Introduction to categorical VPC

Introduction

The tidyvpc package allows users to generate VPC for categorical data using both binning and binless methods.

Data Setup

The tidyvpc package has specific ordering requirements for the observed and simulated input datasets.

Observed data must be ordered by: Subject-ID, IVAR (Time)

Simulated data must be ordered by: Replicate, Subject-ID, IVAR (Time)

The example datasets we'll use in this vignette are correctly ordered, but we will repeat this step for clarity.

```r
library(tidyvpc)
library(data.table)

obs_cat_data <- tidyvpc::obs_cat_data
sim_cat_data <- tidyvpc::sim_cat_data

obs_cat_data <- obs_cat_data[order(PID_code, agemonths)]
sim_cat_data <- sim_cat_data[order(Replicate, PID_code, IVAR)]
```

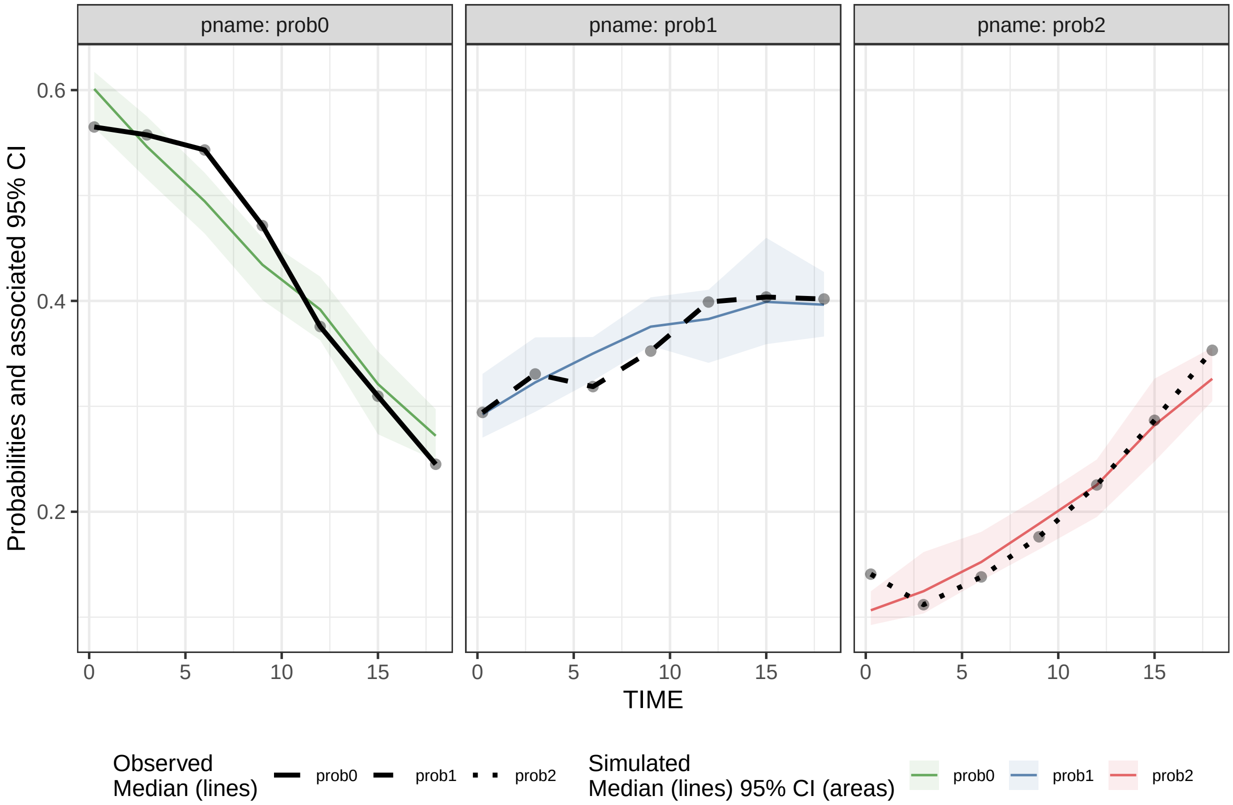
Binning

All traditional binning methods are available to the user, see `?binning`. Note, additional methods available in the `classInt` package can be provided in the `bin` argument.

The syntax for a continuous VPC and categorical VPC are nearly identical, except in `vpcstats()` function, specify `vpc.type = "categorical"`

In the example below, we'll bin directly on our (rounded) x variable, agemonths.

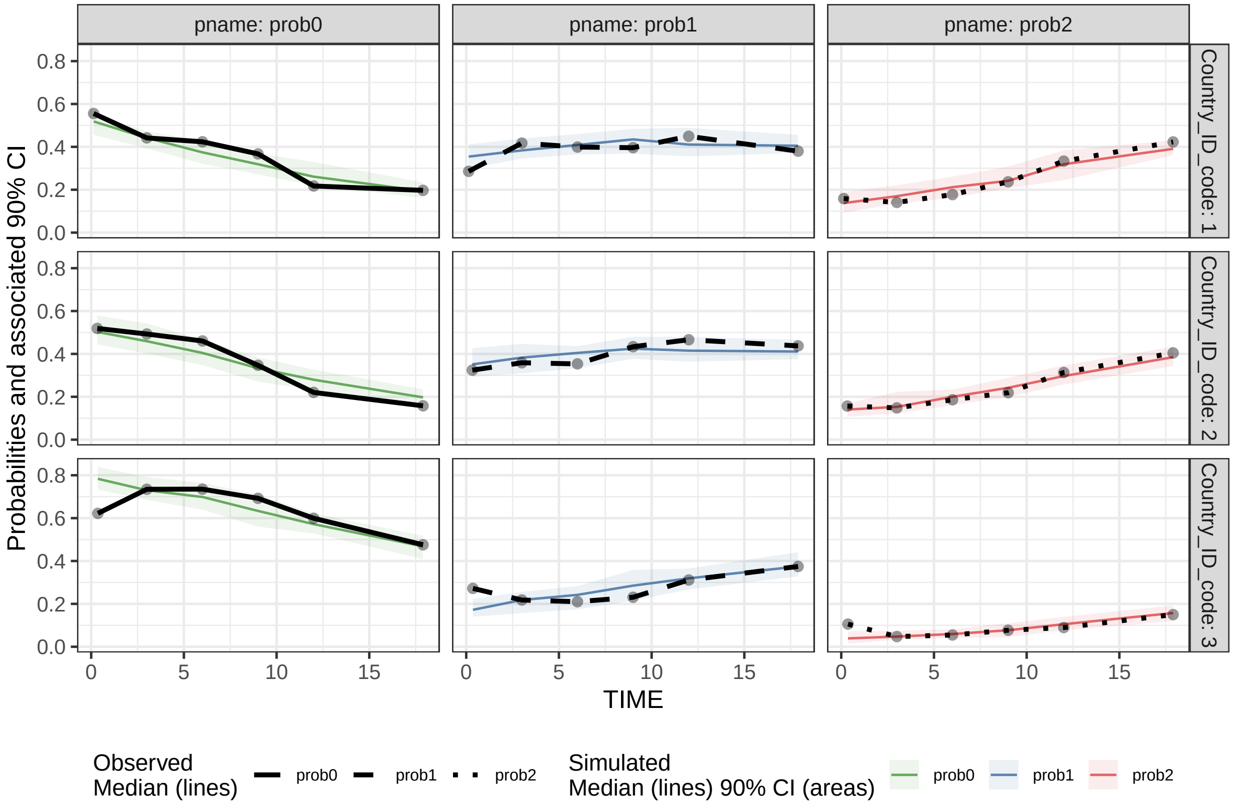
```r
vpc <- observed(obs_cat_data, x = agemonths, yobs = zlencat) %>%
  simulated(sim_cat_data, ysim = DV) %>%
  binning(bin = round(agemonths, 0)) %>%
  vpcstats(vpc.type = "categorical")

plot(vpc, facet = TRUE, legend.position = "bottom", facet.scales = "fixed")
```



Let's explore stratification and provide a different binning method in the following VPC. We can also change our confidence level and quantile type for the prediction intervals (shaded area) by specifying `conf.level = .9` and `quantile.type = 6`.

Note: Phoenix uses `quantile.type = 6` *while tidyvpc uses* `quantile.type = 7` *by default.*

```
vpc <- observed(obs_cat_data, x = agemonths, yobs = zlencat) %>%
  simulated(sim_cat_data, ysim = DV) %>%
  stratify(~ Country_ID_code) %>%
  binning(bin = "pam", nbins = 6) %>%
  vpcstats(vpc.type = "categorical", conf.level = .9, quantile.type = 6)

plot(vpc, facet = TRUE, legend.position = "bottom", facet.scales = "fixed")
```

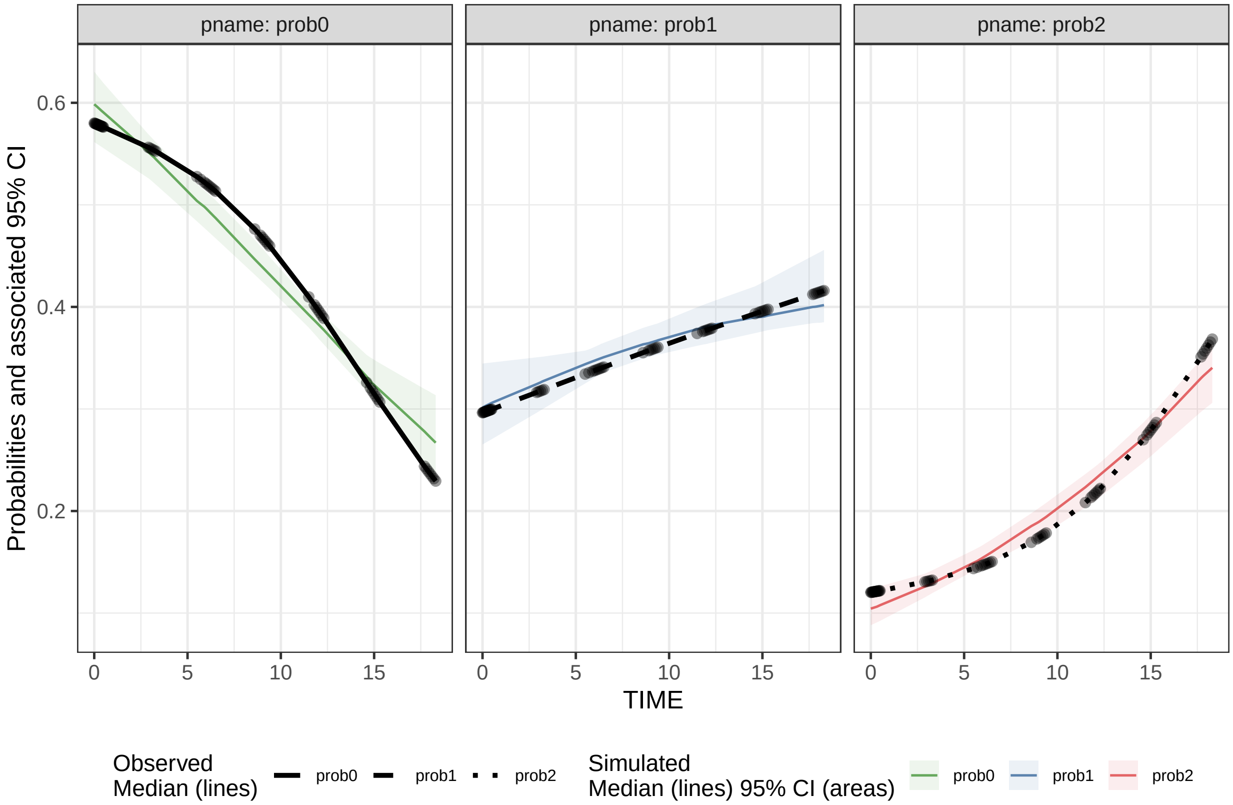


Binless

A binless approach was developed to fit categorical data using `gam(family = "binomial")`. Users can optimize smoothing parameter for the binless fit using `binless(optimize = TRUE)` (default), in which case, the optimized smoothing parameters for each category of DV in the observed data will be automatically defined by minimization of AIC.

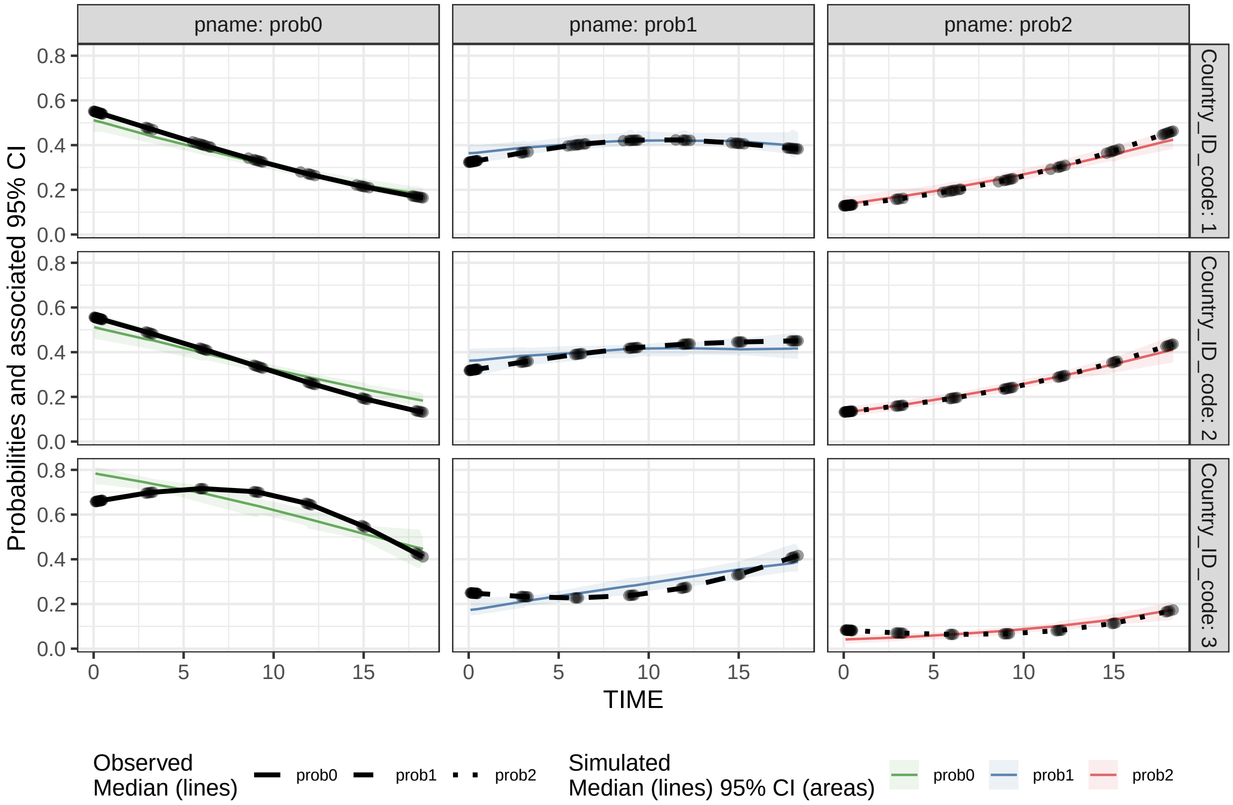
Optimize sp using AIC

```
vpc <- observed(obs_cat_data, x = agemonths, yobs = zlencat) %>%
  simulated(sim_cat_data, ysim = DV) %>%
  binless(optimize = TRUE) %>%
  vpcstats(vpc.type = "categorical", quantile.type = 6)

plot(vpc, facet = TRUE, legend.position = "bottom", facet.scales = "fixed")
```



We can increase the interval used to optimize value of smoothing parameters using the `optimization.interval` argument of the `binless()` function.

```r
vpc <- observed(obs_cat_data, x = agemonths, yobs = zlencat) %>%
  simulated(sim_cat_data, ysim = DV) %>%
  stratify(~ Country_ID_code) %>%
  binless(optimize = TRUE, optimization.interval = c(0,300)) %>%
  vpcstats(vpc.type = "categorical")

plot(vpc, facet = TRUE, legend.position = "bottom", facet.scales = "fixed")
```



User-defined sp

Alternatively, users may supply their own smoothing parameters using the `sp` argument.

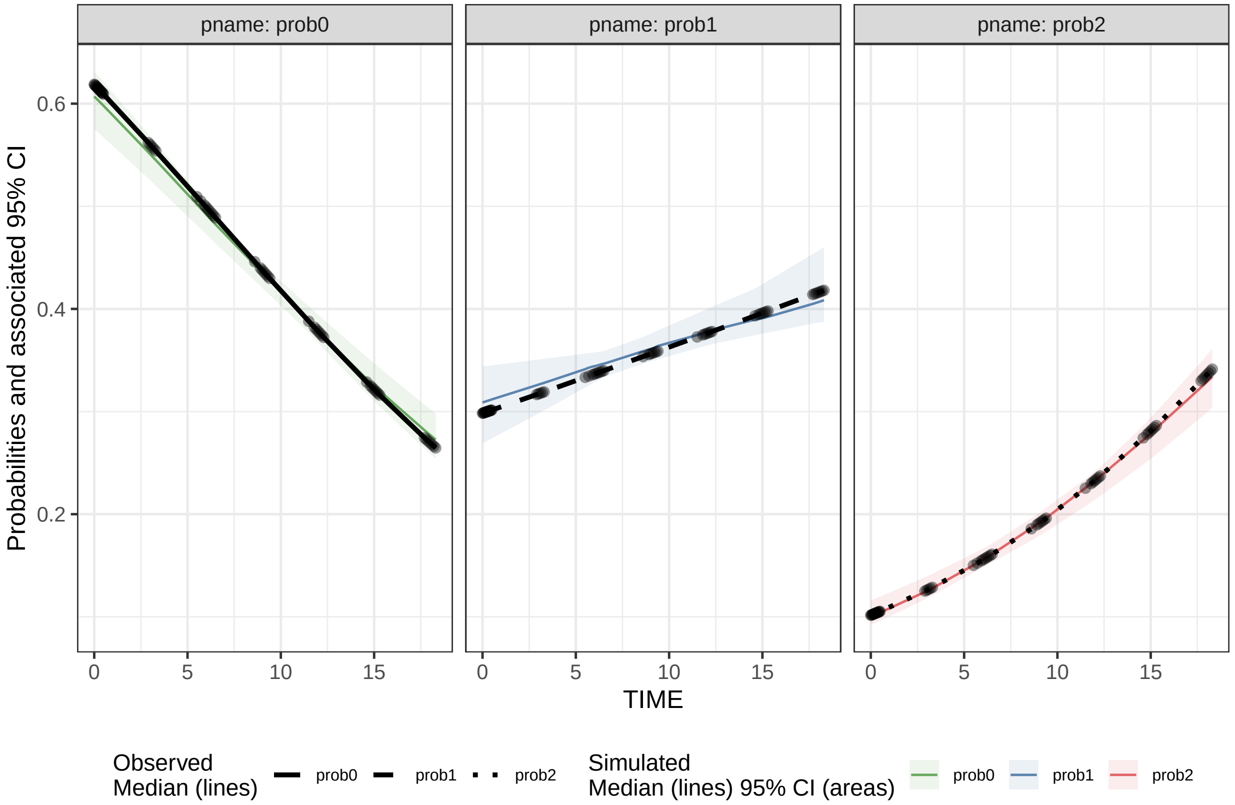
This method uses `gam` with sp values specified for each level of categorical DV.

Note: The `sp` argument must be a list of the same length/order corresponding to the unique values of our categorical DV. See additional details in the next section, if stratification is specified.

```r
sort(unique(obs_cat_data$zlencat))
#> [1] 0 1 2
```

```r
sp_user <- list(p0 = 300,
                p1 = 50,
                p2 = 100)
```

```r
vpc <- observed(obs_cat_data, x = agemonths, yobs = zlencat) %>%
  simulated(sim_cat_data, ysim = DV) %>%
  binless(optimize = FALSE, sp = sp_user) %>%
  vpcstats(vpc.type = "categorical", quantile.type = 6)

plot(vpc, facet = TRUE, legend.position = "bottom", facet.scales = "fixed")
```



Specifying sp for each strata

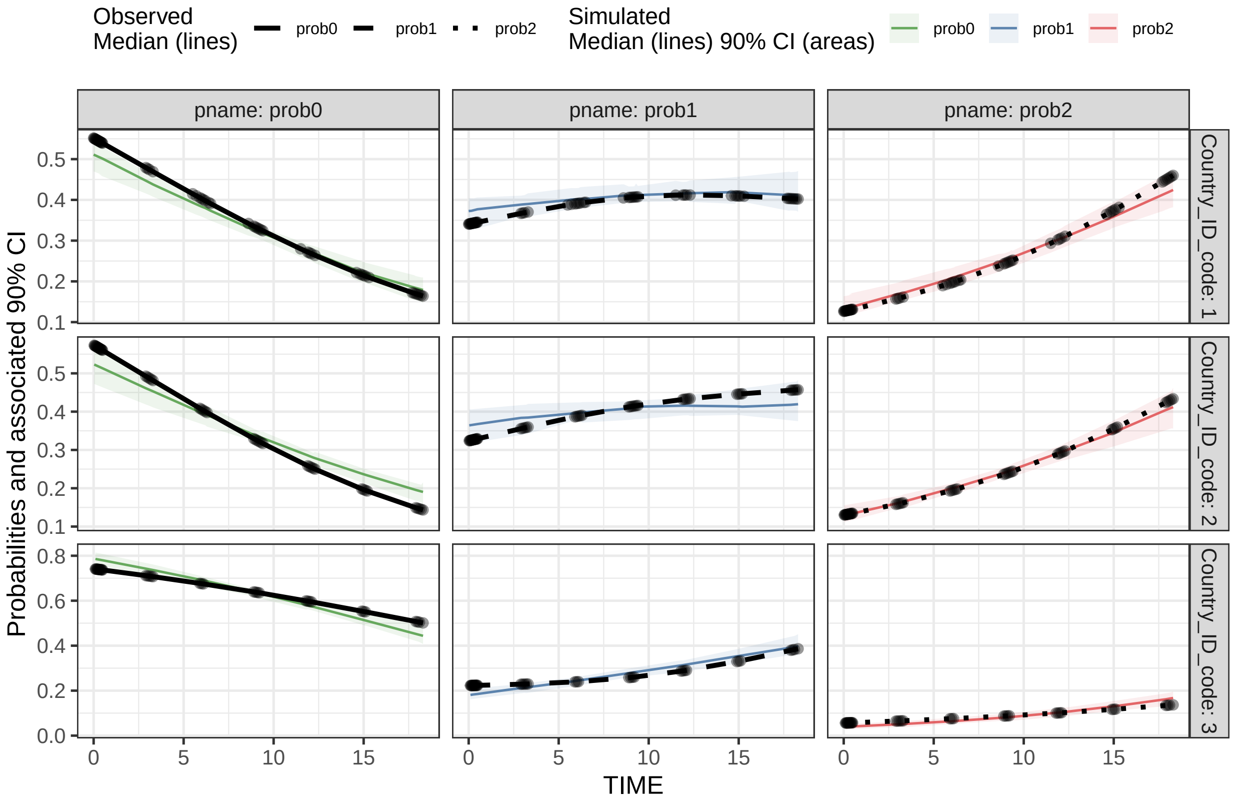
One stratification variable If providing user-supplied sp parameters with one or more stratification variables, the order of sp should be specified as unique combination of strata + DV, in ascending order.

```
sort(unique(obs_cat_data$Country_ID_code))
#> [1] 1 2 3
sort(unique(obs_cat_data$zlencat))
#> [1] 0 1 2
```

```
user_sp <- list(
           Country1_prob0 = 100,
           Country1_prob1 = 3,
           Country1_prob2 = 4,
           Country2_prob0 = 90,
           Country2_prob1 = 3,
           Country2_prob2 = 4,
           Country3_prob0 = 55,
           Country3_prob1 = 3,
           Country3_prob2 = 200)
```

Generate VPC

```r
vpc <- observed(obs_cat_data, x = agemonths, yobs = zlencat) %>%
  simulated(sim_cat_data, ysim = DV) %>%
  stratify(~ Country_ID_code) %>%
  binless(optimize = FALSE, sp = user_sp) %>%
  vpcstats(vpc.type = "categorical"
           , conf.level = 0.9
           , quantile.type = 6
  )
plot(vpc, facet = TRUE)
```



Multiple stratification variables If supplying sp argument with one or more stratification variables, the order of elements in the list provided should be the following: strat1, strat2, . . . , DV.

Add dummy strat variable to obs_cat_data:

```r
library(dplyr)
#> Warning: package 'dplyr' was built under R version 4.3.3
#>
#> Attaching package: 'dplyr'
#> The following objects are masked from 'package:data.table':
#>
#>     between, first, last
#> The following objects are masked from 'package:stats':
#>
#>     filter, lag
#> The following objects are masked from 'package:base':
#>
#>     intersect, setdiff, setequal, union

obs_cat_data <- obs_cat_data %>%
  mutate(gender = ifelse(PID_code %% 2 == 1, "male", "female"))
```

```
vpc <- observed(obs_cat_data, x = agemonths, yobs = zlencat) %>%
  simulated(sim_cat_data, ysim = DV) %>%
  stratify(~ gender + Country_ID_code)
```

View ordering of stratification variables and DV:

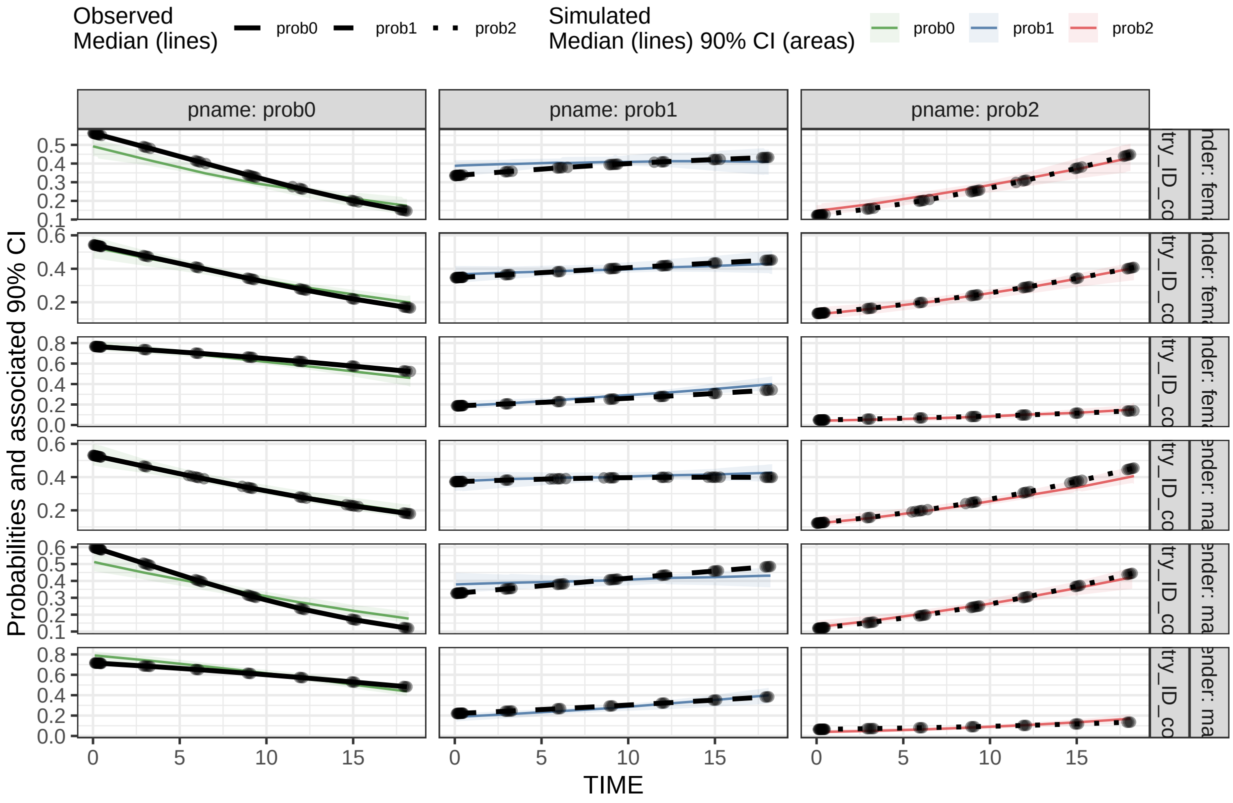
```
sort(unique(obs_cat_data$gender))
#> [1] "female" "male"
sort(unique(obs_cat_data$Country_ID_code))
#> [1] 1 2 3
sort(unique(obs_cat_data$zlencat))
#> [1] 0 1 2
```

We first specified `gender`, then `Country_ID_code` in above formula, so our list of smoothing parameters provided to `sp` argument should be ordered as:

```
user_sp <- list(
  female.1.prob0 = 1,
  female.1.prob1 = 3,
  female.1.prob2 = 9,
  female.2.prob0 = 5,
  female.2.prob1 = 10,
  female.2.prob2 = 12,
  female.3.prob0 = 33,
  female.3.prob1 = 44,
  female.3.prob2 = 88,
  male.1.prob0 = 4,
  male.1.prob1 = 12,
  male.1.prob2 = 15,
  male.2.prob0 = 800,
  male.2.prob1 = 19,
  male.2.prob2 = 28,
  male.3.prob0 = 22,
  male.3.prob1 = 88,
  male.3.prob2 = 11
)
```

Generate VPC

```
vpc <- observed(obs_cat_data, x = agemonths, yobs = zlencat) %>%
  simulated(sim_cat_data, ysim = DV) %>%
  stratify(~ gender + Country_ID_code) %>%
  binless(optimize = FALSE, sp = user_sp) %>%
  vpcstats(vpc.type = "categorical", conf.level = 0.9, quantile.type = 6)

plot(vpc, facet=TRUE)
```


Observed
Median (lines)
prob0
prob1
prob2
Simulated
Median (lines) 90% CI (areas)
prob0
prob1
prob2
pname: prob0
pname: prob1
pname: prob2
try_ID_co
nder: fema
try_ID_co
nder: fema
try_ID_co
nder: fema
try_ID_co
ender: ma
try_ID_co
ender: ma
try_ID_co
ender: ma
Probabilities and associated 90% CI
0.1
0.2
0.3
0.4
0.5
0.6
0.0
0.8
TIME
0
5
10
15