census project

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data

- Census survey
- 40 demographic features

objectives

- Predict income: more or less than $50k
- Customer segmentation

raw data

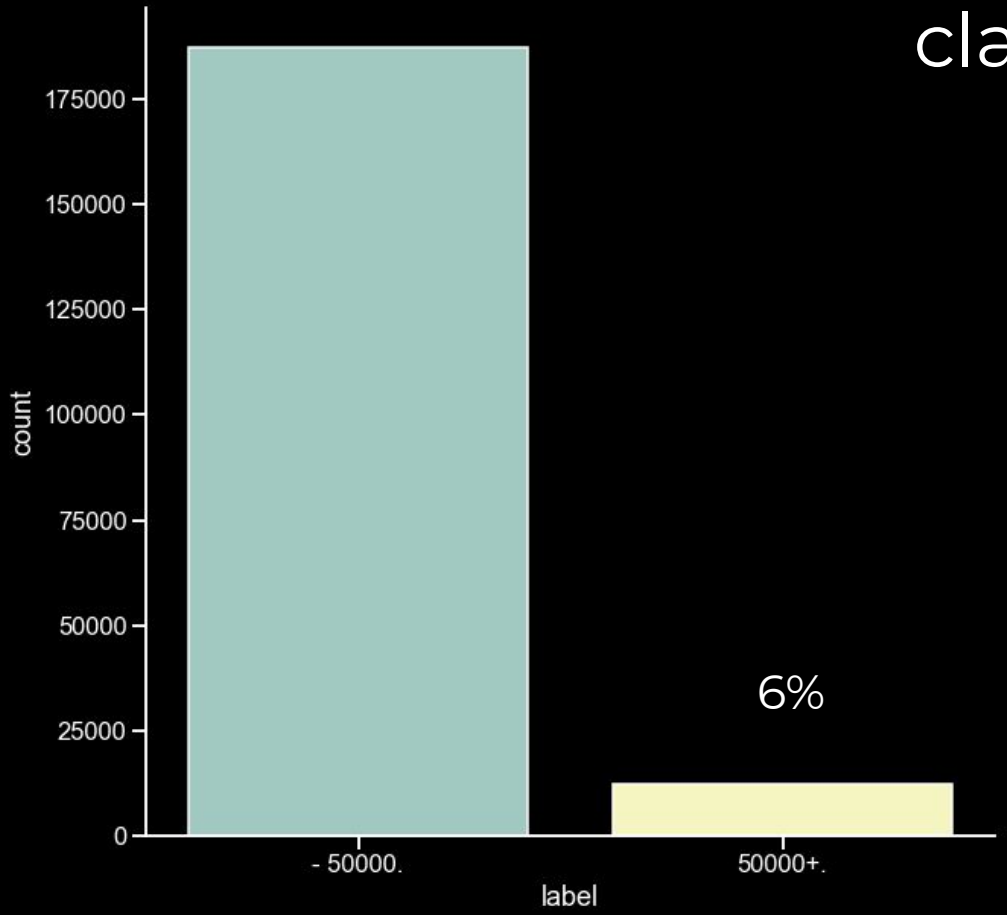
- 200k samples
- 40+2 features
    - numerical and categorical

Two are special:

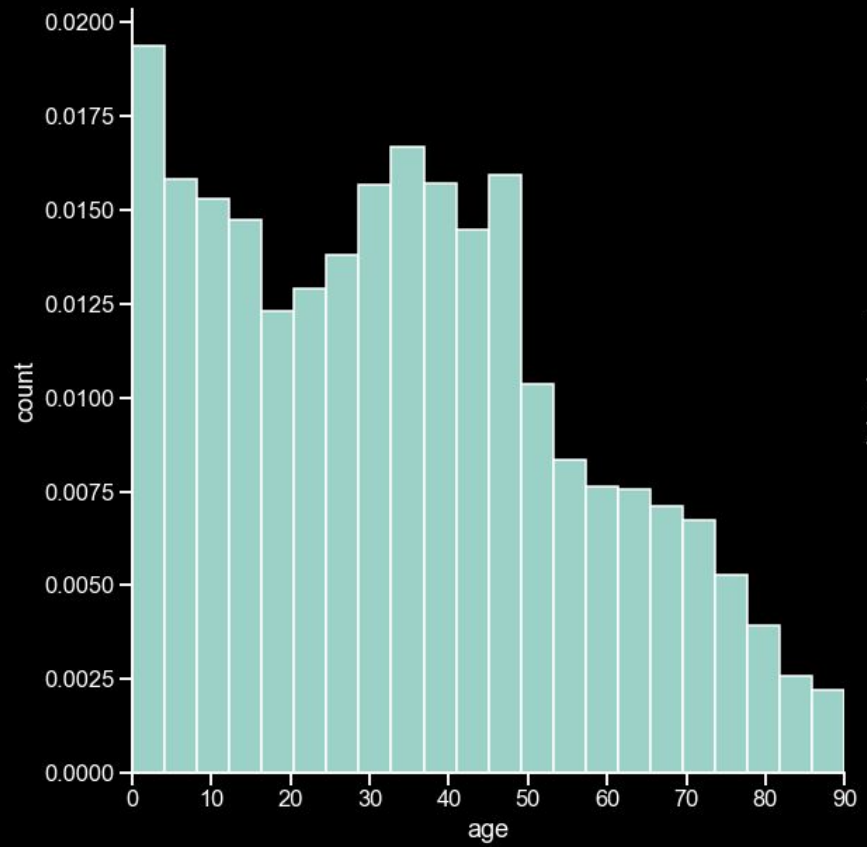
- 'label'
- 'instance weight'

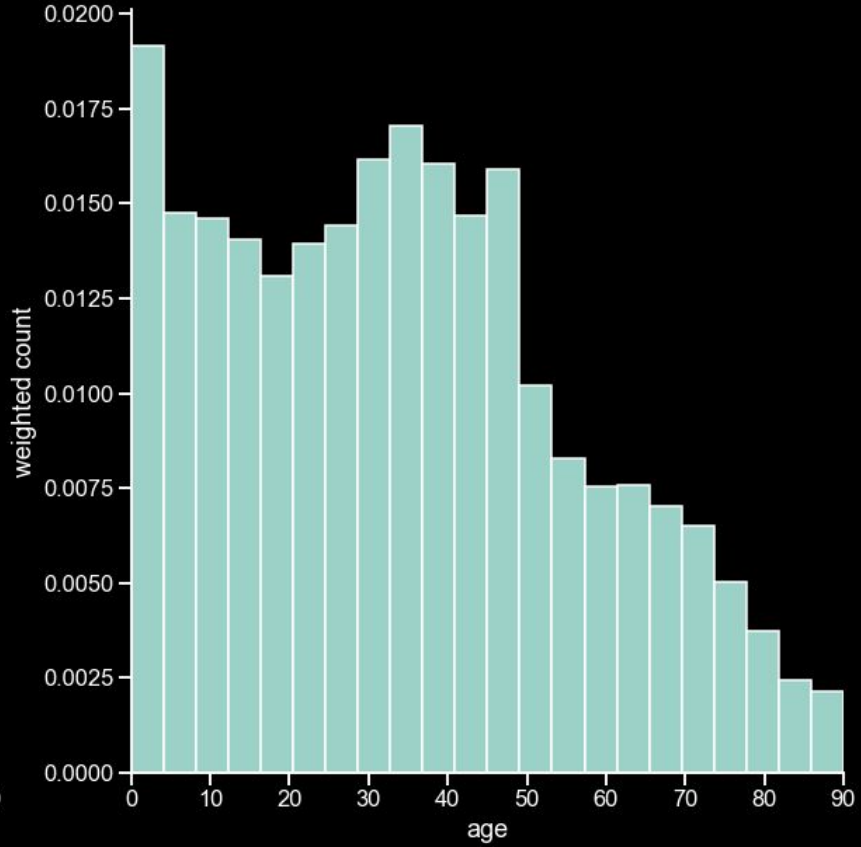
```
age                                          int64
class of worker                             object
detailed industry recode                     int64
detailed occupation recode                   int64
education                                   object
wage per hour                                int64
enroll in edu inst last wk                  object
marital stat                                object
major industry code                         object
major occupation code                       object
race                                        object
hispanic origin                             object
sex                                         object
member of a labor union                     object
reason for unemployment                     object
full or part time employment stat           object
capital gains                                int64
capital losses                               int64
dividends from stocks                        int64
tax filer stat                              object
region of previous residence                object
state of previous residence                 object
detailed household and family stat          object
detailed household summary in household     object
instance weight                            float64
migration code-change in msa                object
migration code-change in reg                object
migration code-move within reg              object
live in this house 1 year ago               object
migration prev res in sunbelt               object
num persons worked for employer              int64
family members under 18                     object
country of birth father                     object
country of birth mother                     object
country of birth self                       object
citizenship                                 object
own business or self employed                int64
fill inc questionnaire for veteran's admin  object
veterans benefits                            int64
weeks worked in year                         int64
year                                         int64
label                                       object
dtype: object
```

class imbalance

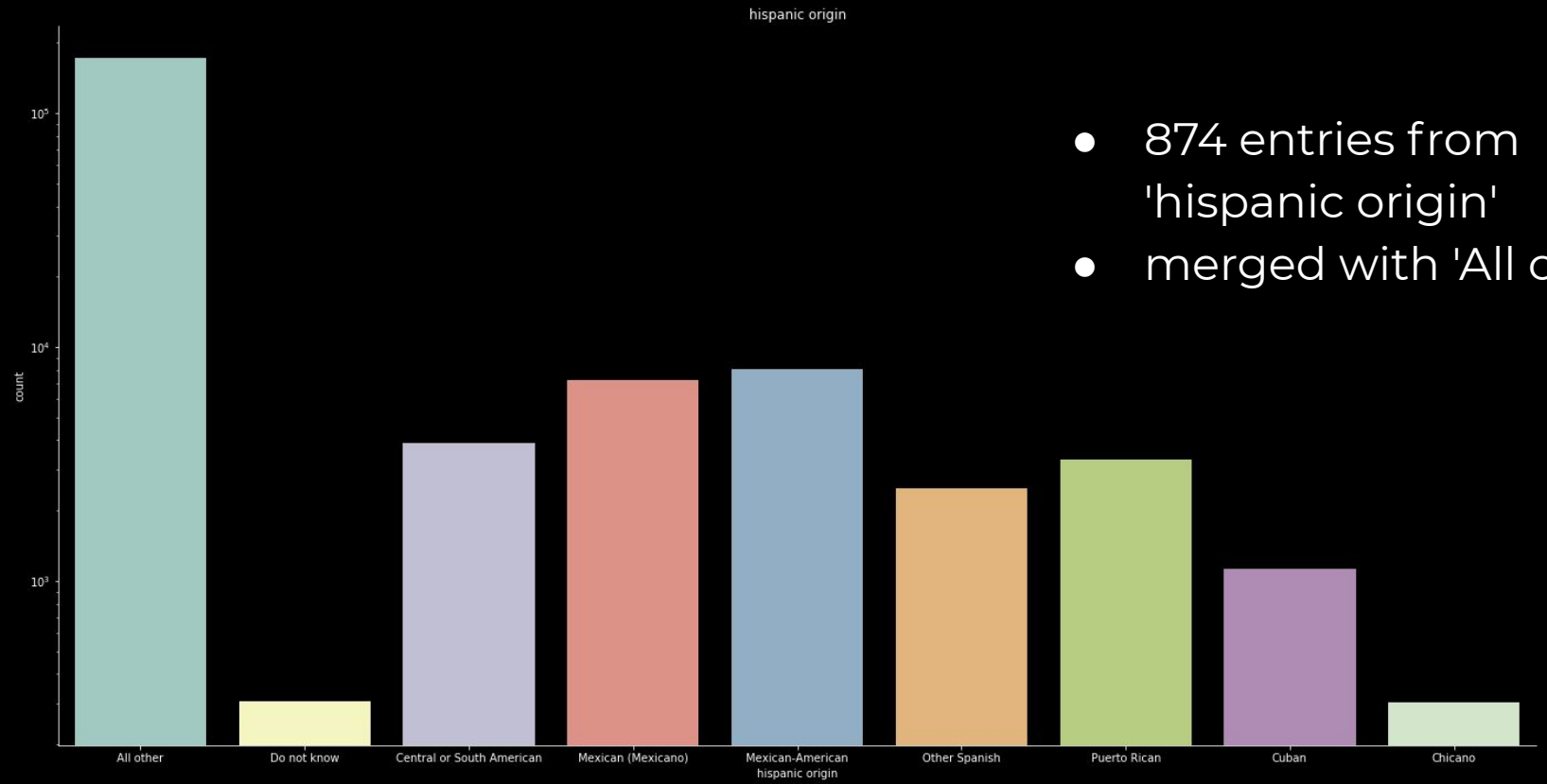


instance weight (sanity check)



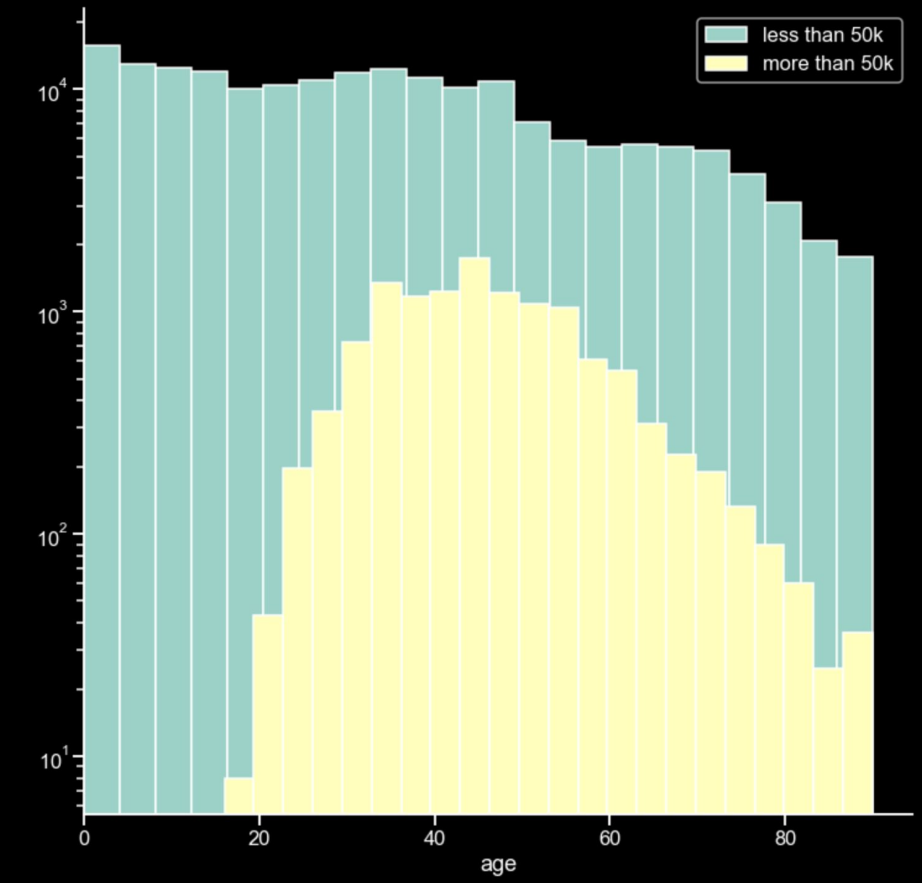


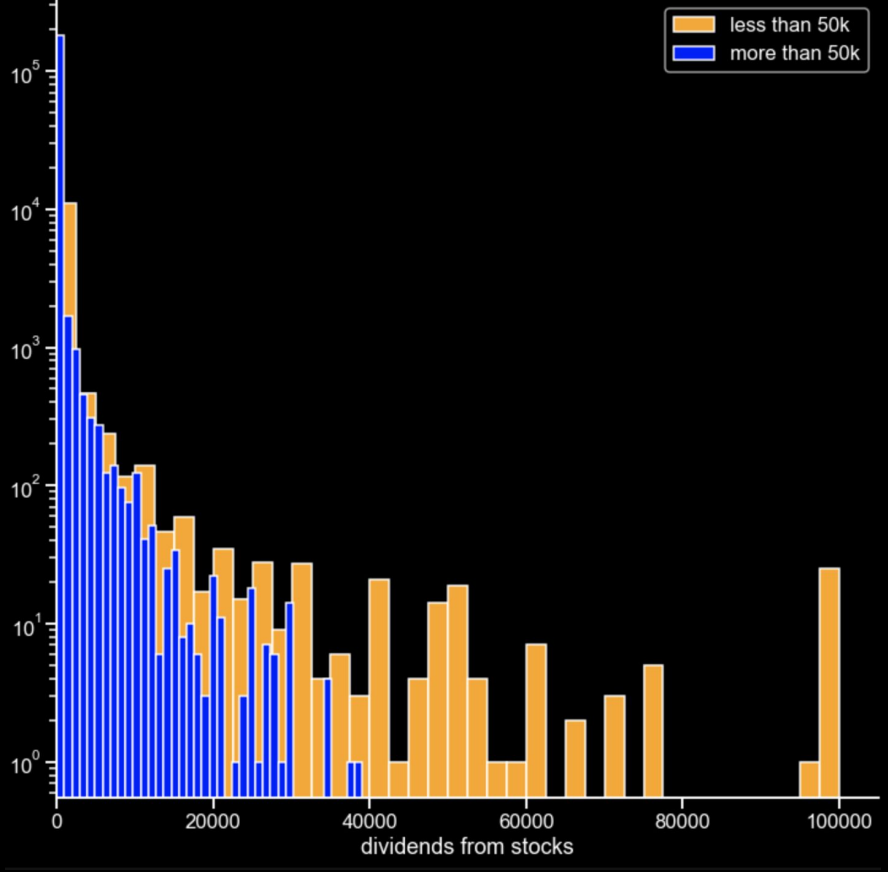
missing values



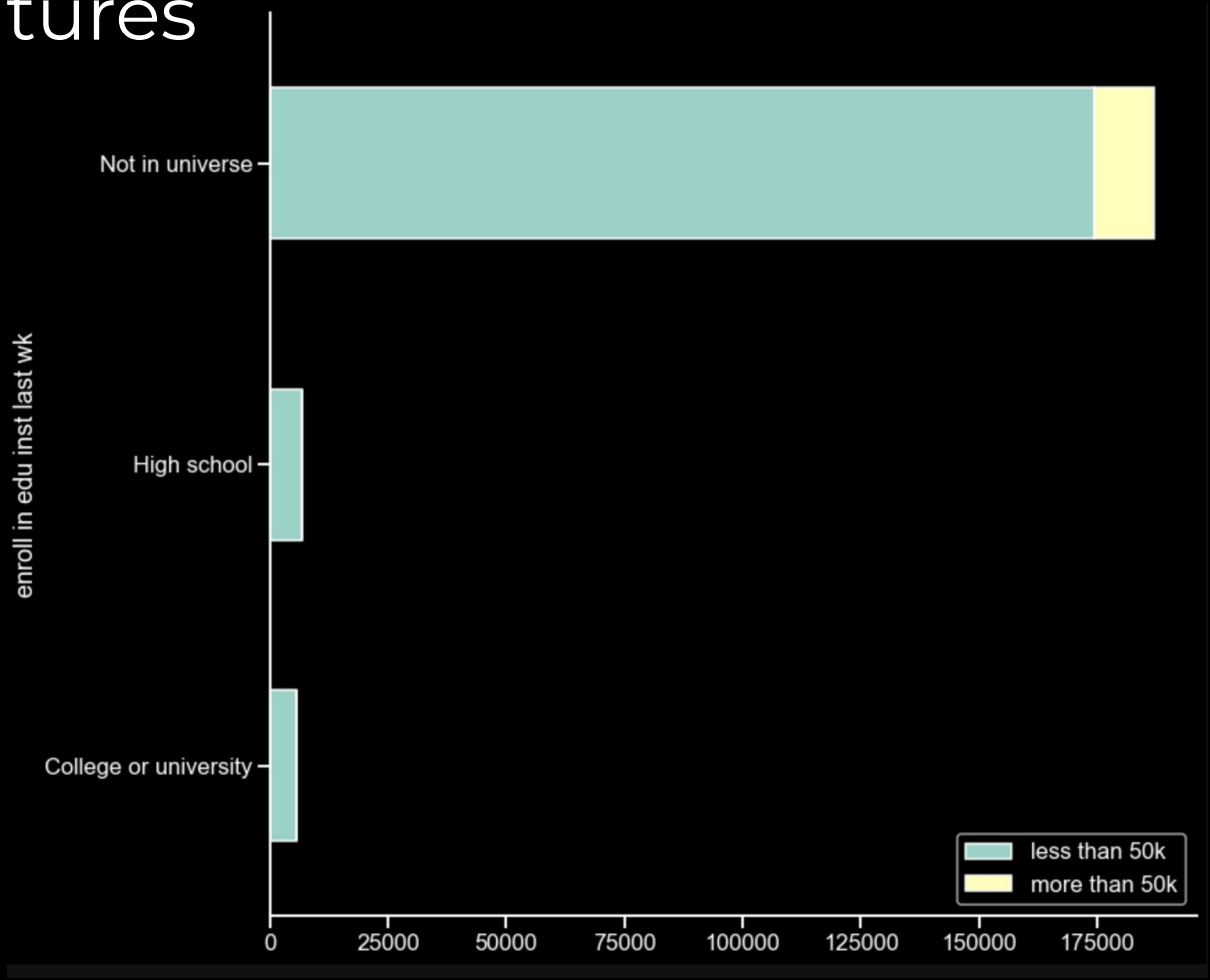
- 874 entries from 'hispanic origin'
- merged with 'All other'

numerical features



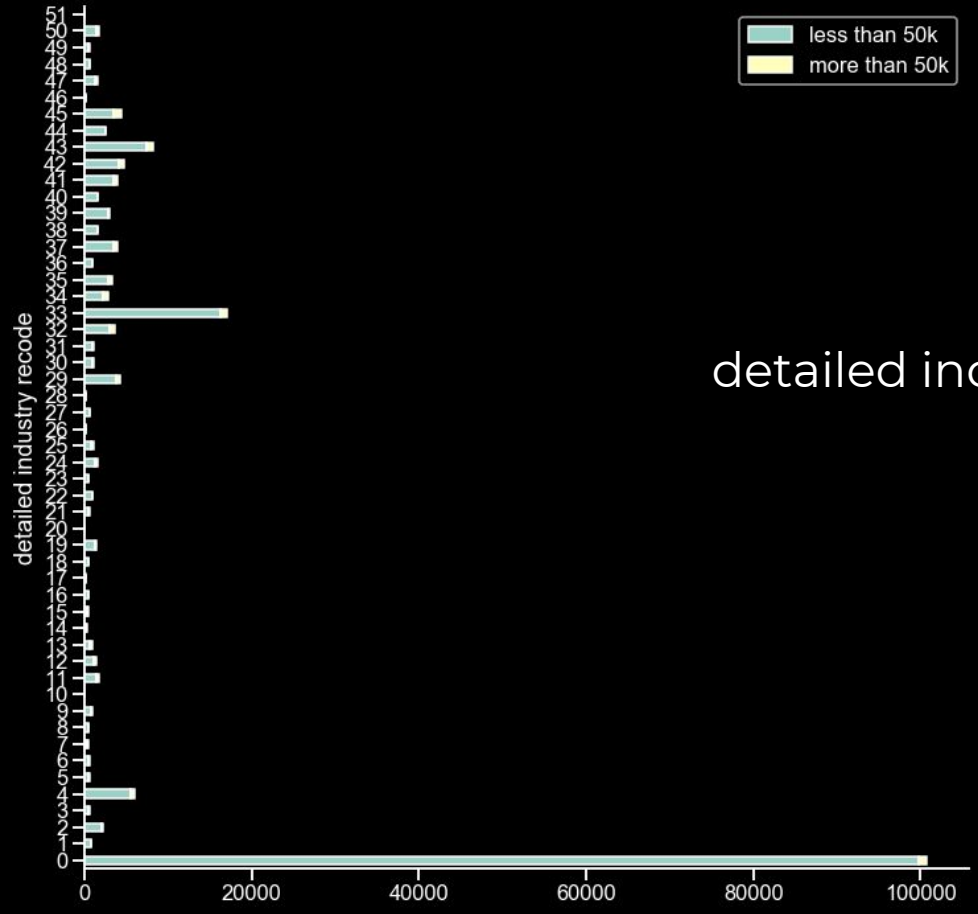


categorical features

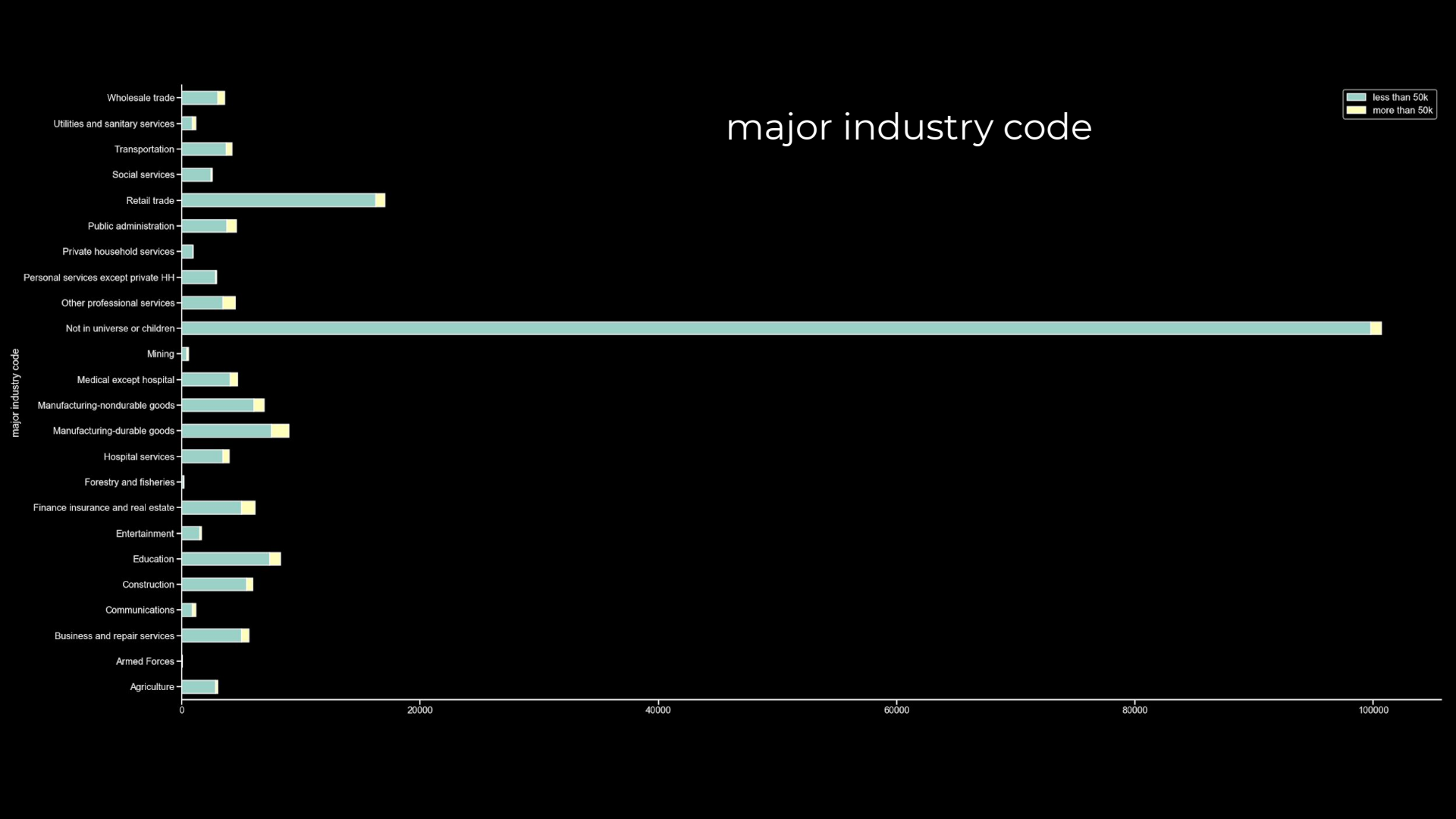


cleaning

- 1/0 encoding of binary features (e.g. label, sex, year)
- one-hot encoding of categorical features
- drop duplicate features (high linear correlation)



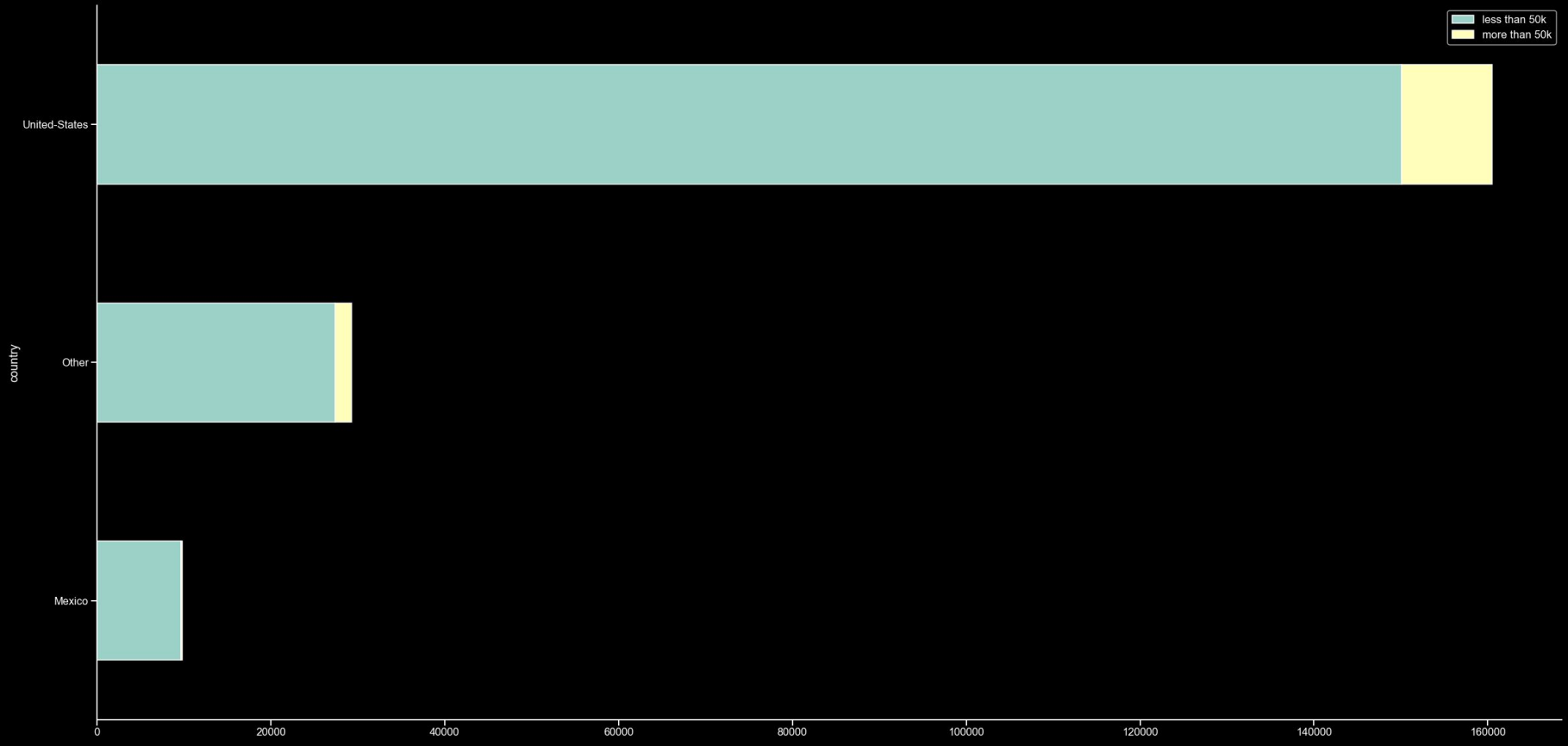
detailed industry recode


major industry code
less than 50k
more than 50k
major industry code
Wholesale trade
Utilities and sanitary services
Transportation
Social services
Retail trade
Public administration
Private household services
Personal services except private HH
Other professional services
Not in universe or children
Mining
Medical except hospital
Manufacturing-nondurable goods
Manufacturing-durable goods
Hospital services
Forestry and fisheries
Finance insurance and real estate
Entertainment
Education
Construction
Communications
Business and repair services
Armed Forces
Agriculture
0
20000
40000
60000
80000
100000

more cleaning

country of birth

more cleaning



cleaned data

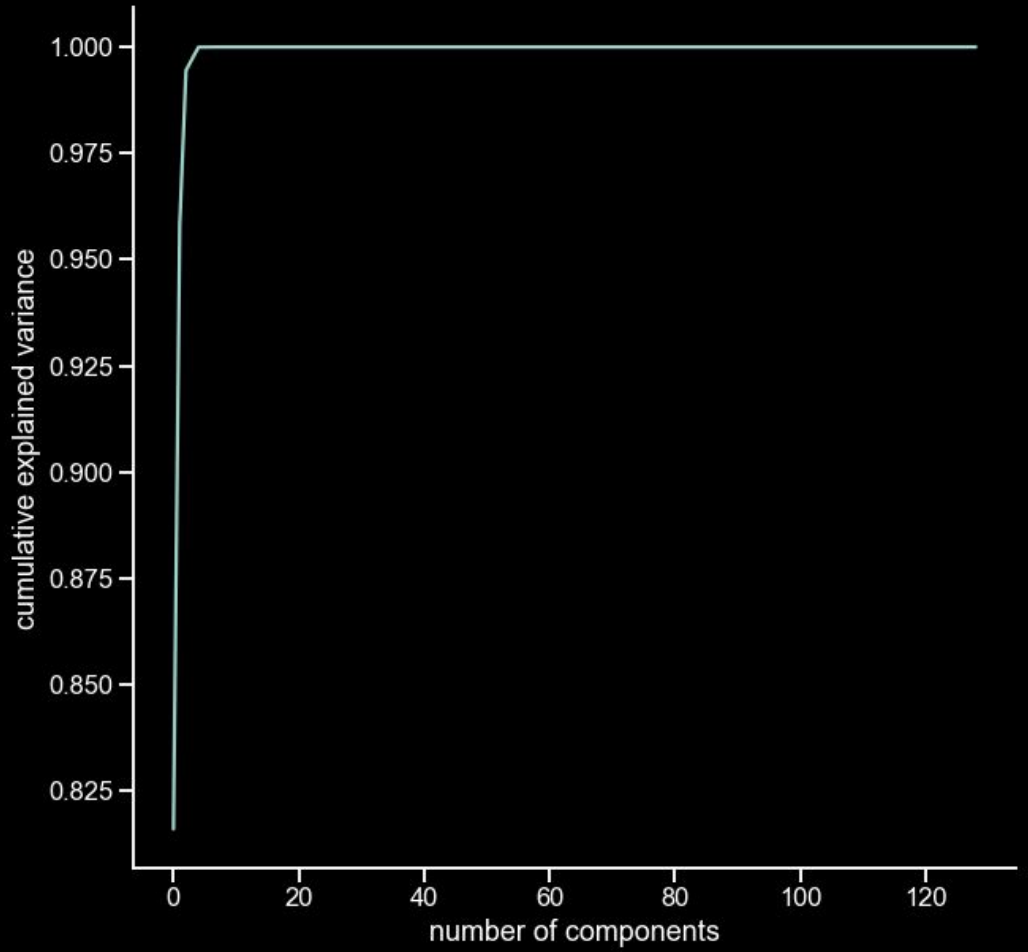
- 26+2 features (before one-hot encoding)

```
age                                        int64
class of worker                           object
education                                 object
wage per hour                              int64
enroll in edu inst last wk                object
marital stat                              object
major occupation code                     object
race                                      object
hispanic origin                           object
member of a labor union                   object
reason for unemployment                   object
full or part time employment stat         object
capital gains                              int64
capital losses                             int64
dividends from stocks                      int64
tax filer stat                            object
region of previous residence              object
detailed household summary in household    object
instance weight                          float64
num persons worked for employer            int64
family members under 18                   object
own business or self employed              int64
veterans benefits                          int64
weeks worked in year                       int64
label_encoded                              int64
sex_encoded                                int64
year_encoded                               int64
country                                   object
dtype: object
```

PCA

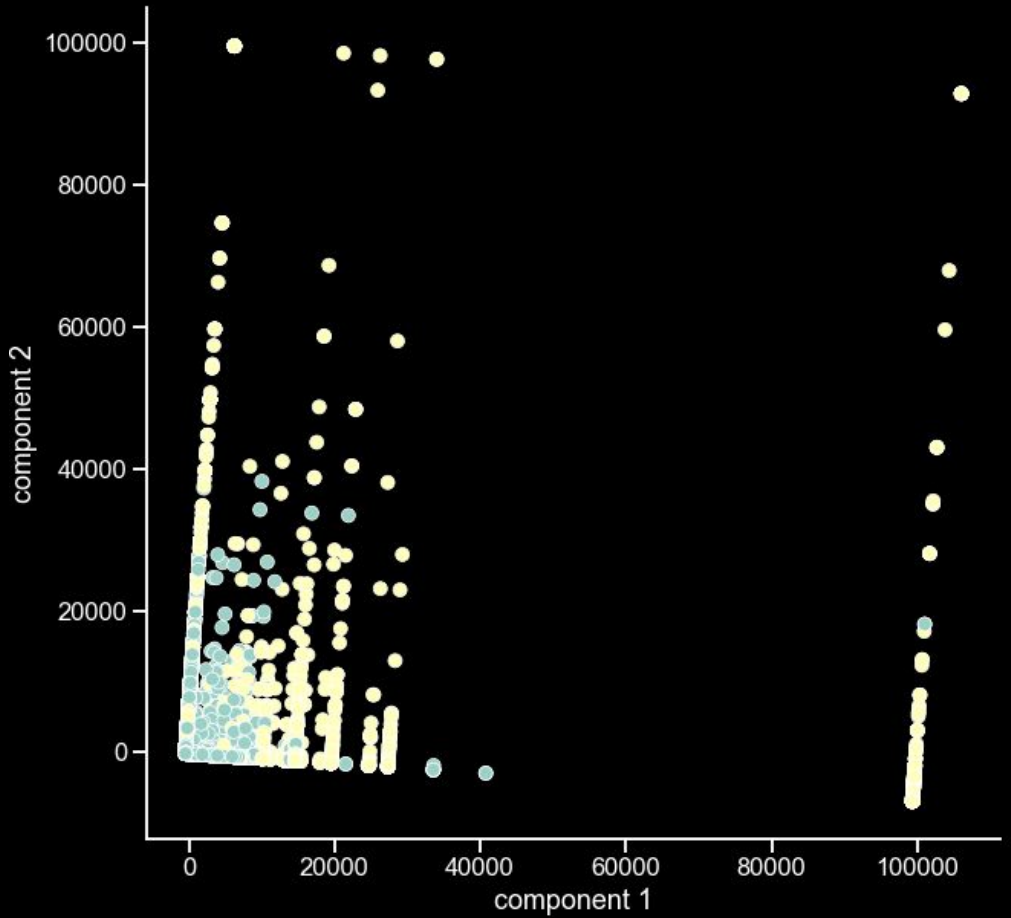
- explained variance:

  2 components overwhelm



PCA: visualized

- PCA projection onto first two components
- data squashed near origin

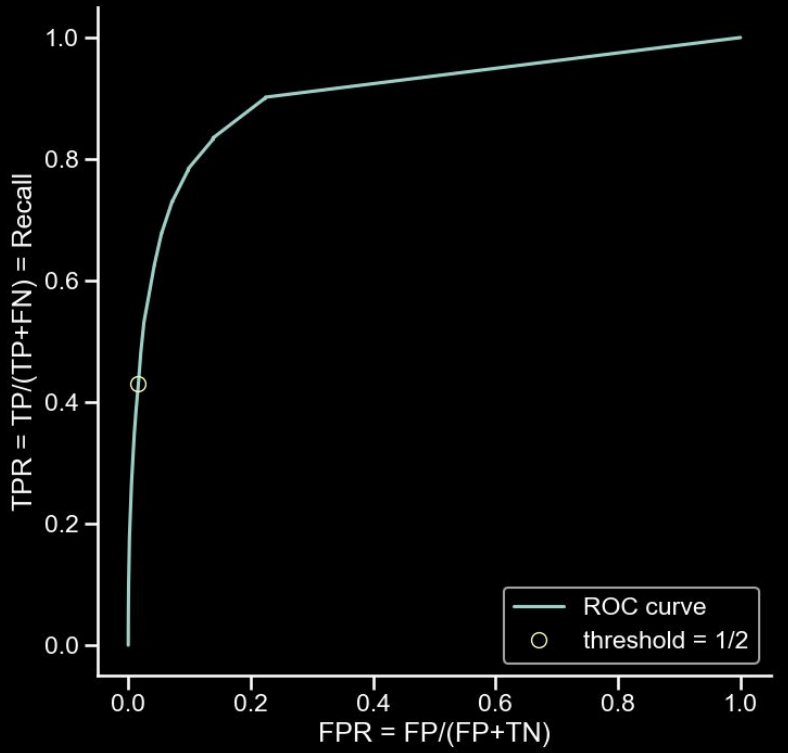


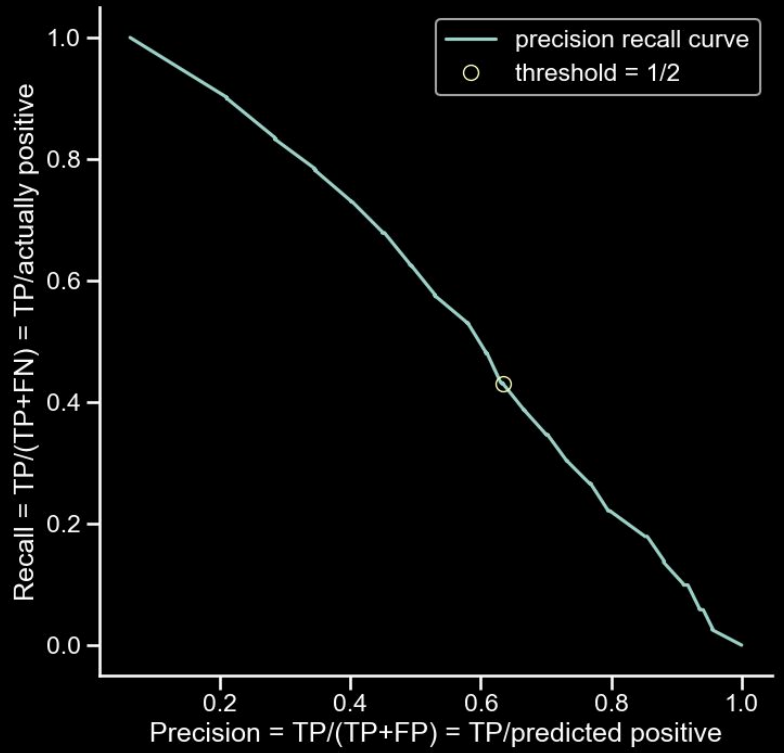
income prediction

- 80/20 train/test split
- logistic regression + L1 regularization: gridsearch+CV
- random forest

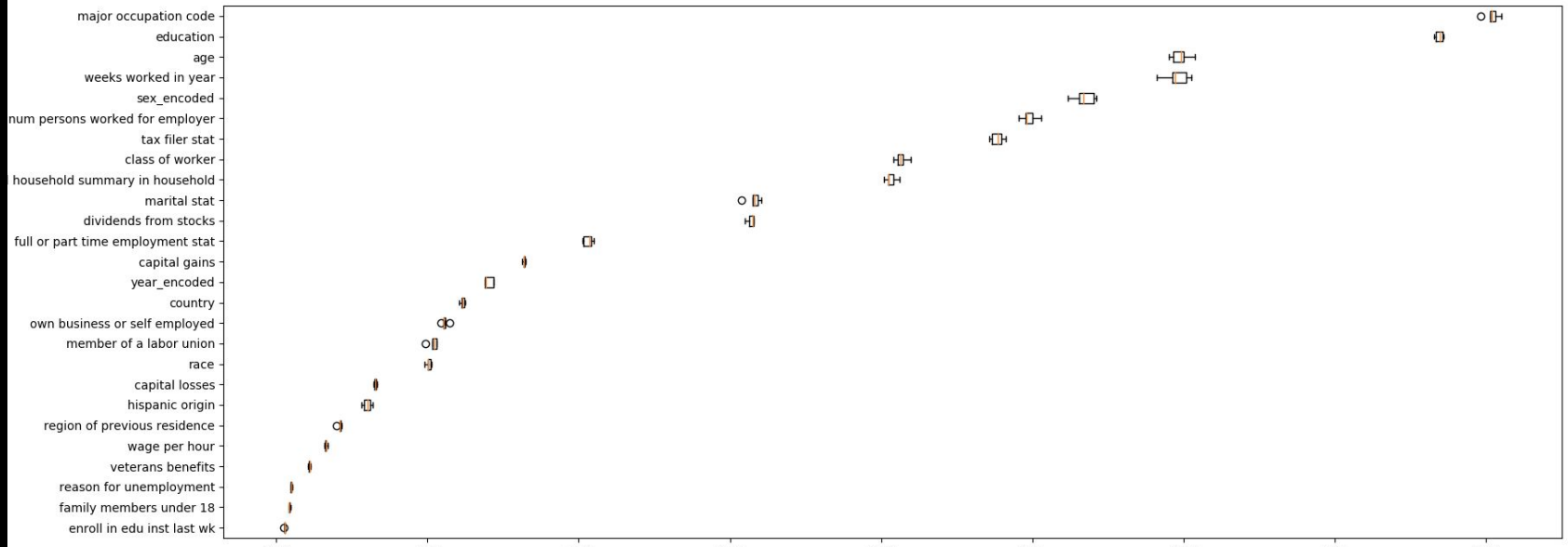
random forest performed better

roc and precision/recall

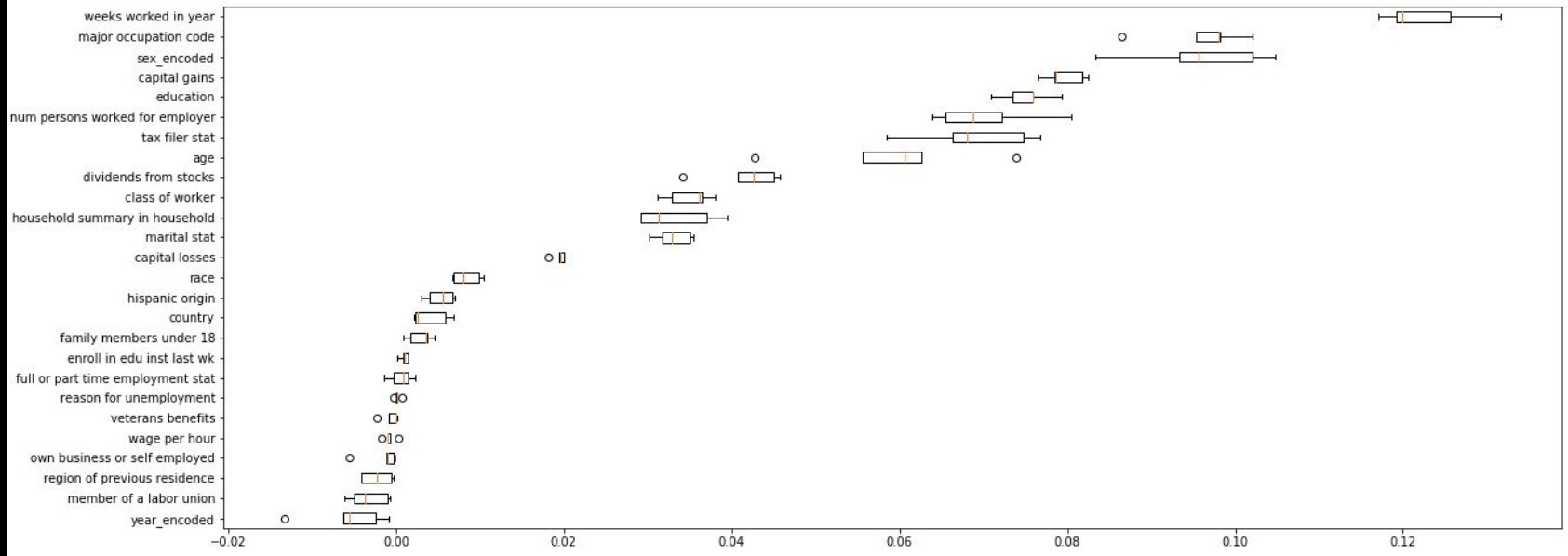




feature importance (permutation): train



feature importance (permutation): test

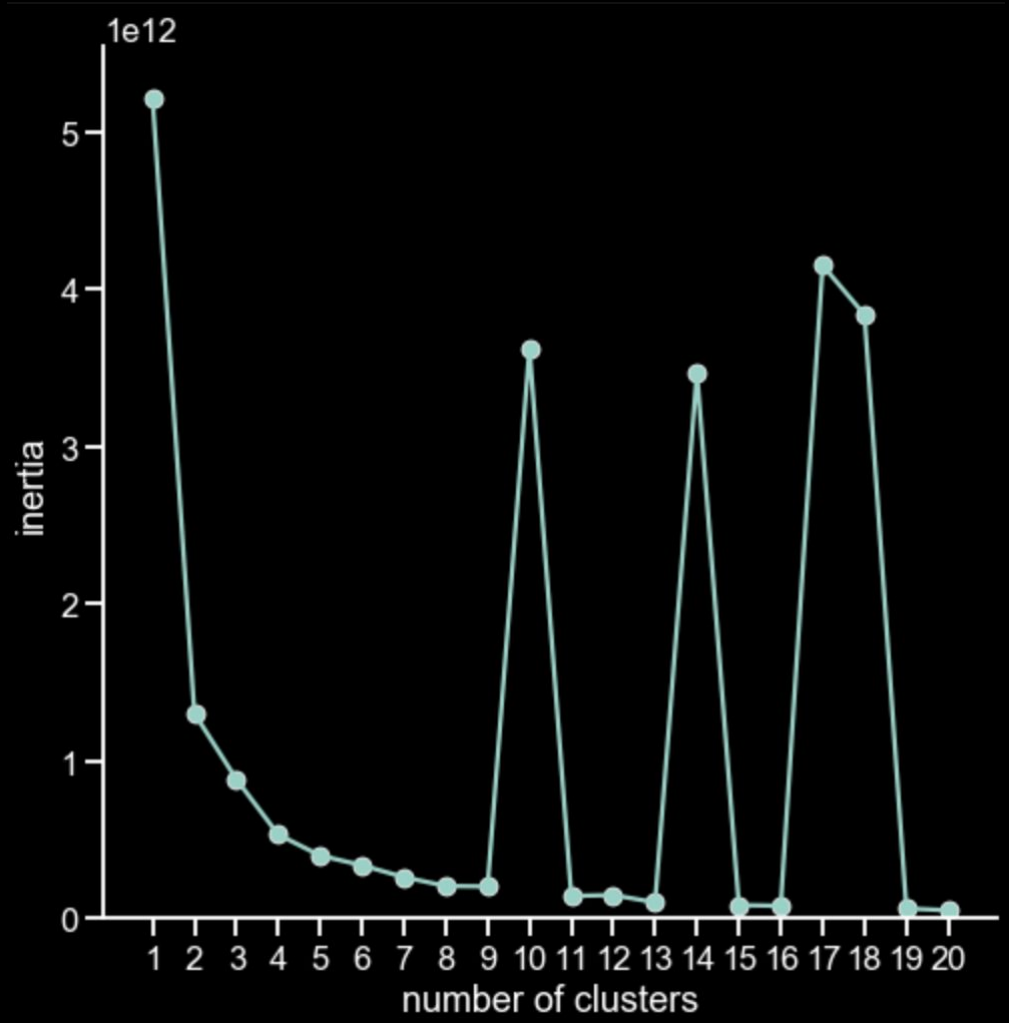


segmentation

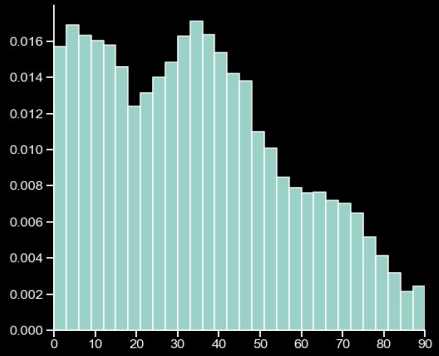
- ~~hierarchical clustering~~ (too slow)
- k-means (with mini-batches)

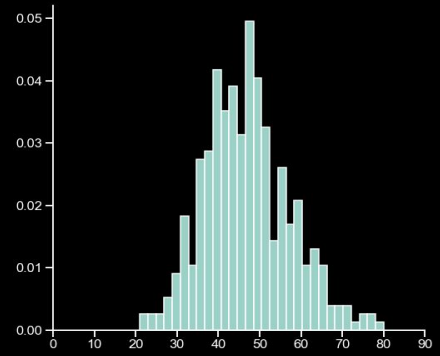
how many clusters?

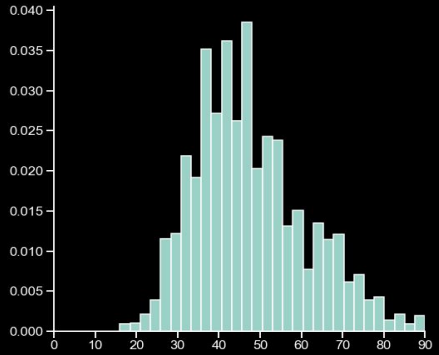
- mini-batch k-means
- batch size = 10k
  - (5% of samples)
- --> 4 clusters

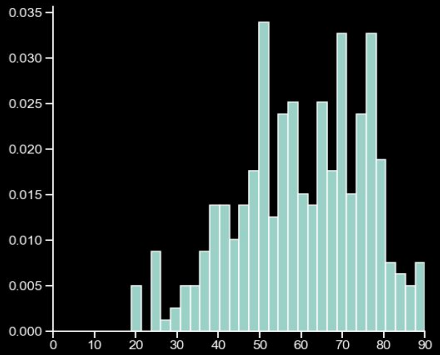


what do the clusters look like?









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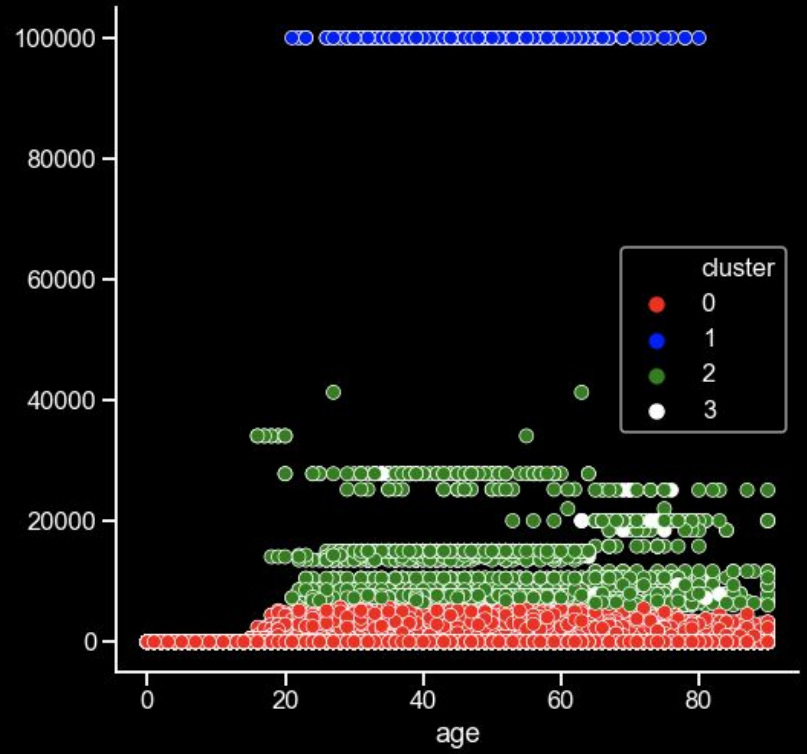

next steps

- income prediction
  - fancier tree model / neural network
  - improve feature selection
- segmentation
  - different clustering method
  - with clear goal: rules + clustering

thanks