data): 固定效應預測變數少於2，不計算 VIF。\n")

}

}

}

}

# 3) 收容犬 lmer 模型

shelter\_data[[behavior]] <- as.numeric(shelter\_data[[behavior]])

shelter\_model\_vars <- c(behavior, "move\_size","clean\_frequent","people\_group", "people\_where", "people\_sex", "dog\_sex", "species","feed\_times","when\_feed", "feed\_what","how\_long\_here","social\_with\_human","social\_with\_dog","how\_many\_roommate","people\_age", "dog\_weight", "dog\_age"

)

dat3 <- na.omit(shelter\_data[, intersect(colnames(shelter\_data), shelter\_model\_vars)])

cat(" 模型 3 (shelter\_data): na.omit 後的樣本數 =", nrow(dat3), "\n")

if (nrow(dat3) < 10) {

cat(" 模型 3 (shelter\_data): 樣本不足 (<10)，跳過。\n")

} else {

if (length(unique(dat3$people\_where)) < 2) {

cat(" 模型 3 (shelter\_data): people\_where 隨機效應組別少於2，模型可能無法建立，跳過。\n")

} else {

fixed\_effects\_mod3\_potential <- c("move\_size","clean\_frequent","people\_group","people\_sex", "dog\_sex", "species", "feed\_what","social\_with\_human","social\_with\_dog","how\_many\_roommate","people\_age", "dog\_weight"

)

valid\_fixed\_effects\_mod3 <- c()

for (fe in fixed\_effects\_mod3\_potential) {

if (fe %in% colnames(dat3)) {

if (is.numeric(dat3[[fe]])) {

if (sd(dat3[[fe]], na.rm = TRUE) > 1e-6) {

valid\_fixed\_effects\_mod3 <- c(valid\_fixed\_effects\_mod3, fe)

}

} else if (is.factor(dat3[[fe]])) {

if (length(levels(factor(dat3[[fe]]))) > 1) {

valid\_fixed\_effects\_mod3 <- c(valid\_fixed\_effects\_mod3, fe)

}

}

}

}

if (length(valid\_fixed\_effects\_mod3) == 0) {

cat(" 模型 3 (shelter\_data): 沒有足夠的有效固定效應預測變數來建立模型，跳過。\n")

} else {

mod3 <- tryCatch({

formula\_str\_mod3 <- paste0(behavior, " ~ ", paste(valid\_fixed\_effects\_mod3, collapse = " + "), " + (1|people\_where)")

lmer(as.formula(formula\_str\_mod3), data = dat3)

}, error = function(e) {

cat(" !!! 模型 3 (shelter\_data) 建立失敗: ", e$message, "\n")

return(NULL)

})

if (!is.null(mod3)) {

mod3\_success <- TRUE

co3 <- tryCatch({

broom.mixed::tidy(mod3, effects = "fixed") %>% mutate(model = "shelter\_data (lmer)")

}, error = function(e) {

cat(" !!! 提取模型 3 (shelter\_data) 固定效應結果失敗: ", e$message, "\n")

return(NULL)

})

n3 <- nobs(mod3)

vc3 <- tryCatch({

as.data.frame(VarCorr(mod3)) %>%

dplyr::select(grp, vcov) %>%

mutate(ICC = ifelse(grp == "people\_group", vcov / (vcov + attr(VarCorr(mod3), "sc")^2), NA),

model = "shelter\_data (lmer)",

section = "Random Effects")

}, error = function(e) {

cat(" !!! 提取模型 3 (shelter\_data) 隨機效應變異失敗: ", e$message, "\n")

return(NULL)

})

if (length(valid\_fixed\_effects\_mod3) > 1) {

vf3\_df <- tryCatch({

cat(" [VIF DEBUG] 模型 3 類型：", class(mod3), "\n")

# 確保 summary 有 correlation 矩陣

s\_mod3 <- summary(mod3, correlation = TRUE)

if (is.null(s\_mod3$correlation)) {

stop("summary(mod3)$correlation 是 NULL，無法計算 VIF")

}

# car::vif 會用 summary(model)$correlation 來計算

vf3 <- car:::vif.mer(mod3)

data.frame(term = names(vf3), VIF = as.numeric(vf3), model = "shelter\_data (lmer)")

}, error = function(e) {

cat(" !!! 計算模型 3 (shelter\_data) VIF 失敗: ", e$message, "\n")

return(NULL)

})

} else {

cat(" 模型 3 (shelter\_data): 固定效應預測變數少於2，不計算 VIF。\n")

}

}

}

}

}

# 實際用到樣本數表格 (只有在模型成功建立的情況下才使用其nobs)

df\_n <- data.frame(

model = c("home\_data (lm)", "shelter\_data (lmer)"),

used\_n = c(if(mod2\_success) n2 else NA, if(mod3\_success) n3 else NA),

section = "Used N"

)

# 固定效應 (使用 if (!is.null(coX) && nrow(coX) > 0) 確保只合併有資料的結果)

df\_coefs <- bind\_rows(

if (!is.null(co2) && nrow(co2) > 0) co2 else NULL,

if (!is.null(co3) && nrow(co3) > 0) co3 else NULL

) %>% mutate(section = "Fixed Effects")

# VIF (使用 if (!is.null(vfX\_df) && nrow(vfX\_df) > 0) 確保只合併有資料的結果)

df\_vif <- bind\_rows(

if (!is.null(vf2\_df) && nrow(vf2\_df) > 0) vf2\_df else NULL,

if (!is.null(vf3\_df) && nrow(vf3\_df) > 0) vf3\_df else NULL

)

if (is.null(df\_vif) || nrow(df\_vif) == 0) {

df\_vif <- data.frame(term = character(0), VIF = numeric(0), model = character(0), section = character(0))

} else {

df\_vif <- df\_vif %>% mutate(section = "VIF")

}

# 隨機效應 (使用 if (!is.null(vcX) && nrow(vcX) > 0) 確保只合併有資料的結果)

df\_random <- bind\_rows(

if (!is.null(vc3) && nrow(vc3) > 0) vc3 else NULL

)

if (is.null(df\_random) || nrow(df\_random) == 0) {

df\_random <- data.frame(grp = character(0), vcov = numeric(0), ICC = numeric(0), model = character(0), section = character(0))

}

# 回傳合併結果

final\_result <- bind\_rows(df\_n, df\_coefs, df\_vif, df\_random)

cat("--- 處理行為：", behavior, "完成，返回", nrow(final\_result), "行結果 ---\n")

return(final\_result)

}, error = function(e) { # 外層 tryCatch 捕捉 analyze\_behavior 函數中的一般性錯誤

cat("！！！行為變項", behavior, "的 analyze\_behavior 函數遇到未預期錯誤：", e$message, "！！！\n")

return(NULL)

})

}

# 5. 定義行為變項名稱

behavior\_vars <- c("train\_and\_obey","aggresive","fear\_and\_anxiety","separate","exciment","attachment","run","activity","behavior79","behavior80","behavior81","behavior82","behavior83","behavior84","behavior85","behavior86","behavior87","behavior88","behavior89","behavior90","behavior91","behavior92","behavior93","behavior94","behavior95","behavior96","behavior97","behavior98","behavior99","behavior100")

# 6. 批次寫入 Excel

wb <- createWorkbook()

for (b in behavior\_vars) {

cat("正在處理行為：", b, "\n")

res <- analyze\_behavior(b)

if (!is.null(res) && nrow(res)>0) {

addWorksheet(wb, sheetName = b)

writeData(wb, sheet = b, x = res)

} else {

cat("行為變項：", b, " - 未能產生有效的分析結果。\n")

}

}

# 7. 儲存檔案

saveWorkbook(wb, file = "C:/Users/User/OneDrive/Desktop/作業資料(高中)/個研資料/0627\_01\_UsedN\_with\_VIF\_integrated.xlsx", overwrite = TRUE)

cat("\n所有行為變項處理完成。請檢查 Excel 檔案和 R Console 輸出。\n")