Multinomial regression of spouse characteristics for the ChitwanABM

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Analyzes the relationship grid data from the CVFS to build a multinomial regression predict the probability of marrying a spouse within each of a set of age groups, together with the probability of marrying someone of a different ethnicity.

The results of this analysis are used to inform the marriage process in the ChitwanABM. Once the determination has been made that a woman is marrying (based on the probability derived from event history analysis), the multinomial regression developed here is used to assign a proability of marriage to each possible spouse, based on the age of that person, so that the age differential between spouses is realistic.

Load the data and setup R

```
library(ggplot2)
library(mlogit)
library(arm)
library(rms)  # Note 'Design' package was renamed to 'rms'
theme_update(theme_bw(base_size = 10))
```

```
load("V:/Nepal/CVFS_R_format/hhrel_with_respIDs.Rdata")
hhrel <- hhrel_with_respIDs

# Drop 'other' ethnicity for consistency with existing work
hhrel <- hhrel[!(hhrel$ethnic == "Other"), ]
hhrel$ethnic <- factor(hhrel$ethnic)
hhrel$CENGENDR <- factor(hhrel$CENGENDR)

hhrel$age_cat <- cut(hhrel$CENAGE, breaks = c(0, 15, 20, 30, 40,
    50, 60, 999), ordered_result = TRUE)
```

Basic statistics

First look at some basic statistics on who is married, and on how many spouses they have, by gender.

```
hhrel$HASSPOUSE1 <- !is.na(hhrel$SPOUSE1)
hhrel$HASSPOUSE2 <- !is.na(hhrel$SPOUSE2)
hhrel$HASSPOUSE3 <- !is.na(hhrel$SPOUSE3)
xtabs(~CENGENDR + HASSPOUSE1, data = hhrel)
```

```
##         HASSPOUSE1
## CENGENDR FALSE TRUE
##   female  2218 1892
##   male    2293 1849
```

```
xtabs(~CENGENDR + HASSPOUSE2, data = hhrel)
```

```
##         HASSPOUSE2
## CENGENDR FALSE TRUE
##   female  4110    0
##   male    4109   33
```

```
xtabs(~CENGENDR + HASSPOUSE3, data = hhrel)
```

```
##         HASSPOUSE3
## CENGENDR FALSE TRUE
##   female  4110    0
##   male    4140    2
```

Now look at who has more than one spouse (only males do) by age group:

```
xtabs(~age_cat + HASSPOUSE2, data = hhrel)
```

```
##           HASSPOUSE2
## age_cat    FALSE TRUE
##   (0,15]    3228    0
##   (15,20]    989    0
##   (20,30]   1393    1
##   (30,40]    970    7
##   (40,50]    711    7
##   (50,60]    470   10
##   (60,999]   458    8
```

```
xtabs(~age_cat + HASSPOUSE3, data = hhrel)
```

```
##           HASSPOUSE3
## age_cat    FALSE TRUE
##   (0,15]    3228    0
##   (15,20]    989    0
##   (20,30]   1394    0
##   (30,40]    977    0
##   (40,50]    718    0
##   (50,60]    479    1
##   (60,999]   465    1
```

Having multiple wives is mostly confied to older men. Now look into the difference in spouse age, by gender.

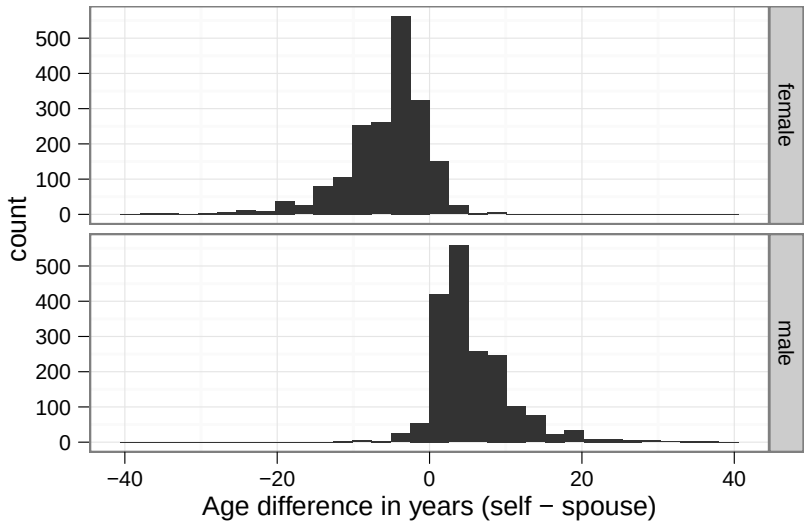
```
spouse1_row <- match(hhrel$SPOUSE1, hhrel$RESPID)
hhrel$sp_age <- hhrel$CENAGE[spouse1_row]
hhrel$sp_age_cat <- hhrel$age_cat[spouse1_row]
hhrel$sp_age_diff <- hhrel$CENAGE - hhrel$sp_age
xtabs(~age_cat + sp_age_cat, data = hhrel)
```

```
##           sp_age_cat
## age_cat    (0,15] (15,20] (20,30] (30,40] (40,50] (50,60] (60,999]
##   (0,15]        0       1       2       0       0       0        0
##   (15,20]       1      88     160       8       0       1        0
##   (20,30]       2     160     689     271      27       6        1
##   (30,40]       0       7     265     425     194      31        8
##   (40,50]       0       0      26     189     268     146       41
##   (50,60]       0       1       4      28     142     133       85
##   (60,999]      0       0       1       7      38      83      188
```

```
qplot(sp_age_diff, facets = CENGENDR ~ ., xlab = "Age difference in years (self - spouse)",
    data = hhrel)
```

```
## stat_bin: binwidth defaulted to range/30. Use 'binwidth = x' to adjust
## this.
```

```
## stat_bin: binwidth defaulted to range/30. Use 'binwidth = x' to adjust
## this.
```



Comparison of spouse age difference by gender

Setup some age categories for the difference in spouse age.

```
hhrel$sp_age_diff_cat <- cut(hhrel$sp_age_diff, breaks = c(-999,
    -15, -10, -5, -2, -1, 0, 1, 2, 5, 10, 15, 999), ordered_result = TRUE)
xtabs(~sp_age_diff_cat + age_cat + CENGENDR, data = hhrel)
```

```
## , , CENGENDR = female
##
##                 age_cat
## sp_age_diff_cat (0,15] (15,20] (20,30] (30,40] (40,50] (50,60] (60,999]
##      (-999,-15]      0       4      29      34      41      14        2
##      (-15,-10]       1      17      64      68      59      30       12
##      (-10,-5]        1      79     242     146      95      51       30
```

```
##      (-5,-2]         1      78     219     122      77      23      23
##      (-2,-1]         0      25      48      24      14      12       7
##      (-1,0]          0       4      27      30      16      11       8
##      (0,1]           0       3       8       8       5       6       3
##      (1,2]           0       0       5       6       5       2       3
##      (2,5]           0       1       3       5       8       3       5
##      (5,10]          0       0       1       0       4       1       2
##      (10,15]         0       0       0       0       1       0       2
##      (15,999]        0       0       0       0       1       0       0
##
## , , CENGENDR = male
##
##                 age_cat
## sp_age_diff_cat (0,15] (15,20] (20,30] (30,40] (40,50] (50,60] (60,999]
##      (-999,-15]      0       0       1       0       0       0       0
##      (-15,-10]       0       0       1       2       0       0       3
##      (-10,-5]        0       0       1       3       6       1       3
##      (-5,-2]         0       2       9       9      10       4       4
##      (-2,-1]         0       3       9       8       4       6       3
##      (-1,0]          0       6      27      30      14      12       8
##      (0,1]           0      17      54      25      13      14       7
##      (1,2]           0       8      81      42      36      13      14
##      (2,5]           0      11     212     162     100      45      28
##      (5,10]          0       0     106     165      99      75      60
##      (10,15]         0       0       9      33      49      50      37
##      (15,999]        0       0       0       8      13      20      53
##
```

Do people marry outside of their ethnic group?

```
spouse1_row <- match(hhrel$SPOUSE1, hhrel$RESPID)
hhrel$spouse_ethnicity <- hhrel$ethnic[spouse1_row]
xtabs(~ethnic + spouse_ethnicity, data = hhrel)
```

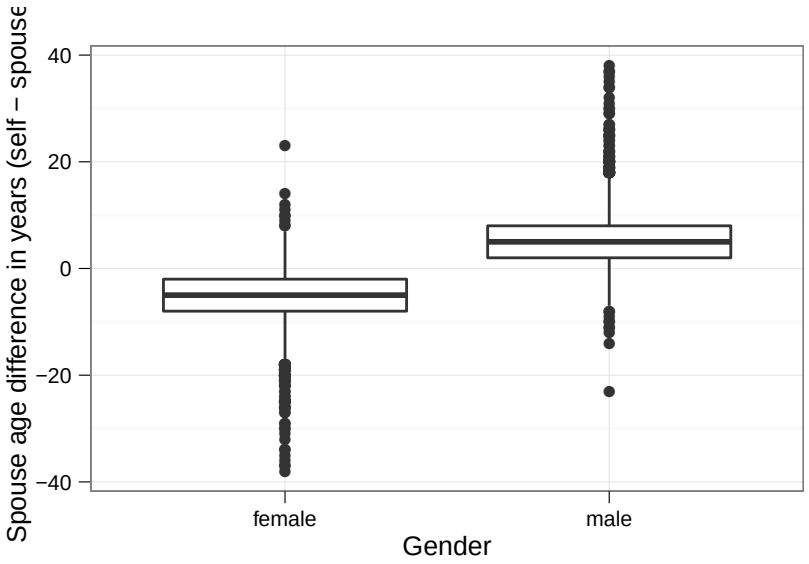
```
##             spouse_ethnicity
## ethnic        UpHindu HillTibeto LowHindu Newar TeraiTibeto
##   UpHindu        1733          2        0     0           0
##   HillTibeto        2        633        0     0           2
##   LowHindu          0          0      413     0           0
##   Newar             0          0        0   244           0
##   TeraiTibeto       0          2        0     0         696
```

Marriages outside of your ethnic group are VERY uncommon. There are only 4 in the data. So we will disallow these marriages in the model - there are not enough of them to develop any kind of predictive model of when they might occur.

Make a few final summary plots: the mean of spouse_age_diff versus gender, and a histogram of spouse_age_diff by gender.

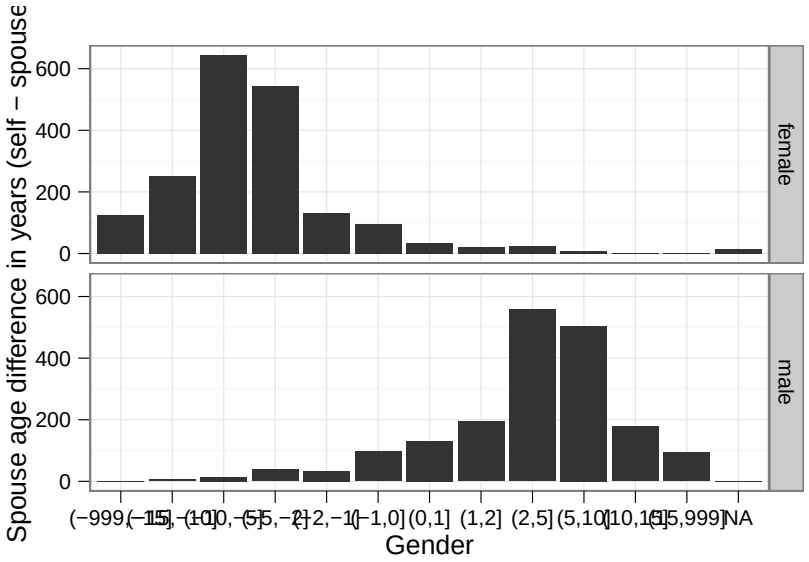
```
qplot(CENGENDR, sp_age_diff, geom = "boxplot", xlab = "Gender", ylab = "Spouse age difference in years (self - spouse)",
    data = hhrel)
```

```
## Warning: Removed 4525 rows containing non-finite values (stat_boxplot).
```



plot of chunk mean-sp-age-diff-versus-age

```
qplot(sp_age_diff_cat, facets = CENGENDR ~ ., geom = "histogram",
    xlab = "Gender", ylab = "Spouse age difference in years (self - spouse)",
    data = hhrel[hhrel$HASSPOUSE1, ])
```



Histogram of marriages by spouse age categories and gender

Probability distribution for men marrying women of varying age differences

```
married_men_rows <- (hhrel$CENGENDR == "male") & hhrel$HASSPOUSE1
table(married_men_rows)
```

```
## married_men_rows
## FALSE  TRUE
##  6403  1849
```

```
male_marr_prob <- with(hhrel[married_men_rows, ], table(sp_age_diff_cat))
(male_marr_prob <- male_marr_prob/sum(male_marr_prob))
```

```
## sp_age_diff_cat
## (-999,-15]  (-15,-10]   (-10,-5]    (-5,-2]    (-2,-1]     (-1,0]
##  0.0005411  0.0032468  0.0075758  0.0205628  0.0178571  0.0524892
##      (0,1]      (1,2]      (2,5]     (5,10]    (10,15]   (15,999]
##  0.0703463  0.1049784  0.3019481  0.2732684  0.0963203  0.0508658
```

Multinomial logistic regression predicting spouse age difference based on gender

> ***Note***
>
> The multinomial logit is NOT used in the ChitwanABMInstead the simpler approach of a probability distribution of husbands age minus wifes age is used to assign probabilities to each man of marrying each woman. This simpler approach should be equivalent, for the case of gender as the single predictor, to using the multinomial logit outlined below.

```
hhrel_mlogit_data <- mlogit.data(hhrel, varying = NULL, choice = "sp_age_diff_cat",
    shape = "wide")
mlogit_spouseage <- mlogit(sp_age_diff_cat ~ 1 | CENGENDR, data = hhrel_mlogit_data)
summary(mlogit_spouseage)
```

```
##
## Call:
## mlogit(formula = sp_age_diff_cat ~ 1 | CENGENDR, data = hhrel_mlogit_data,
##     method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##     (-1,0]   (-10,-5]  (-15,-10]    (-2,-1]    (-5,-2] (-999,-15]
##     0.0518     0.1765     0.0690     0.0437     0.1559     0.0335
##      (0,1]      (1,2]    (10,15]   (15,999]      (2,5]     (5,10]
##     0.0437     0.0577     0.0486     0.0255     0.1564     0.1376
##
## nr method
## 8 iterations, 0h:0m:2s
## g'(-H)^-1g = 3.65E-06
## successive fonction values within tolerance limits
##
## Coefficients :
##                          Estimate Std. Error t-value Pr(>|t|)
## (-10,-5]:(intercept)        1.903      0.109   17.40  < 2e-16 ***
## (-15,-10]:(intercept)       0.961      0.120    8.01  1.1e-15 ***
```

```
## (-2,-1]:(intercept)        0.303      0.135    2.25    0.024 *
## (-5,-2]:(intercept)        1.733      0.111   15.65  < 2e-16 ***
## (-999,-15]:(intercept)     0.256      0.136    1.88    0.060 .
## (0,1]:(intercept)         -1.068      0.202   -5.29  1.2e-07 ***
## (1,2]:(intercept)         -1.520      0.241   -6.31  2.8e-10 ***
## (10,15]:(intercept)       -3.466      0.586   -5.91  3.4e-09 ***
## (15,999]:(intercept)      -4.564      1.005   -4.54  5.6e-06 ***
## (2,5]:(intercept)         -1.345      0.225   -5.99  2.1e-09 ***
## (5,10]:(intercept)        -2.485      0.368   -6.75  1.5e-11 ***
## (-10,-5]:CENGENDRmale     -3.839      0.306  -12.54  < 2e-16 ***
## (-15,-10]:CENGENDRmale    -3.744      0.437   -8.56  < 2e-16 ***
## (-2,-1]:CENGENDRmale      -1.381      0.242   -5.70  1.2e-08 ***
## (-5,-2]:CENGENDRmale      -2.670      0.221  -12.08  < 2e-16 ***
## (-999,-15]:CENGENDRmale   -4.831      1.014   -4.76  1.9e-06 ***
## (0,1]:CENGENDRmale         1.361      0.242    5.62  2.0e-08 ***
## (1,2]:CENGENDRmale         2.213      0.271    8.16  2.2e-16 ***
## (10,15]:CENGENDRmale       4.073      0.600    6.79  1.1e-11 ***
## (15,999]:CENGENDRmale      4.533      1.016    4.46  8.1e-06 ***
## (2,5]:CENGENDRmale         3.095      0.250   12.38  < 2e-16 ***
## (5,10]:CENGENDRmale        4.135      0.384   10.76  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -6720
## McFadden R^2:  0.212
## Likelihood ratio test : chisq = 3620 (p.value = <2e-16)
```

```
mlogit_spouseage_odds <- cbind(odds_ratio = exp(coef(mlogit_spouseage)),
    exp(confint.default(mlogit_spouseage)))
(mlogit_spouseage_odds <- round(mlogit_spouseage_odds, 4))
```

```
##                         odds_ratio   2.5 %   97.5 %
## (-10,-5]:(intercept)        6.7083  5.4136   8.3127
## (-15,-10]:(intercept)       2.6146  2.0666   3.3079
## (-2,-1]:(intercept)         1.3542  1.0402   1.7629
## (-5,-2]:(intercept)         5.6562  4.5529   7.0270
## (-999,-15]:(intercept)      1.2917  0.9895   1.6860
## (0,1]:(intercept)           0.3437  0.2315   0.5105
## (1,2]:(intercept)           0.2187  0.1364   0.3508
## (10,15]:(intercept)         0.0312  0.0099   0.0986
## (15,999]:(intercept)        0.0104  0.0015   0.0747
## (2,5]:(intercept)           0.2604  0.1677   0.4044
## (5,10]:(intercept)          0.0833  0.0405   0.1714
## (-10,-5]:CENGENDRmale       0.0215  0.0118   0.0392
## (-15,-10]:CENGENDRmale      0.0237  0.0100   0.0558
## (-2,-1]:CENGENDRmale        0.2512  0.1562   0.4040
## (-5,-2]:CENGENDRmale        0.0693  0.0449   0.1068
## (-999,-15]:CENGENDRmale     0.0080  0.0011   0.0583
## (0,1]:CENGENDRmale          3.8988  2.4247   6.2690
## (1,2]:CENGENDRmale          9.1429  5.3742  15.5543
## (10,15]:CENGENDRmale       58.7216 18.1262 190.2349
## (15,999]:CENGENDRmale      93.0309 12.7110 680.8861
## (2,5]:CENGENDRmale         22.0899 13.5320  36.0599
## (5,10]:CENGENDRmale        62.4742 29.4146 132.6904
```

```
write.csv(coef(mlogit_spouseage), file = "mlogit_spouseage_coefs.csv")
write.csv(mlogit_spouseage_odds, file = "mlogit_spouseage_odds.csv")
```