p8131_hw4_jsg2145

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```
df_low = tibble(
  conx = rep(c("low", "high"), 3),
  hous_tp = rep(c("tr_bk", "apt", "hous"), each = 2),
  values = c(65, 34, 130, 141, 67, 130)
) %>%
  mutate(sat = "low")

df_med = tibble(
  conx = rep(c("low", "high"), 3),
  hous_tp = rep(c("tr_bk", "apt", "hous"), each = 2),
  values = c(54, 47, 76, 116, 48, 105)
) %>%
  mutate(sat = "med")

df_high = tibble(
  conx = rep(c("low", "high"), 3),
  hous_tp = rep(c("tr_bk", "apt", "hous"), each = 2),
  values = c(100, 100, 111, 191, 62, 104)
) %>%
  mutate(sat = "high")

df_sum = union(df_low, df_med) %>%
  union(df_high) %>%
  unnest() %>%
  pivot_wider(names_from = sat, values_from = values)

df_tbl = df_sum %>%
  group_by(conx, hous_tp) %>%
  mutate(n = sum(low, med, high)) %>%
  summarize(low = low/n,
            med = med/n,
            high = high/n)
```

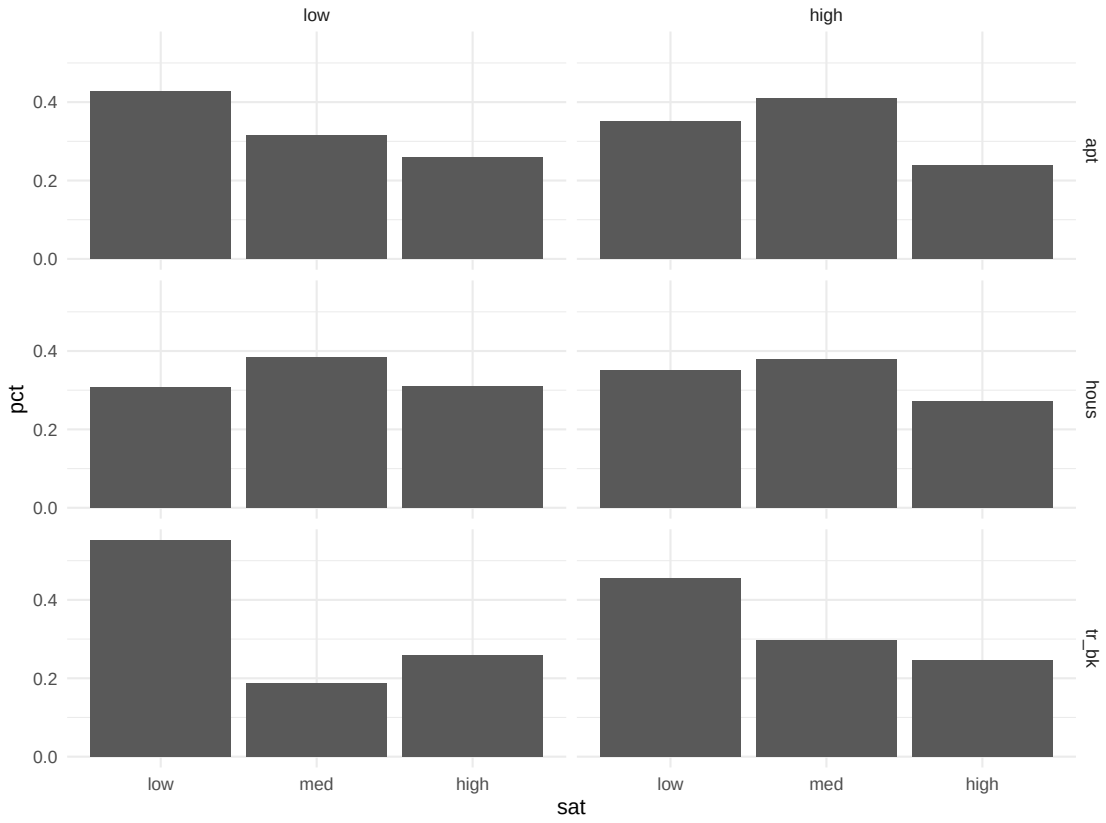
```
df_conx = df_sum %>%
  group_by(conx) %>%
  summarize(low = sum(low),
            med = sum(med),
            high = sum(high),
            n = sum(low, med, high)) %>%
  group_by(conx) %>%
  summarize(low = low/n,
            med = med/n,
            high = high/n)
```

```
df_hous_tp = df_sum %>%
  group_by(hous_tp) %>%
```

```
  summarize(low = sum(low),
            med = sum(med),
            high = sum(high),
            n = sum(low, med, high)) %>%
  group_by(hous_tp) %>%
  summarize(low = low/n,
            med = med/n,
            high = high/n)
```

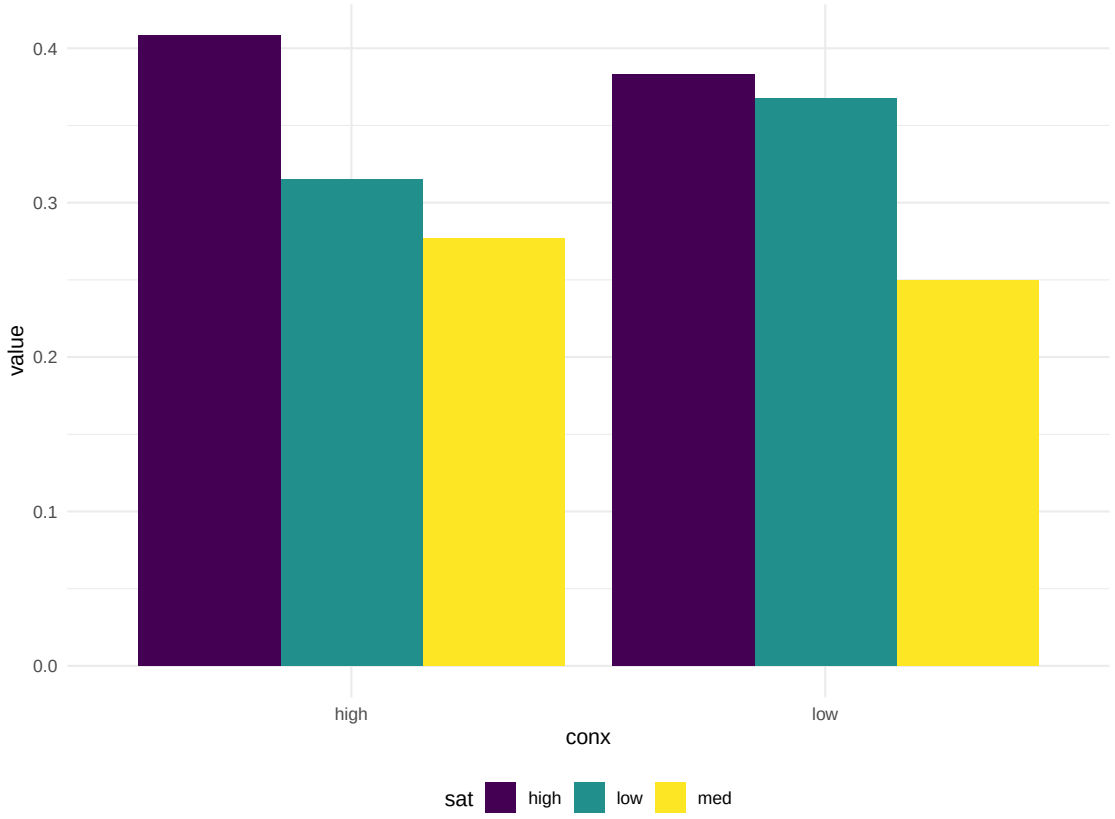
```
df_tidy_tbl = df_tbl %>%
  pivot_longer(cols = c(low, med, high), names_to = "sat", values_to = "pct") %>%
  ungroup() %>%
  mutate(sat = str_remove(sat, "_pct$"),
         sat = factor(sat, labels = c("low", "med", "high")),
         conx = factor(conx, labels = c("low", "high")),
         hous_tp = factor(hous_tp, labels = c("apt", "hous", "tr_bk")))
```

```
df_tidy_tbl %>%
  ggplot(aes(x = sat, y = pct)) +
  geom_col() +
  facet_grid(hous_tp~conx)
```

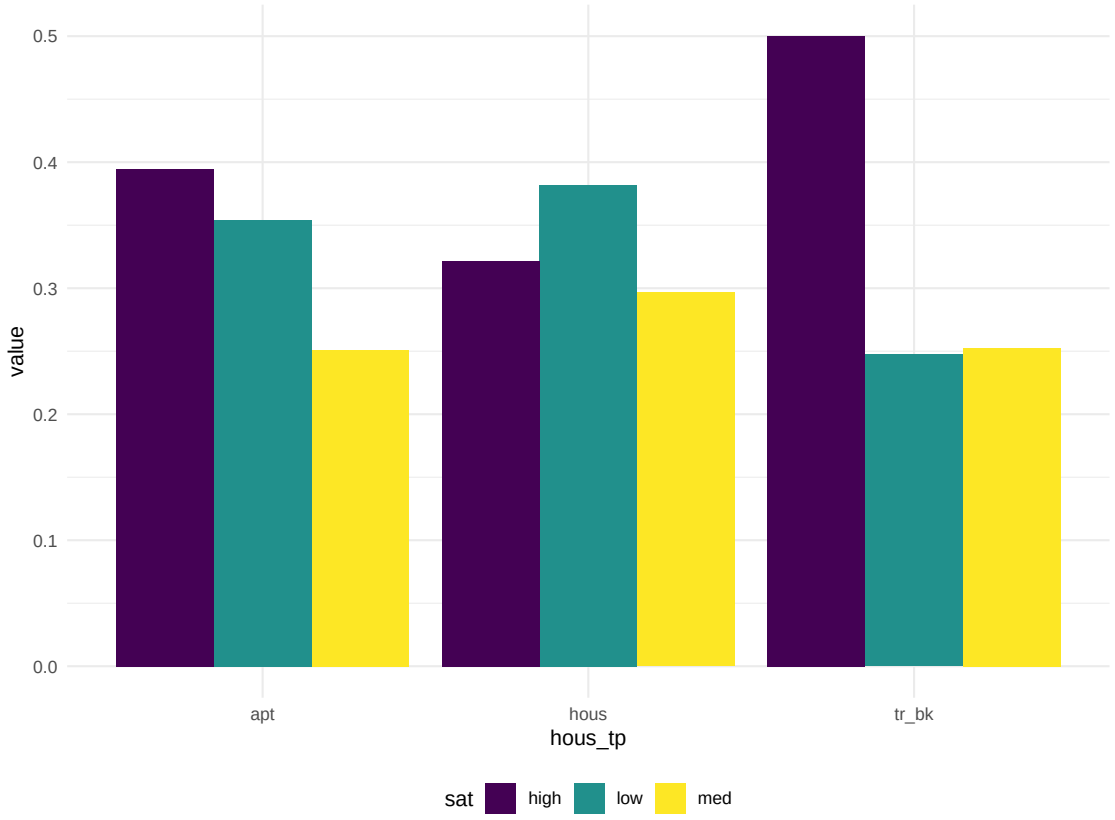



```
df_conx %>%
  pivot_longer(cols = low:high, names_to = "sat") %>%
```

```
  ggplot(aes(x = conx, y = value, fill = sat)) +
  geom_bar(position = "dodge", stat = "identity")
```




```
df_hous_tp %>%
  pivot_longer(cols = low:high, names_to = "sat") %>%
  ggplot(aes(x = hous_tp, y = value, fill = sat)) +
  geom_bar(position = "dodge", stat = "identity")
```




```
hagen.multi = nnet::multinom(cbind(low, med, high) ~ conx + hous_tp, data = df_sum)
```

```
## # weights:  15 (8 variable)
## initial  value 1846.767257
## iter  10 value 1803.046285
## final  value 1802.740161
## converged
```

```
summary(hagen.multi)
```

```
## Call:
## nnet::multinom(formula = cbind(low, med, high) ~ conx + hous_tp,
##     data = df_sum)
##
## Coefficients:
##      (Intercept)    conxlow hous_tphous hous_tptr_bk
## med   -0.2180364 -0.2959832  0.06967922    0.4067631
## high   0.2474047 -0.3282264 -0.30402275    0.6415948
##
## Std. Errors:
##      (Intercept)   conxlow hous_tphous hous_tptr_bk
## med   0.10930968 0.1301046   0.1437749    0.1713009
## high  0.09783068 0.1181870   0.1351693    0.1500774
##
## Residual Deviance: 3605.48
## AIC: 3621.48
```

It appears that low contact with neighbors is associated with lower medium and high satisfaction holding housing type constant, while higher contact with neighbors is associated with an increase in medium and high satisfaction in the tower block housing compared to apartments. But, there is no clear trend between satisfaction and house type between houses and apartments while holding contact constant.

```
pihat = predict(hagen.multi, type = "probs")
m = rowSums(df_sum[3:5])
res.pearson = (df_sum[3:5] - pihat * m) / sqrt(pihat * m)
```

```
G.stat = sum(res.pearson ^ 2) # Generalized Pearson Chisq Stat
G.stat
```

```
## [1] 6.932341
```

```
pval = 1 - pchisq(G.stat, df = (6 - 4) * (3 - 1))
pval
```

```
## [1] 0.1395072
```

The p-value is 0.14, so we do not reject the null, indicating the fit is acceptable.

```
tidy.err = summary(hagen.multi)$standard.error %>%
  broom::tidy() %>%
  mutate(value = "err")

tidy.coef = summary(hagen.multi)$coefficients %>%
  broom::tidy() %>%
  mutate(value = "coef")

tidy.multi = union(tidy.coef, tidy.err) %>%
  janitor::clean_names() %>%
  dplyr::select(-x_intercept) %>%
  pivot_longer(cols = c(conxlow, hous_tphous, hous_tptr_bk), values_to = "estimate") %>%
  pivot_wider(names_from = value, values_from = estimate)
```

```
tidy.ci = tidy.multi %>%
  group_by(rownames, name) %>%
  mutate(
    lower = (coef - qnorm(.975) * err),
    upper = (coef + qnorm(.975) * err)) %>%
  dplyr::select(rownames, name, lower, upper) %>%
  ungroup() %>%
  rename(sat = rownames, par = name)

tidy.ci %>%
  knitr::kable(digits = 3)
```

sat	par	lower	upper
med	conxlow	-0.551	-0.041
med	hous_tphous	-0.212	0.351

sat	par	lower	upper
med	hous_tptr_bk	0.071	0.743
high	conxlow	-0.560	-0.097
high	hous_tphous	-0.569	-0.039
high	hous_tptr_bk	0.347	0.936

The odds ratio of reporting medium satisfaction compared to low satisfaction is 0.7437874, CI95%: (0.5763731, 0.9598291) for low contact compared to high contact holding house type constant.

The odds ratio of reporting medium satisfaction compared to low satisfaction is 1.0725082 CI95%: (0.8089647, 1.4204873) for people living in houses compared to those living in apartments holding contact constant.

The odds ratio of reporting medium satisfaction compared to low satisfaction is 1.5023041 CI95%: (1.0735812, 2.1022328) for people living in tower blocks compared to those living in apartments holding contact constant.

The odds ratio of reporting high satisfaction compared to low satisfaction is 0.720363 CI95%: (0.5712091, 0.907556) for people who reported low contact compared to those who reported high contact holding housing type constant.

The odds ratio of reporting high satisfaction compared to low satisfaction is 0.7378609 CI95%: (0.5660912, 0.9617507) for people who live in houses compared to those who live in apartments holding contact constant.

The odds ratio of reporting high satisfaction compared to low satisfaction is 1.9002776 CI95%: (1.4148167, 2.5497619) for people who live in tower blocks compared to those who live in apartments holding contact constant.

Part iii

```
# proportional odds model
freq = df_sum %>%
  pivot_longer(cols = c(low, med, high), names_to = "sat")

df_ord = df_tidy_tbl %>%
  left_join(freq, by = c("sat", "conx", "hous_tp")) %>%
  mutate(sat = factor(sat,
                      levels = c("low", "med", "high"),
                      ordered = TRUE))

# fit proportional odds model
df_polr = polr(sat ~ conx + hous_tp, data = df_ord, weights = value)

summary(df_polr)
```

```
##
## Re-fitting to get Hessian

## Call:
## polr(formula = sat ~ conx + hous_tp, data = df_ord, weights = value)
##
## Coefficients:
##                Value Std. Error t value
## conxlow      -0.2524    0.09306  -2.713
```

```
## hous_tphous  -0.2353    0.10521  -2.236
## hous_tptr_bk  0.5010    0.11675   4.291
##
## Intercepts:
##          Value   Std. Error t value
## low|med  -0.7488  0.0818    -9.1570
## med|high  0.3637  0.0801     4.5393
##
## Residual Deviance: 3610.286
## AIC: 3620.286
```

The change in log odds of falling into a lower satisfaction category associated with low contact is -0.252 compared to high contact holding housing type constant.

The change in log odds of falling into a lower satisfaction category associated with living in a house is -0.235 compared to those living in apartments holding level of contact constant.

The change in log odds of falling into a lower satisfaction category associated with living in a tower block is 0.501 compared to those living in apartments holding level of contact constant.

Part iv

```
# Pearson residuals for proportional odds model

pihat = predict(df_polr, df_sum, type = 'p')
m = df_sum %>%
  group_by(conx, hous_tp) %>%
  mutate(total = sum(low, med, high)) %>%
  ungroup() %>%
  dplyr::select(total) %>%
  simplify()
res.pearson = (df_sum[,3:5] - pihat * m) / sqrt(pihat * m)
G = sum(res.pearson^2)
G
```

```
## [1] 11.64205
```

```
numsamp = (3 - 1) * 6 # degree of freedom for grouped data
numparam = 2 + 3 # total num of param
pval = 1 - pchisq(G, df = numsamp - numparam)
pval
```

```
## [1] 0.112962
```

The p-value is 0.113 (>0.05), indicating that the model is a good fit.

```
## find the discrepancies

bind_cols(df_sum, res.pearson) %>%
  dplyr::select(conx, hous_tp, low1:high1)
```

```
## # A tibble: 6 x 5
##   conx  hous_tp   low1   med1   high1
##   <chr> <chr>    <dbl>  <dbl>   <dbl>
## 1 low   tr_bk    0.779 -0.370 -0.315
## 2 high  tr_bk   -0.995  0.455  0.335
## 3 low   apt      0.918 -1.07  -0.0152
## 4 high  apt     -0.237 -0.405  0.538
## 5 low   hous    -1.14   0.140  1.24
## 6 high  hous     0.274  1.37  -1.48
```

It appears that much of the discrepancy between the observed and expected models are in the low contact group and the group living in houses. However, there is also a high residual in the group with high contact living in the tower blocks.