census project

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data

- Census survey
- 40 demographic features

objectives

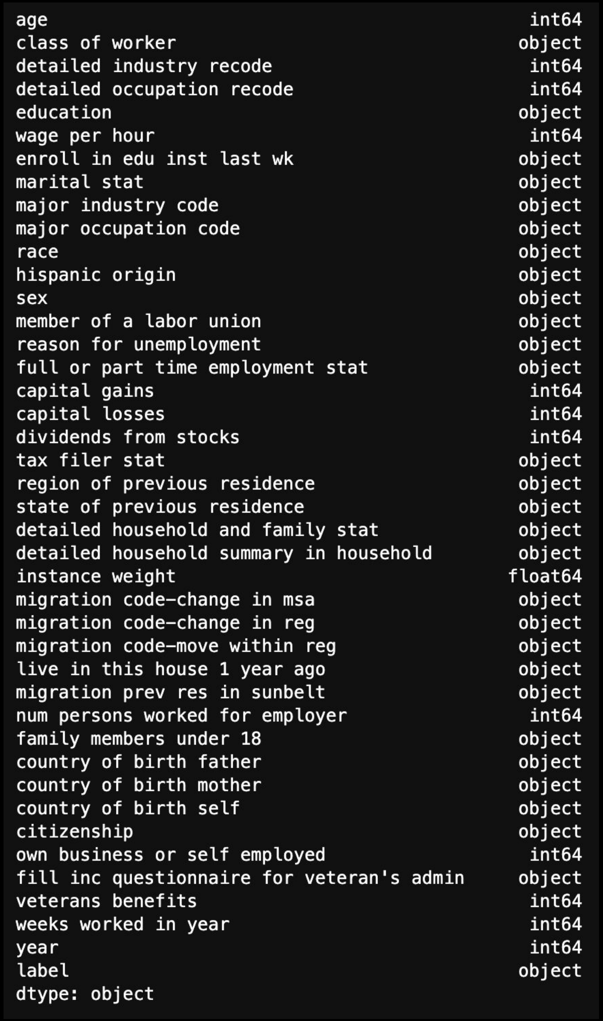
- Predict income: more or less than $50k
- Customer segmentation

raw data

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

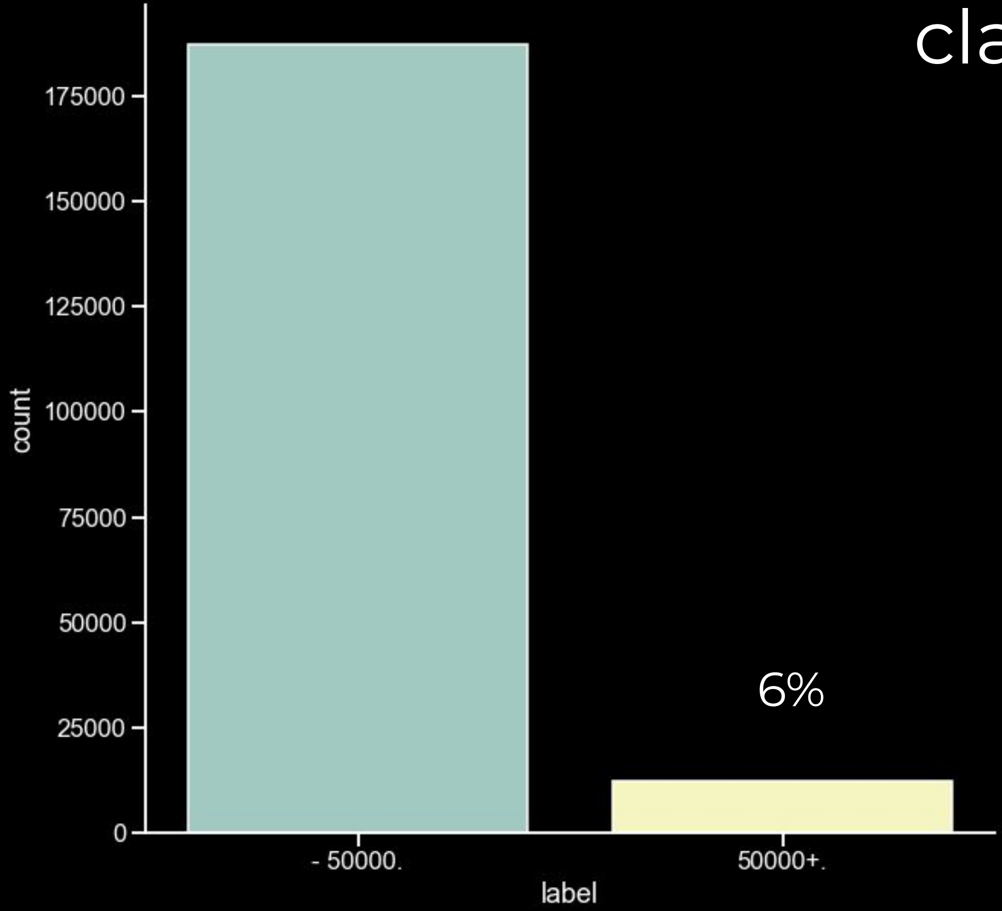
Two are special:

- 'label'
- 'instance weight'

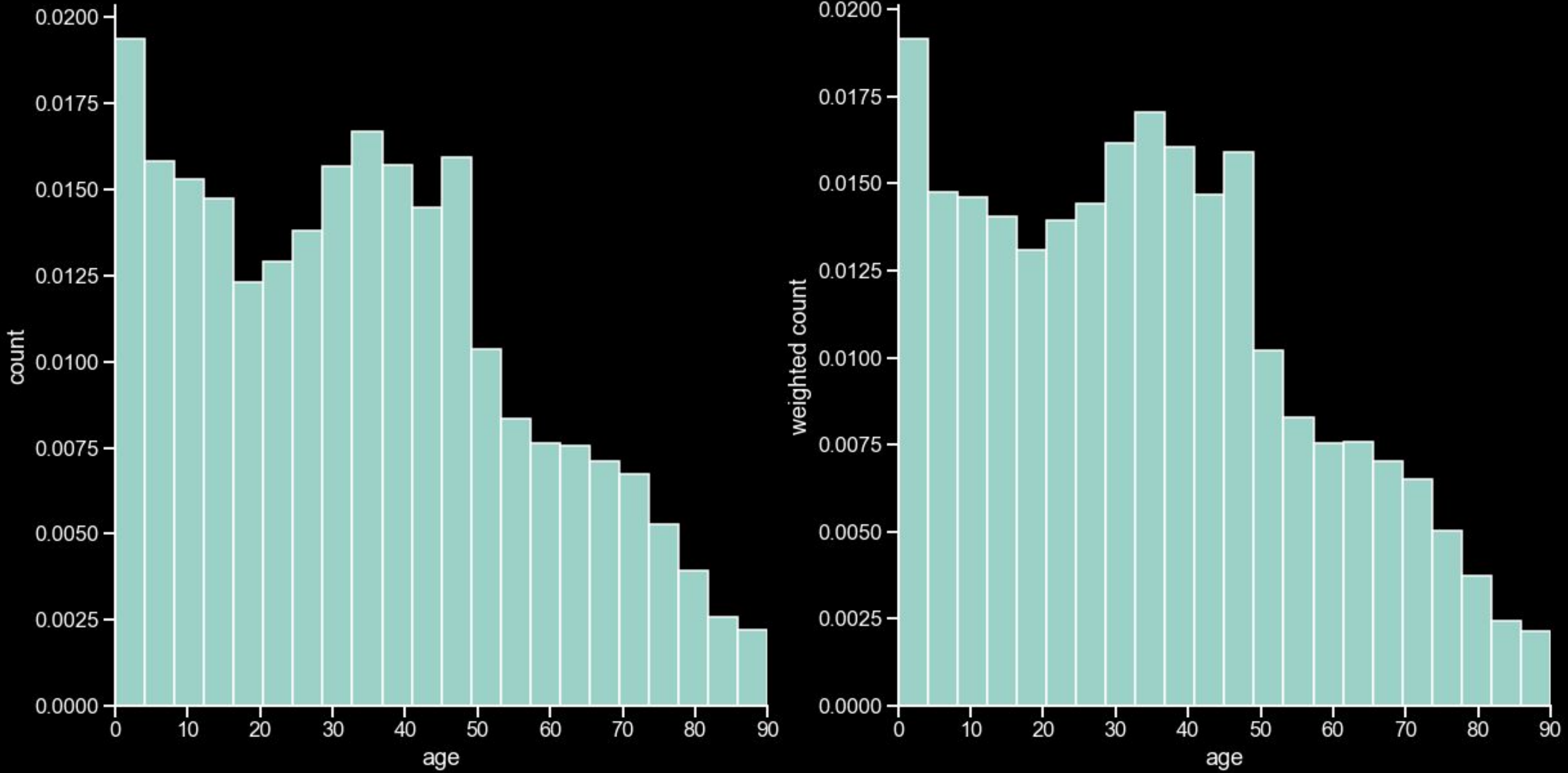


```
age                                              int64
class of worker                                 object
detailed industry recode                         int64
detailed occupation recode                       int64
education                                       object
wage per hour                                    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
```

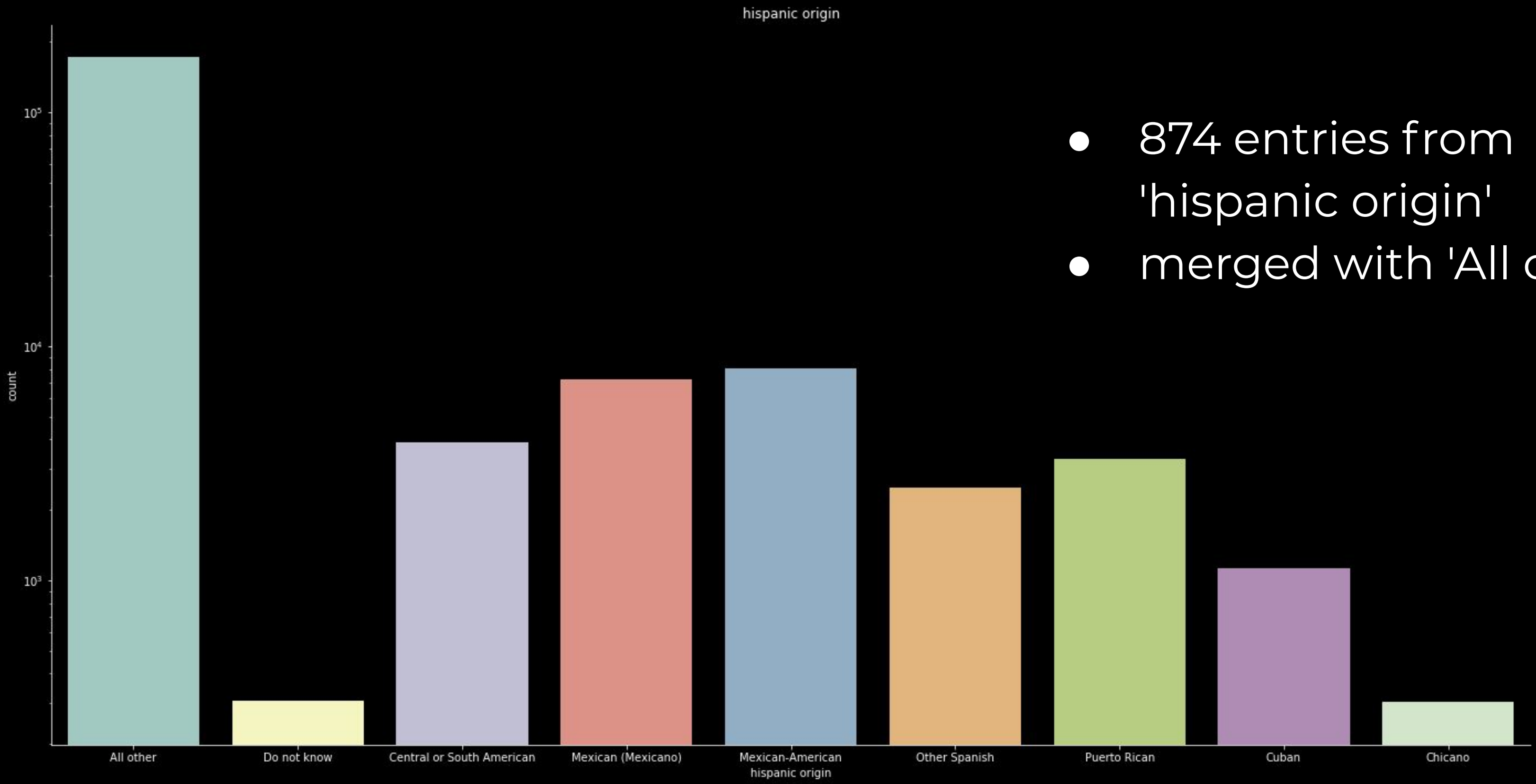
class imbalance



instance weight (sanity check)

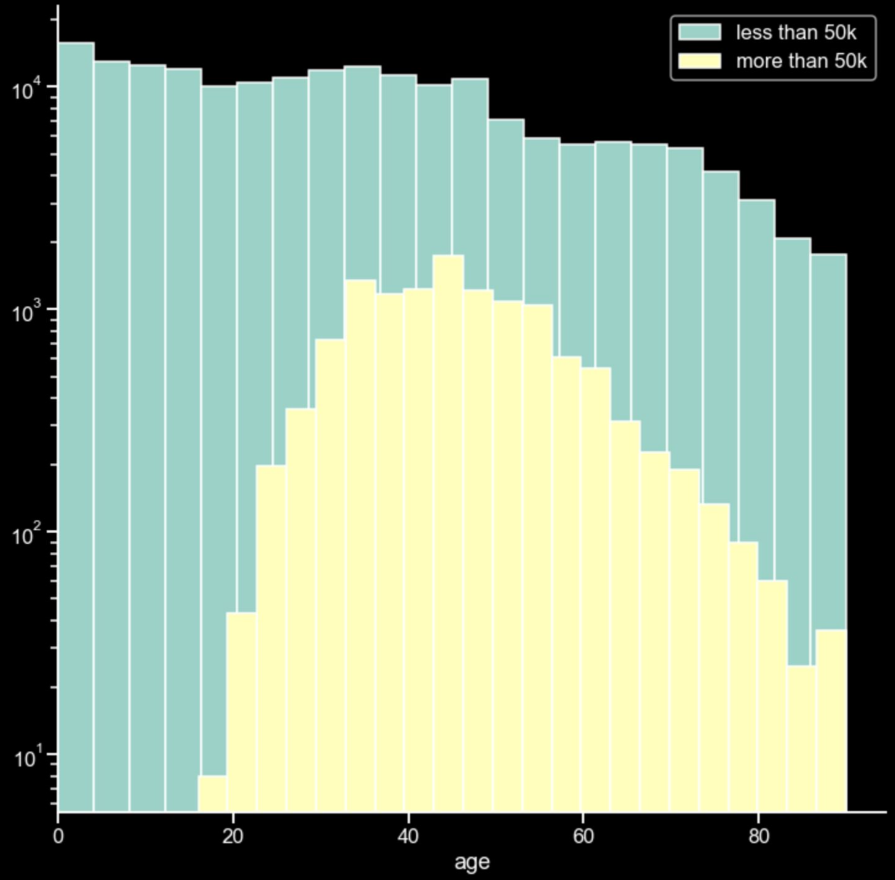


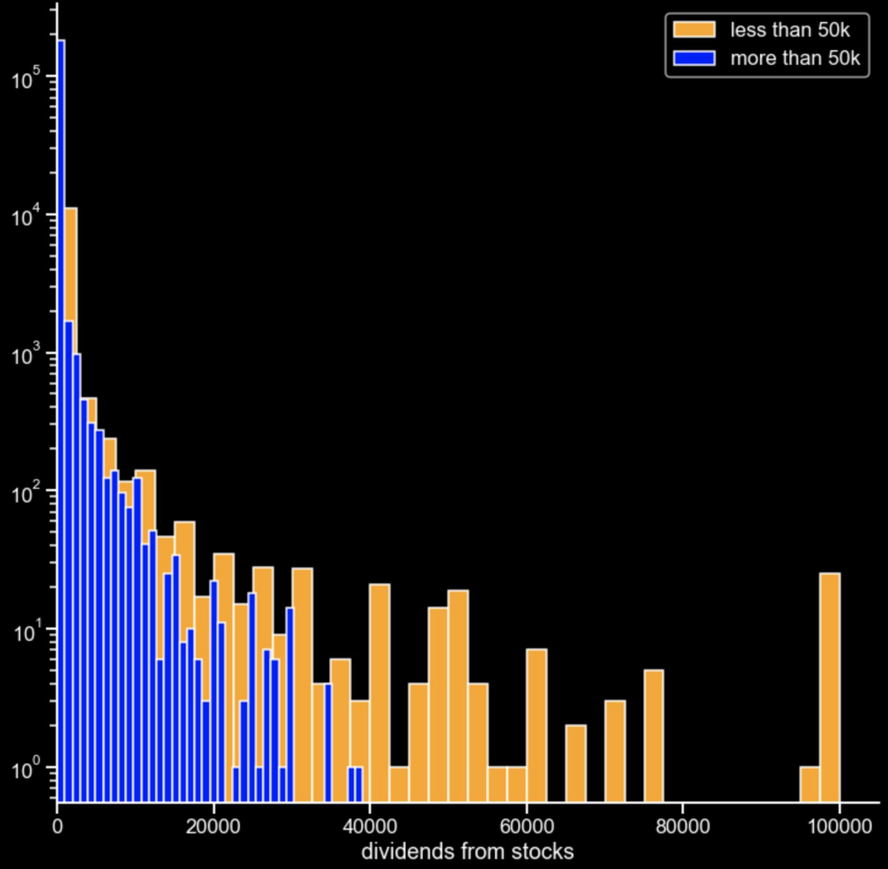
missing values



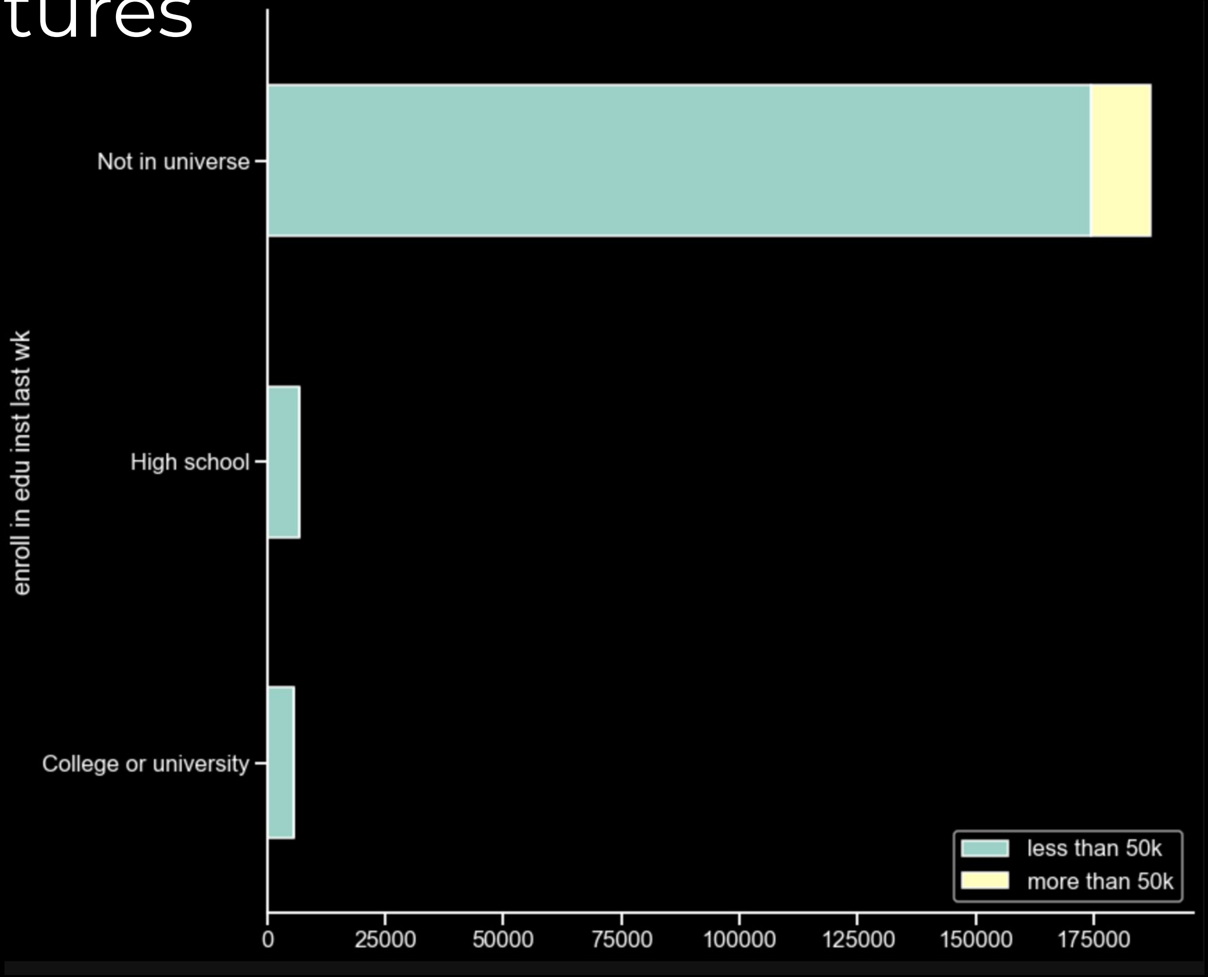
- 874 entries from 'hispanic origin'
- merged with 'All other'

numerical features



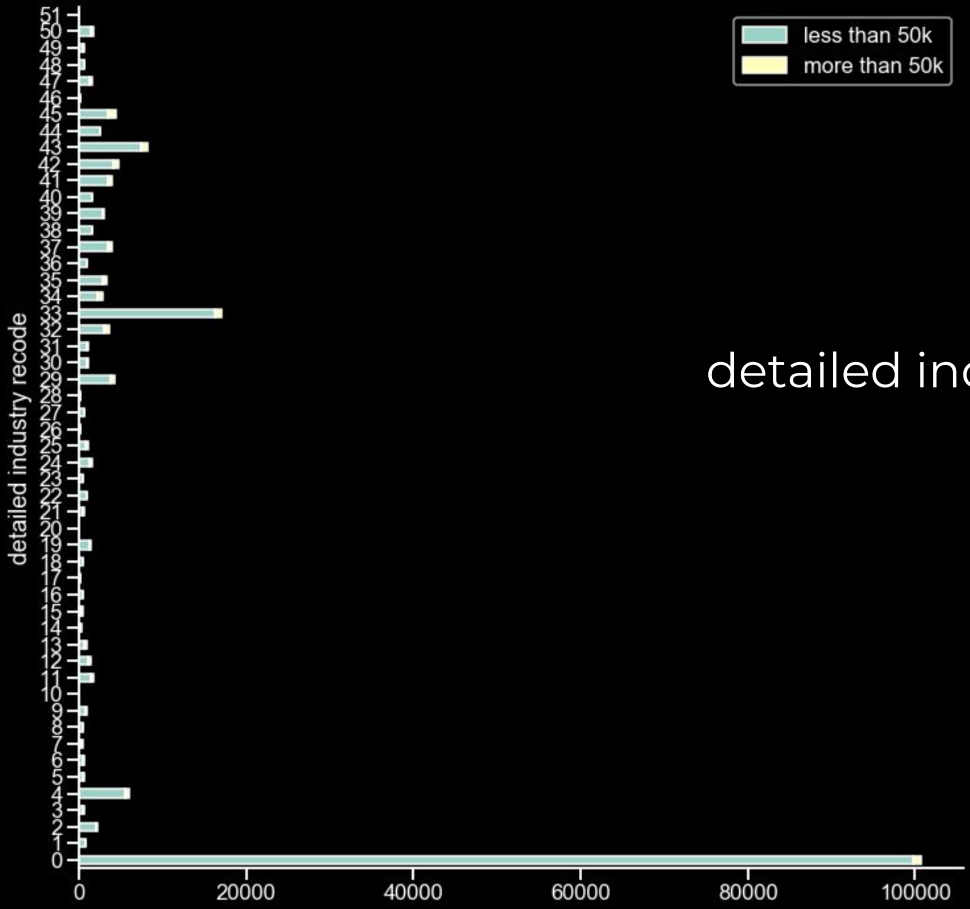


categorical features



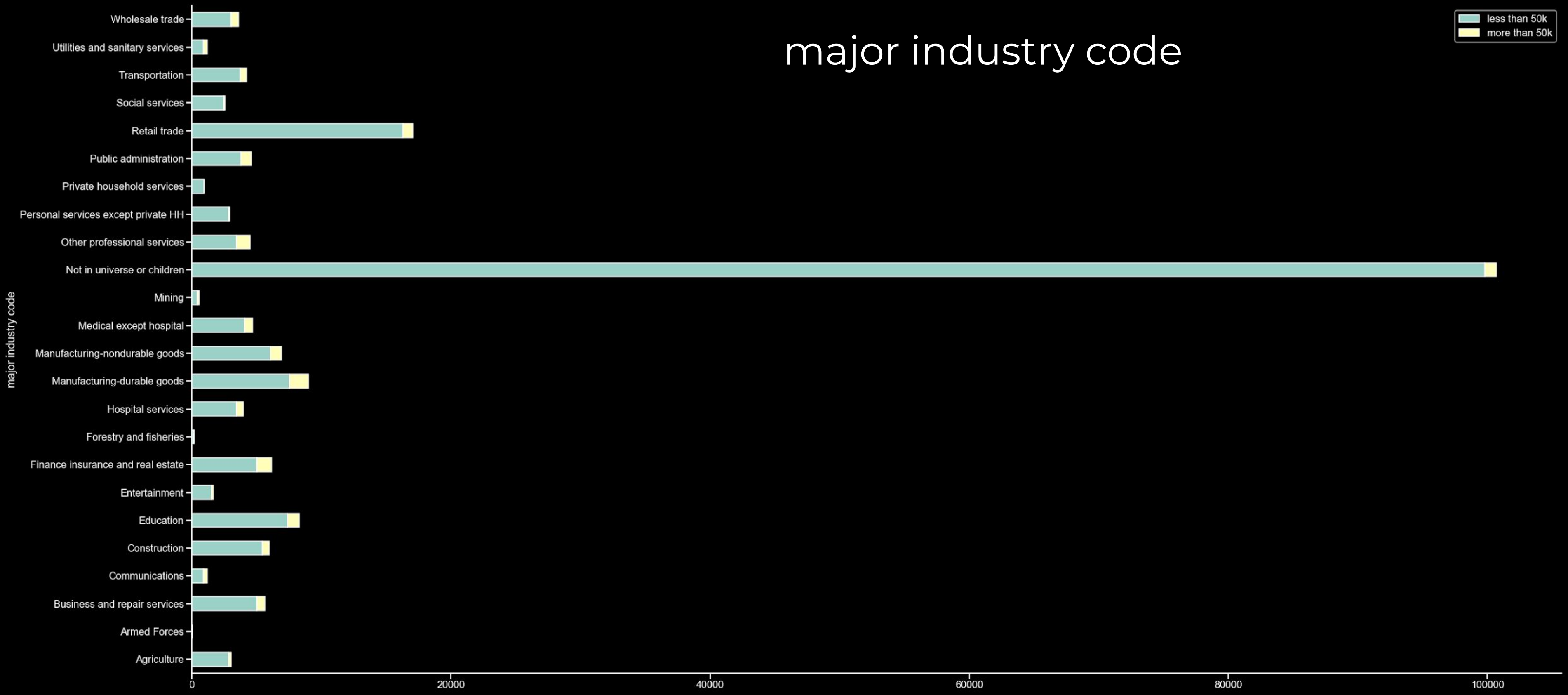
cleaning

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

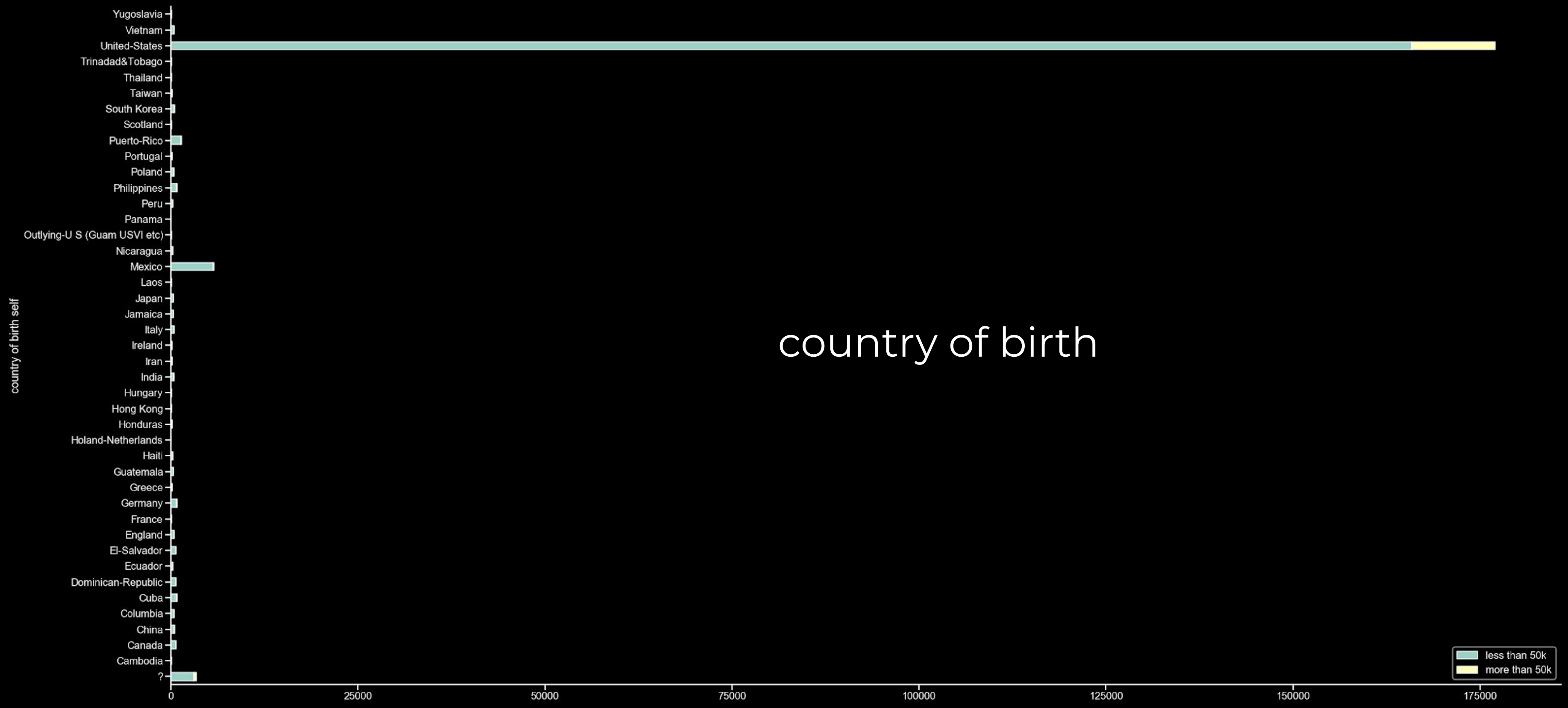


detailed industry recode

major industry code

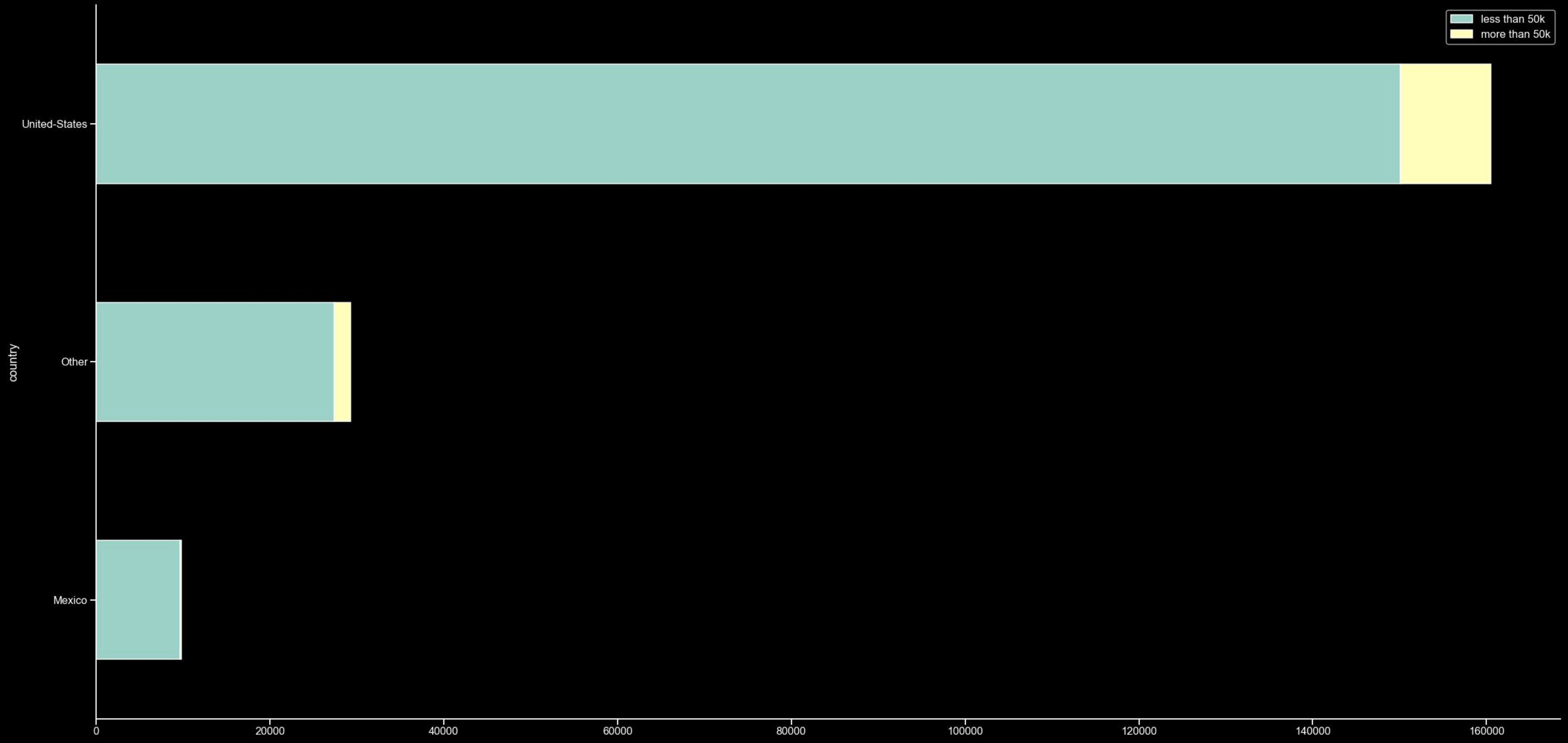


more cleaning



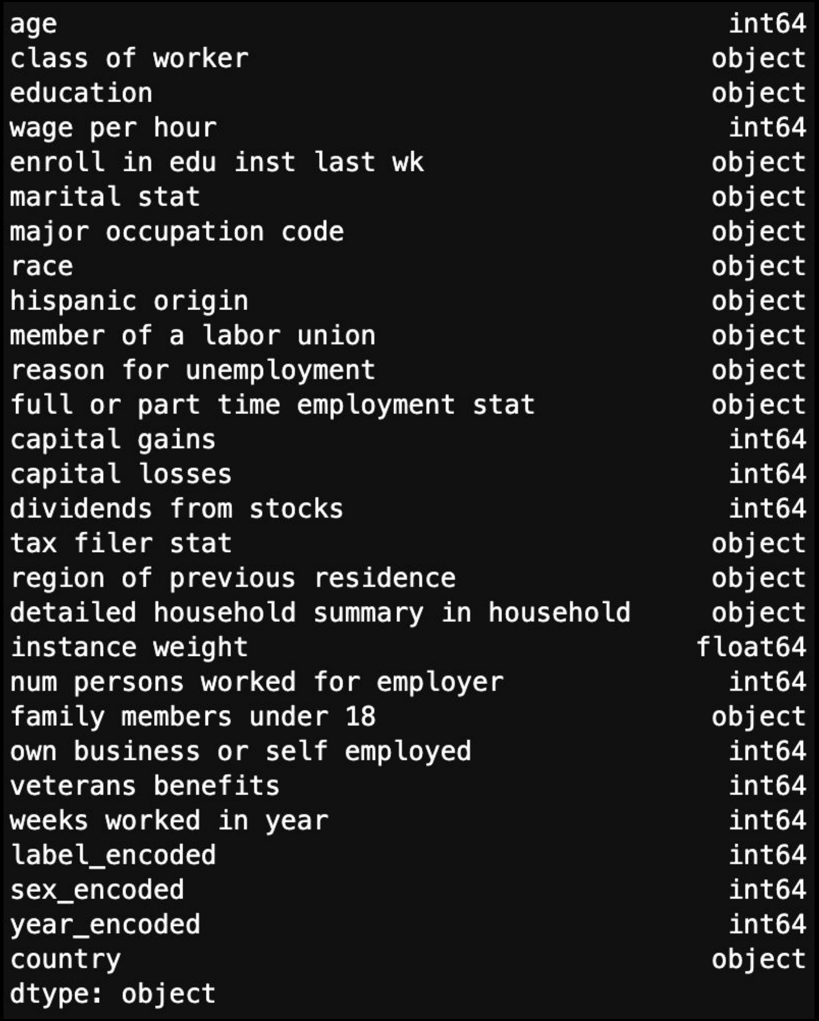
country of birth

more cleaning



cleaned data

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



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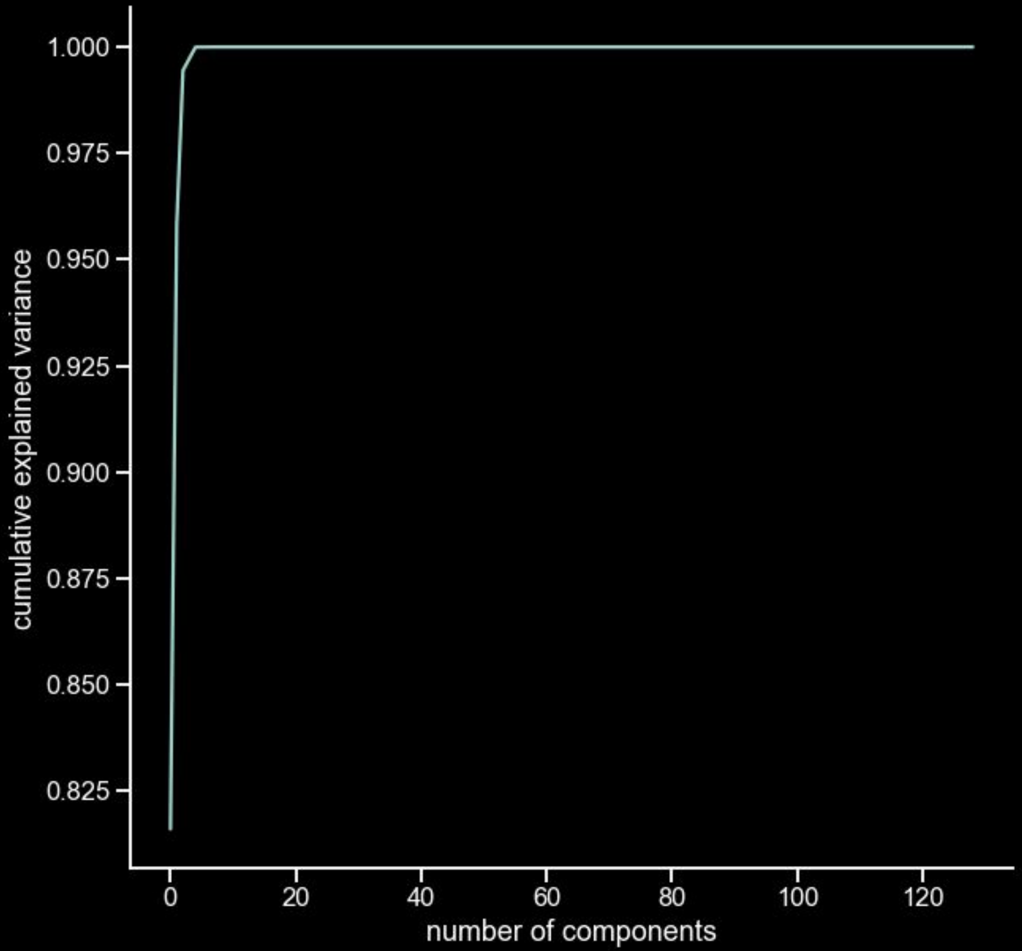
capital gains                                int64
capital losses                               int64
dividends from stocks                        int64
tax filer stat                              object
region of previous residence                object
detailed household summary in household     object
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

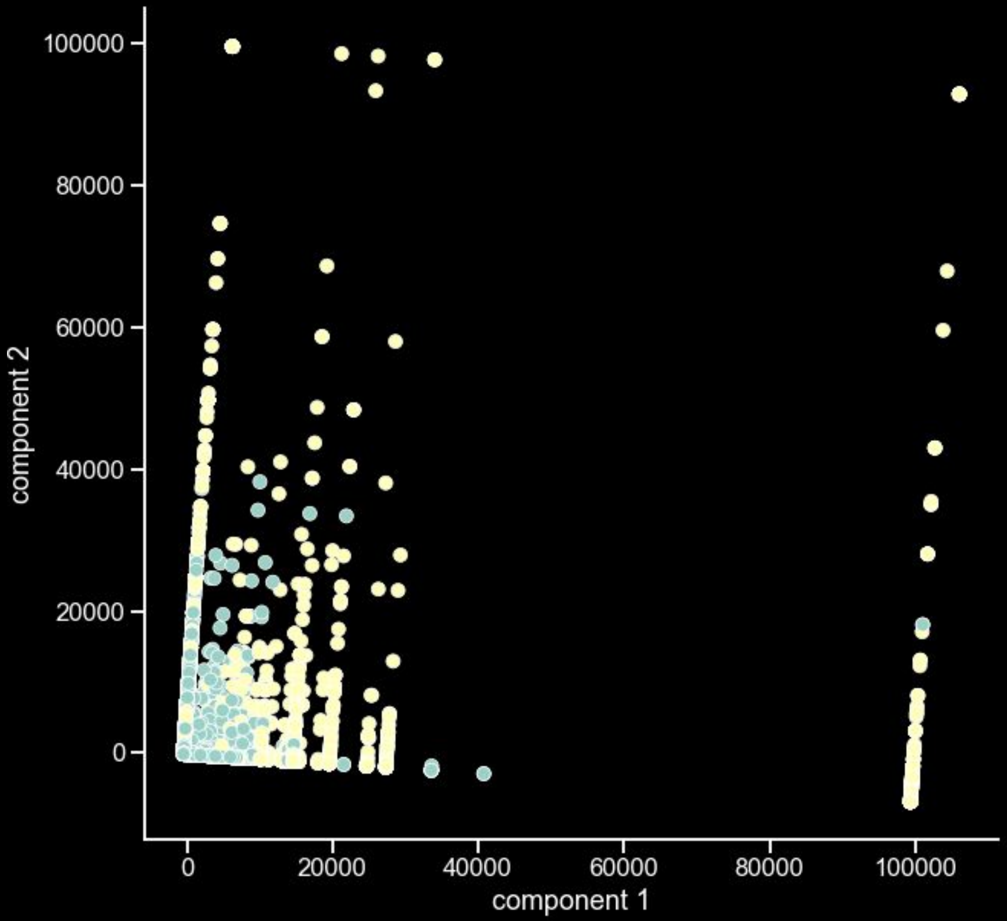
- explained variance:

  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: 50 trees, max_depth=12.

random forest performed better

raw scores

Training:

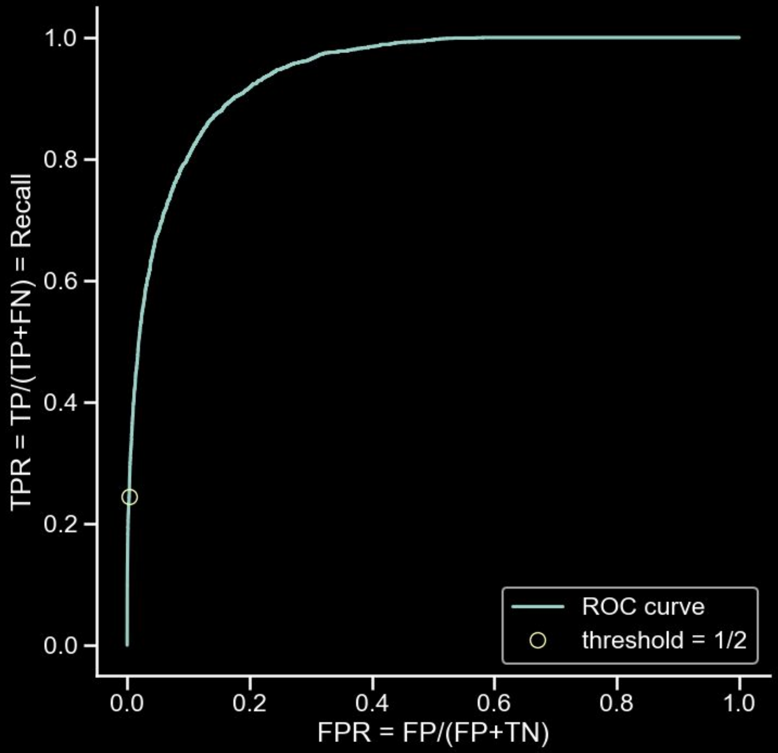
- f1: 0.61
- precision: 0.52
- recall: 0.73
- accuracy: 0.94
- auc: 0.94

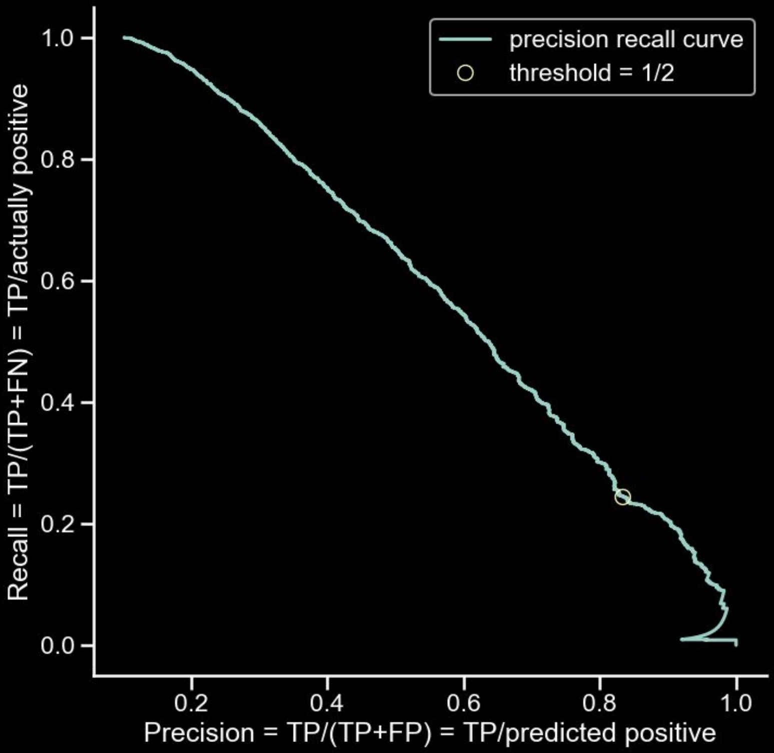
threshold = 0.2

Testing:

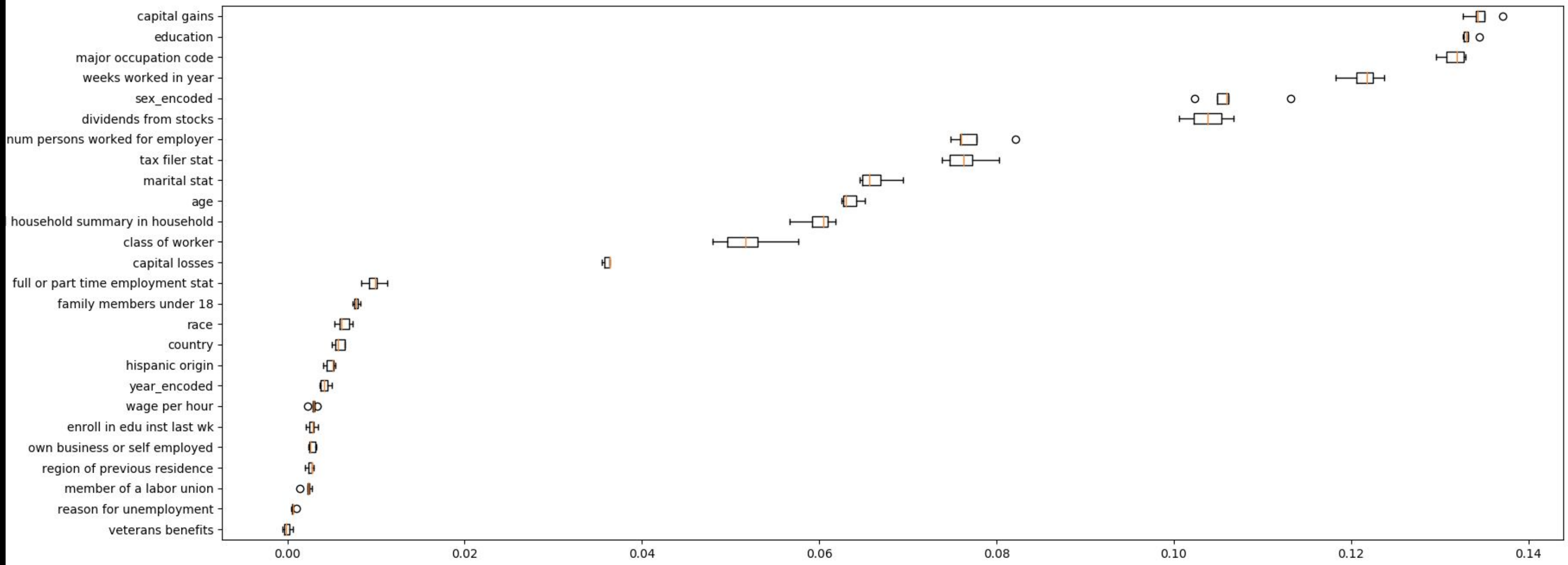
- f1: 0.56
- precision: 0.48
- recall: 0.68
- accuracy: 0.93
- auc: 0.94

roc and precision/recall



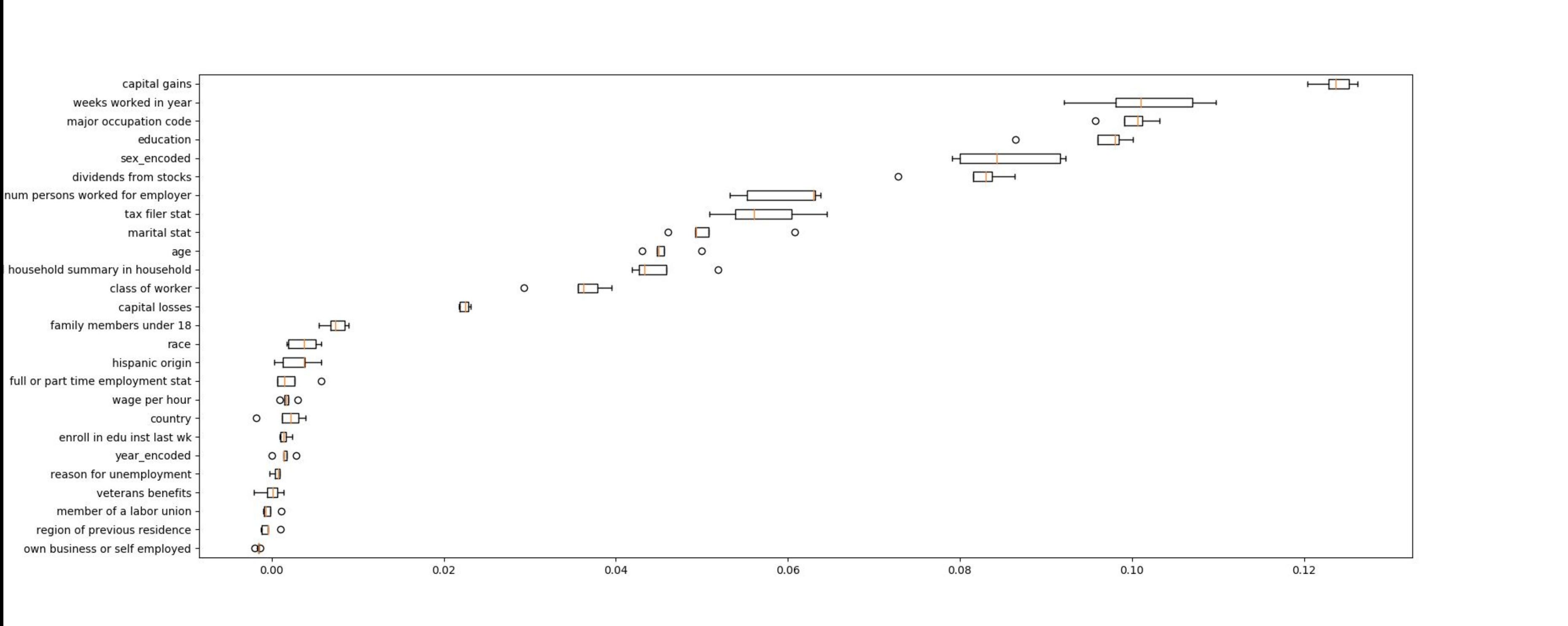


feature importance (permutation): train



top 5: capital gains, education, major occupation code, weeks worked in a year, sex.

feature importance (permutation): test



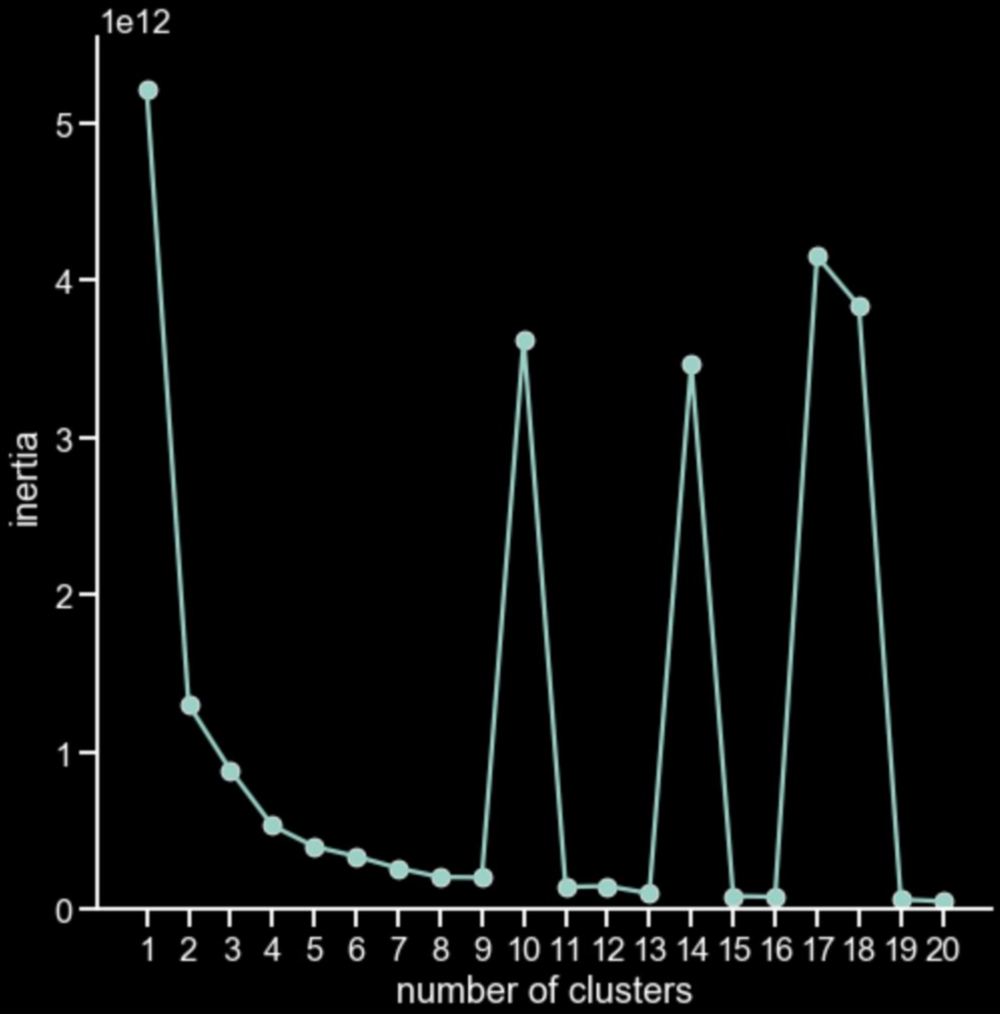
top 5: capital gains, weeks worked in a year, major occupation code, education, sex.

segmentation

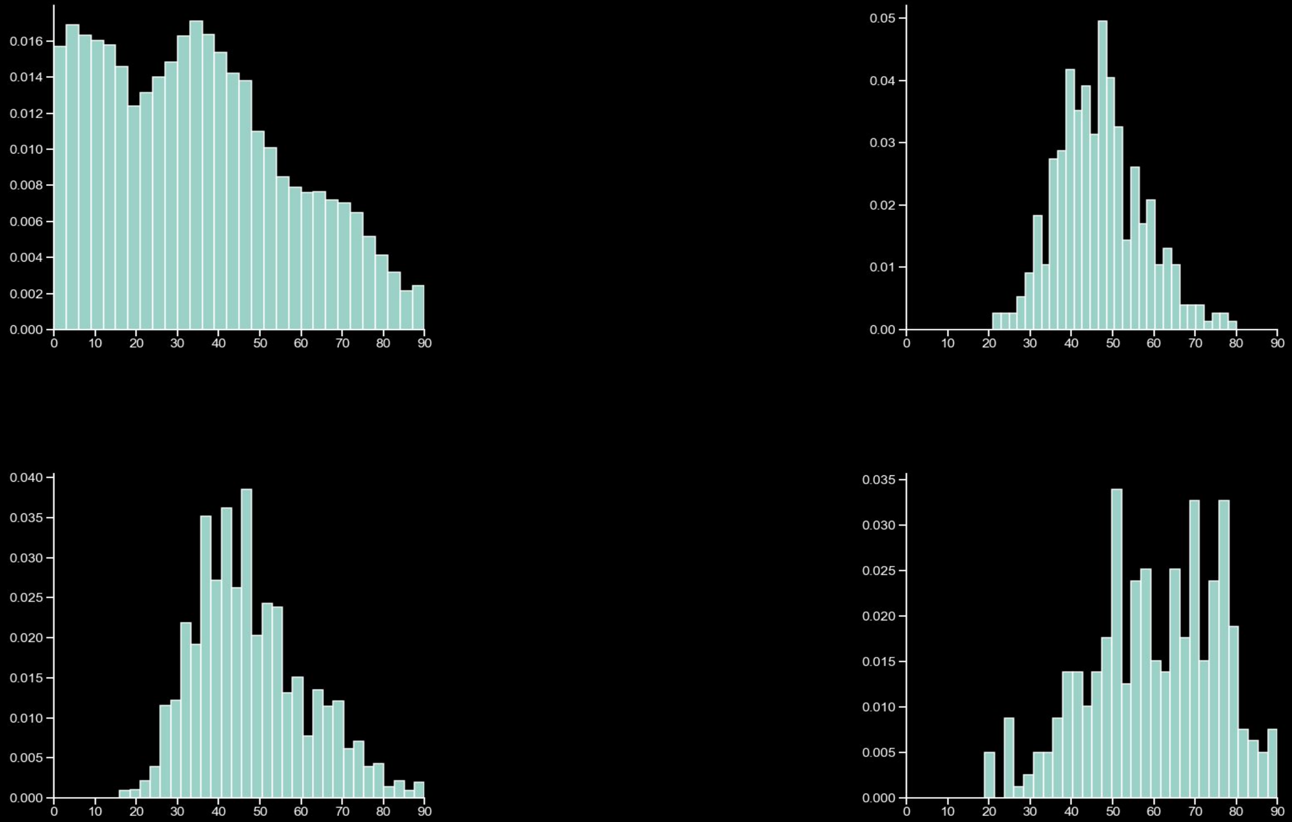
- ~~hierarchical clustering~~ (too slow)
- k-means (with mini-batches)

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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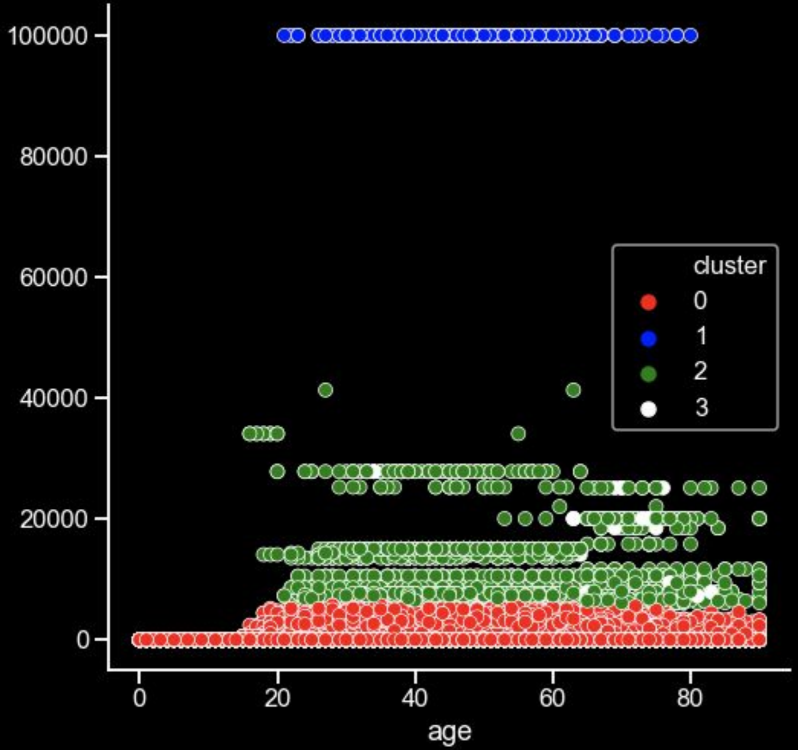

next steps

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

thanks