An R Markdown program to create the experimental design for a Discrete Choice Experiment (DCE) exploring online help seeking in socially anxious young people

Pilot survey design sub-routine (replication)

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1 About this code

1.1 Motivation

This program can be used to generate pilot survey efficient design and choice cards for studies to replicate a Discrete Choice Experiment study that is currently being written up. Future versions of this program will include details of the parent study.

1.2 Status

This code has is a re-organised version of the script we used in the original study (refer to the Pilot_Design_Reproduction.pdf file).

1.3 Use

When using this code it is important to note that some of the steps in this program involve interactivity - they generate a prompt that a user must respond to before proceeding. Therefore, **this code should be run step by step** (i.e run one chunk at a time and do not try to run the program by knitting the R Markdown version of this code). Although it would be possible to add work-arounds to the interactivity issue, running the program by knitting the RMD version is still not recommended as it will prevent the documents generated by this program from rendering properly.

2 Install and load required libraries

If you do not already have the required libraries to run this program installed, you can do so by un-commenting and running the following lines.

```
# utils::install.packages("idefix")
# utils::install.packages("kableExtra")
# utils::install.packages("knitr")
# utils::install.packages("magick")
# utils::install.packages("magrittr")
# utils::install.packages("shiny")
# utils::install.packages("stringr")
# utils::install.packages("webshot")
# utils::install.packages("xfun")
# utils::install.packages("devtools")
# devtools::install_github("ready4-dev/ready4")
# devtools::install_github("ready4-dev/ready4use")
```

Next load the libraries required to run this program.

```
library(magrittr)
library(ready4)
library(ready4use)
```

3 Create custom functions

Next we create a number of functions that we will use in subsequent parts of this program.

```r
export_eff_des <- function(survey_features_ls,
                           parallel = FALSE,
                           output_dir,
                           pilot_analysis = NULL,
                           start_des = NULL){
  if(is.null(pilot_analysis))
    par.draws <- survey_features_ls$p.d
  else
    par.draws <- pilot_analysis$sample
  no_app_optout_ls <- idefix::Modfed(cand.set = survey_features_ls$candidate_des_mat,
                                     n.sets = survey_features_ls$n_sets,
                                     n.alts = survey_features_ls$n_alts,
                                     no.choice = survey_features_ls$no_choice_lgl,
                                     alt.cte = survey_features_ls$alt_cte,
                                     parallel = parallel,
                                     par.draws = par.draws,
                                     start.des = start_des)
  ## This section needs generalising before the function can be used for other survey designs.
  dir.create(output_dir)
  dir.create(paste0(output_dir,"/block_1"))
  dir.create(paste0(output_dir,"/block_2"))
  saveRDS(no_app_optout_ls,paste0(output_dir,"/no_app_optout_ls.rds")) # Future dev: add prompt before writing to file
  return(no_app_optout_ls)
}
## Choice Card Functions
make_block_choice_tbs_ls <- function(block_ind,
                                     choices_tb){
  purrr::map(block_ind,
             ~ dplyr::filter(choices_tb, startsWith(Choice, paste0("set",.x,"."))))
}
make_choice_card <- function(choice_card_sng_tb){
  formatted_tb <- t(choice_card_sng_tb) %>%
    tibble::as_tibble(rownames = "Attribute") %>%
    dplyr::filter(Attribute != "Choice") %>%
    dplyr::rename(`Social Anxiety App 1` = V1,
```

```r
                    `Social Anxiety App 2` = V2)
  row_names <- formatted_tb %>% dplyr::pull(Attribute)
  formatted_tb <- formatted_tb %>% dplyr::select(-Attribute)
  formatted_tb <- formatted_tb %>%
    as.data.frame()
  rownames(formatted_tb) <- row_names

  formatted_tb %>%
    knitr::kable(escape = F) %>%
    kableExtra::kable_styling(bootstrap_options = c("striped", "hover", "condensed", "responsive"), full_width = F, position = "left") %>%
    kableExtra::column_spec(1,bold = T, border_right = T) %>%
    kableExtra::column_spec(2:3,
                            color = "black", border_right = T)
}
make_one_block_choice_cards_ls <- function(block_choice_tbs_ls){
  purrr::map(1:length(block_choice_tbs_ls),
             ~ make_choice_card(block_choice_tbs_ls %>% purrr::pluck(.x)))
}
save_one_block_choice_cards <- function(block_choice_cards_ls,
                                        save_path_stub,
                                        output_type = ".png"){

  purrr::walk2(block_choice_cards_ls,
               1:length(block_choice_cards_ls),
               ~ save_choice_card_as(.x, # Future dev: add prompt before writing to file
                                     .y,
                                     save_path_stub = save_path_stub,
                                     output_type = output_type)
  )
}
save_choice_card_as <- function(choice_kab,
                                choice_nbr,
                                save_path_stub,
                                output_type){
  file_path = paste0(save_path_stub,
                     "/choice_",
                     choice_nbr,
                     output_type)
```

```r
  if(output_type==".png"){
    kableExtra::as_image(choice_kab,
                         file = file_path)
  }else{
    kableExtra::save_kable(choice_kab, # Future dev: add prompt before writing to file
                           file = file_path,
                           self_contained = F)
  }
}
export_choice_cards <- function(survey_features_ls,
                                no_app_optout_ls,
                                output_dir
                                ){
  survey_ls <- idefix::Decode(des = no_app_optout_ls$design,
                              lvl.names = survey_features_ls$lvl_names,
                              coding = survey_features_ls$c_type,
                              c.lvls = survey_features_ls$con_lvls,
                              alt.cte = survey_features_ls$alt_cte,
                              n.alts = survey_features_ls$n_alts,
                              no.choice = survey_features_ls$no_choice_idx)
  saveRDS(survey_ls,paste0(output_dir, # Future dev: add prompt before writing to file
                           "/survey_ls.rds"))
  choices_tb <- tibble::as_tibble(survey_ls$design,
                                  rownames = "Choice") %>%
    dplyr::rename(Outcomes = V1,
                  `Information sharing` = V2,
                  Social = V3,
                  Endorsers = V4,
                  Cost = V5) %>%
    dplyr::filter(!startsWith(Choice, "no"))
  saveRDS(choices_tb,paste0(output_dir, # Future dev: add prompt before writing to file
                            "/choices_tb.rds"))
  # Needs generalising
  block_1_ind <- sample(1:survey_features_ls$n_sets,survey_features_ls$n_sets/survey_features_ls$n_blocks) %>% sort()
  block_2_ind <- setdiff(1:survey_features_ls$n_sets,block_1_ind)
  blocks_choice_tbs_ls_ls <- purrr::map(list(block_1_ind,
                                             block_2_ind),
                                        ~ make_block_choice_tbs_ls(.x,choices_tb))
```

```r
  choice_cards_by_block_ls <- purrr::map(blocks_choice_tbs_ls_ls,
                                         ~ make_one_block_choice_cards_ls(.x))
  purrr::walk2(choice_cards_by_block_ls,
               paste0(output_dir,"/block_",c(1:length(choice_cards_by_block_ls))),
               ~ save_one_block_choice_cards(.x, # Future dev: add prompt before writing to file
                                             .y,
                                             output_type = ".html"))
  list(survey_ls = survey_ls,
       choices_tb = choices_tb,
       blocks_choice_tbs_ls_ls = blocks_choice_tbs_ls_ls,
       choice_cards_by_block_ls = choice_cards_by_block_ls)


}
preview_survey <- function(no_app_optout_ls,
                           survey_features_ls,
                           pilot = T){
  attributes <- names(survey_features_ls$lvl_names) %>% stringr::str_replace_all("_"," ")
  labels <- survey_features_ls$lvl_names %>% unname()
  if(pilot)
    i.text <- "Pilot Survey Preview (All choice cards from all blocks)"
  else
    i.text <- "Final Survey Preview (All choice cards from all blocks)"
  b.text <- "Please choose the alternative you prefer"
  e.text <- "Thanks for taking the survey"
  idefix::SurveyApp(des = no_app_optout_ls$design,
                    n.total = survey_features_ls$n_sets,
                    alts = survey_features_ls$alternatives,
                    atts = attributes,
                    lvl.names = labels,
                    c.lvls = survey_features_ls$con_lvls,
                    coding = survey_features_ls$c_typ,
                    buttons.text = b.text,
                    intro.text = i.text,
                    end.text = e.text,
                    no.choice = survey_features_ls$no_choice_idx,
                    alt.cte = survey_features_ls$alt_cte)

}
```

4 Specify survey features and priors

Our first main step is to define the key features of the survey (attributes, levels, choice cards, blocks) and our prior expectation of the relative importance of attributes and levels.

4.1 Specify choice attributes and levels

We can now define the attributes and levels for the choices to be included in the survey.

```
attribute_levels <- list(Outcomes = c("Provides knowledge and skills to  manage future situations",
                                      "Addresses current symptoms",
                                      "Addresses current symptoms and provides knowledge and skills  to manage future situations"),
                         Information_sharing = c("No information is shared with your treating clinician",
                                                 "Information is shared with your treating clinician in accordance with app policy",
                                                 "Information is shared with your treating clinician based on settings you control"),
                         Social = c("No discussions with other app users",
                                    "Unmoderated discussions with other app users",
                                    "Discussions with other app users moderated by trained peers",
                                    "Discussions with other app users moderated by mental health clinicians",
                                    "Discussions with other app users moderated by both trained peers and mental health clinicians"),
                         Endorsers = c("App has no endorsers",
                                       "App is endorsed by respected non experts",
                                       "App is endorsed by youth mental health experts"),
                         Cost = c(0,
                                  5,
                                  15,
                                  30,
                                  60))
```

4.2 Create candidate choices matrix

We now create a design matrix of the full factorial of all attribute / level combinations. To do this we create a list specifying the number of attributes for each level and record whether coefficients for each attribute are Continuous ("C") or Dummy ("D").

```
cost_attr_indx <- 5
lvl_names <- attribute_levels %>%
  purrr::discard(is.numeric) %>%
  append(list(paste("$",
                    as.character(attribute_levels[[cost_attr_indx]]),
                    " per month")) %>%
```

```
        stats::setNames("Cost"))
at_lvls <- purrr::map_int(attribute_levels,~length(.x)) %>%
  unname()
c_type <- c("D","D","D","D","C")
con_lvls <- purrr::keep(attribute_levels, is.numeric) %>%
  unname()
candidate_des_mat <- idefix::Profiles(lvls = at_lvls,
                                      coding = c_type,
                                      c.lvls = con_lvls)
```

4.3   Specifiy additional features about our survey

We now provide additional detail about our intended survey design, specifying the number of alternatives (3 - including opt out), the position of the opt out option (third of three options) and the alternative specific constants (zero for each active option, one for the opt out option), the labels for each alternative and the total number of choice sets (30 - two blocks of 15).

```
n_alts <- 3
no_choice_lgl <- TRUE
no_choice_idx <- 3
alt_cte <- c(0,0,1)
alternatives <- c("Social Anxiety App A", "Social Anxiety App B", "Do not use a social anxiety app")
n_sets <- 30
n_blocks <- 2
```

4.4   Specify coefficient priors

We now specify our prior expectation of the values of coefficients for each attribute and an opt out constant. The coefficients supplied in this section were based on study authors' perception of participant feedback at a number of focus groups.

```
mu <- c(-0.15, # Opt out constant
        0.5,1, # Outcomes
        0.2,0.4, # Information sharing
        0.1,0.2,0.3,0.4, # Social
        0.1,0.2,# Endorsers
        -0.05) # Cost
v <- diag(length(mu)) ## Prior variance matrix
```

4.5 Create matrices of parameter value draws

We now create a matrix comprised of ten draws for each parameter and then split the matrix into two: one for the alternative specific constant, the other for the coefficients.

```r
set.seed(1987)
pd <- MASS::mvrnorm(n = 10, mu = mu, Sigma = v)
p.d <- list(matrix(pd[,1], ncol = 1), pd[,2:12])
```

We can now save a list object with the summary information about our survey.

```r
survey_features_ls <- list(candidate_des_mat = candidate_des_mat,
                           lvl_names = lvl_names,
                           c_type = c_type,
                           con_lvls = con_lvls,
                           n_alts = n_alts,
                           alternatives = alternatives,
                           no_choice_lgl = no_choice_lgl,
                           no_choice_idx = no_choice_idx,
                           alt_cte = alt_cte,
                           n_sets = n_sets,
                           n_blocks = n_blocks,
                           p.d = p.d)
```

5 Create efficient pilot survey design

We first specify where on our local machine that we want copies of our output to be saved to.

```r
output_dir <- "pilot_survey"
```

We can now create the initial efficient design to be used in the pilot survey. Note this step can take a long time (about an hour).

```r
pilot_survey_ls <- export_eff_des(survey_features_ls,
                                  parallel = FALSE,
                                  output_dir = output_dir)
```

6 Create choice cards for each block

We can now generate HTML choice cards for each block.

```
choice_cards_pilot_ls <- export_choice_cards(no_app_optout_ls = pilot_survey_ls,
                                             survey_features_ls = survey_features_ls,
                                             output_dir = output_dir)
```

7   Preview survey

We can now preview all of our choice cards in an interactive Shiny app.

```
preview_survey(no_app_optout_ls = pilot_survey_ls,
               survey_features_ls = survey_features_ls,
               pilot = T)
```

8   Share work

The final step is to share our work with others in an online repository. Note, you will need to supply your own repository details to run this part of the code successfully as you will not have write permissions to the repositories that we specify below.

```
X <- Ready4useRepos(dv_nm_1L_chr = "springtolife", # Replace with values for a dataverse & dataset for which
                    dv_ds_nm_1L_chr = "https://doi.org/10.7910/DVN/VGPIPS", #  you have write permissions.
                    dv_server_1L_chr = "dataverse.harvard.edu")
Y <- share(X,
           obj_to_share_xx = list(survey_features_ls = survey_features_ls,
                                  choice_cards_pilot_ls = choice_cards_pilot_ls,
                                  mu = mu,
                                  pilot_survey_ls = pilot_survey_ls,
                                  v = v),
           fl_nm_1L_chr = "BBB_pilot_design_repln_ls",
           description_1L_chr = "List object to help replicate pilot survey (output of dce_sa_design replication program)")
```