Capstone Project

This is the proposal for the capstone project for the Machine Learning Nanodegree in Udacity.

Domain background

Height is determined by a combination of genetics and environmental factors. Nutrition and illness in childhood limits the human growth. So height is a very good measurement of living conditions and therefore used by the historians to understand the evolution of human living condition [1]. Additionally, the variation in height within a given population is largely determined by the genetics.

In this work, we will look at height-vs-age data collected by Nancy Powell in 1969 for the Kung! tribe.[2] The goal is to capture the characteristic and variation in this age-vs-height data into a model. By comparing the historical evolution of this model, which is not a part of this study, we can estimate the progress of human living standard.

Kung! is a tribe which lives in the southern part of Africa, on the western part of the Kalahari sand system. They are hunter-gatherers with a total population somewhere between 50,000 and 100,000. The !Kung language, commonly called Ju, is one of the larger click languages. Here is a wikipedia link for more information about Kung! tribe.

Project Aim

The project aims at understanding the relationship between the height and age for the Kung! tribe. Below is a snapshot of the data from a public website.

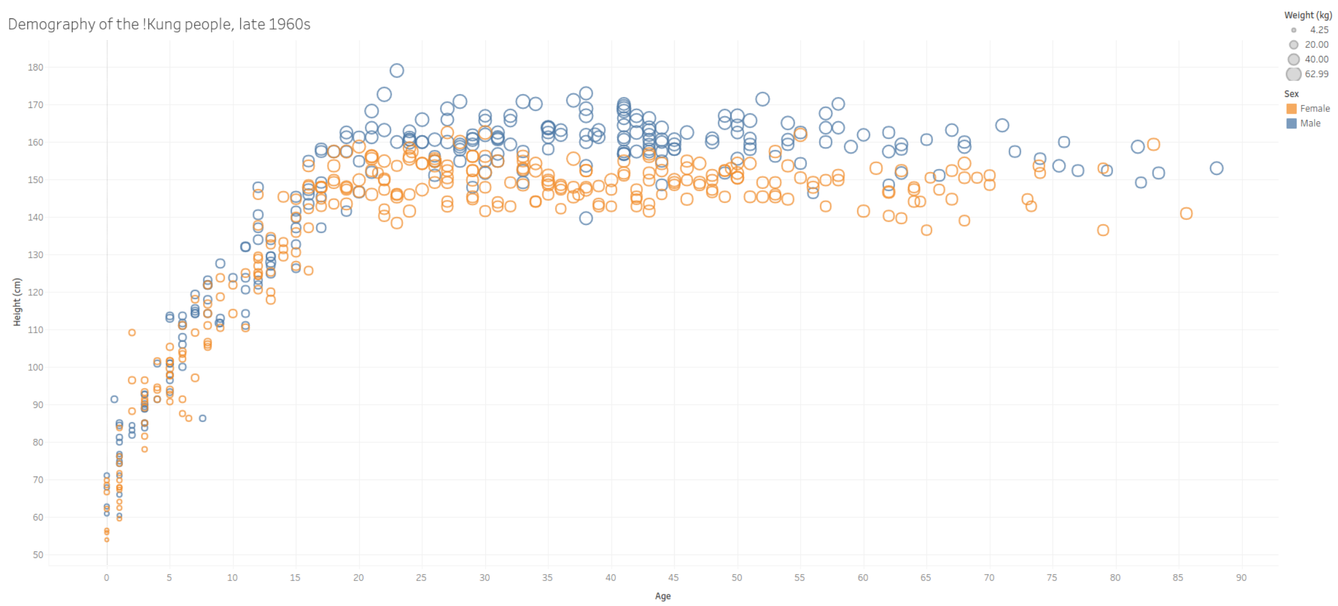


Fig 1: Plot of height vs age data for Kalahari Kung! San people collected by Nancy Howell.

Problem statement

This is a regression and supervised learning problem where the model takes age as input and produces the expected output for height. We will built a probabilistic machine learning model for the height vs age relationship for the Kung! tribe.

This problem is picked from the book Statistical Rethinking by Richard McElreath.

Dataset

The dataset was collected by Nancy Howell. It can be found at this location.

It consists of following columns:

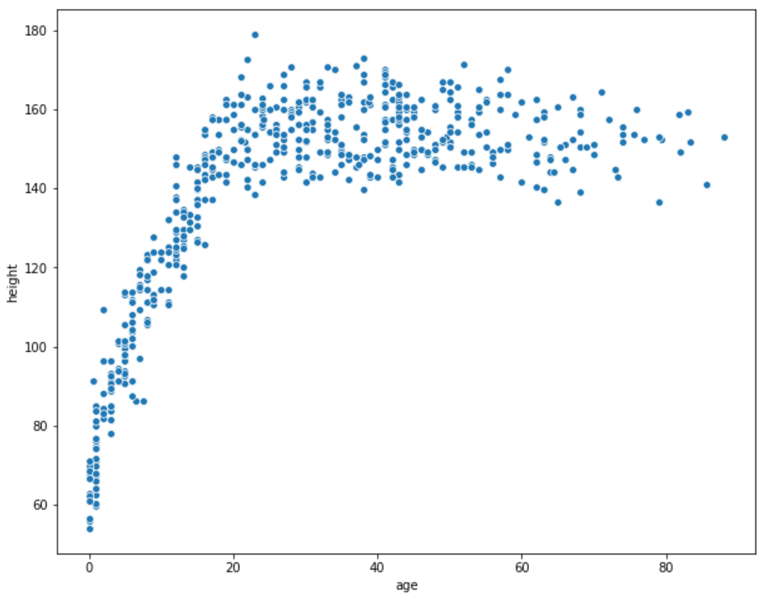
- height: Height in cm
- weight: Weight in kg
- age: Age in years
- male: Gender indicator
- age.at.death: If deceased, age at death
- alive: Indicator if still alive

For our purpose, we will only use the height and age columns.

Descriptive analysis

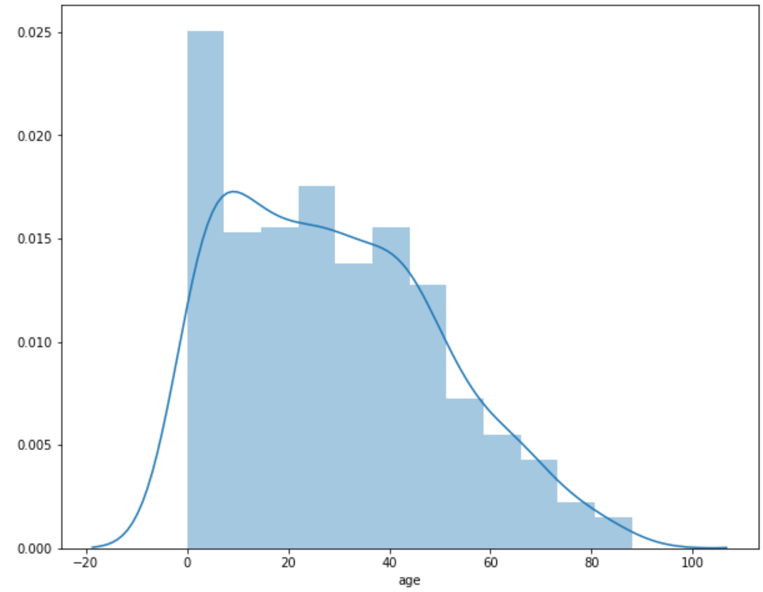
Scatter plot for age vs height

The scatter plot between age and height is clearly non-linear with steep increase of height with age in the beginning. Though there is less data for age 50 and above, it appears there is a negative trend in the data. So the older folks are shorter which might indicate that the the nutritional status of the tribe has improved over the years.

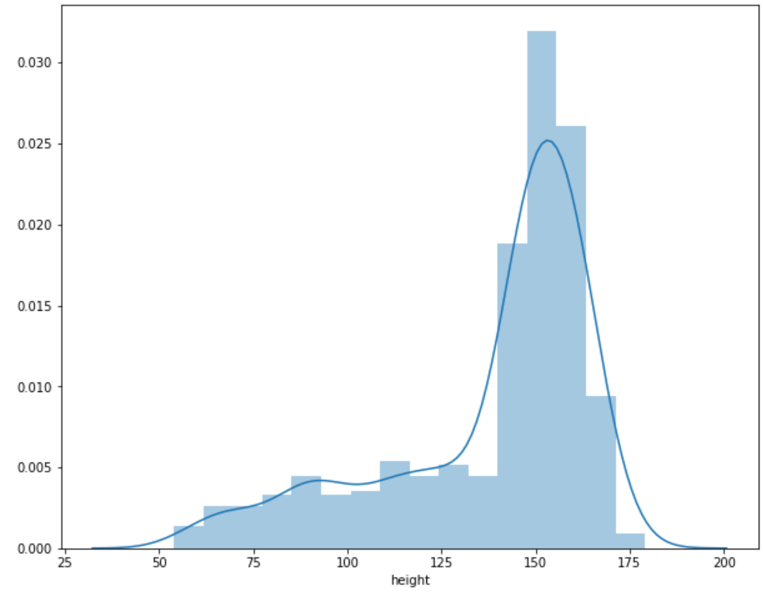


Distribution of age

The distribution of age clearly shows that we have more data points for age 50 and below compared to 50 and above.



Distribution of height



Solution statement

Given the non-linear relationship between the height and age data in Fig 1, we will fit a set of polynomial models to the data.

Benchmark model

We will use a simple linear model as a benchmark for this.

Evaluation metrics

We will compare different polynomial models using Widely Applicable Information Criterion (WAIC) and test-sample deviance.

Project design

The project will follow the following workflow:

- Download the data.
- Select only the age and height columns
- Standardize the data
- Split the data into train and test data sets.
- Define polynomial models up to degree p and weakly regularizing priors for the parameters
- Fit the p models on the training data set
- Compare the models using WAIC
    - Choose the model with the best WAIC (M_{WAIC})
- Compare the models using test-sample deviance
    - Choose the model with the best test-sample deviance (M_{best})
- Does WAIC do a good job of estimating the test deviance?
    - M_{WAIC} = M_{best}
- Choose the best model (M_{best})

We will use the PyMC3 package for this work. PyMC3 is a Python package for Bayesian statistical modeling and Probabilistic Machine Learning.

References

1. Walker, R., Gurven, M., Hill, K., Migliano, A., Chagnon, N., De Souza, R., Djurovic, G., Hames, R., Hurtado, A. M., Kaplan, H., Kramer, K., Oliver, W. J., Valeggia, C., & Yamauchi, T. (2006). Growth rates and life histories in twenty-two small-scale societies. American Journal of Human Biology, 18(3), 295-311. https://doi.org/10.1002/ajhb.20510
2. Nancy Howell (2010). Life Histories of the Dobe !Kung: Food, Fatness, and Well-being over the Life-span.