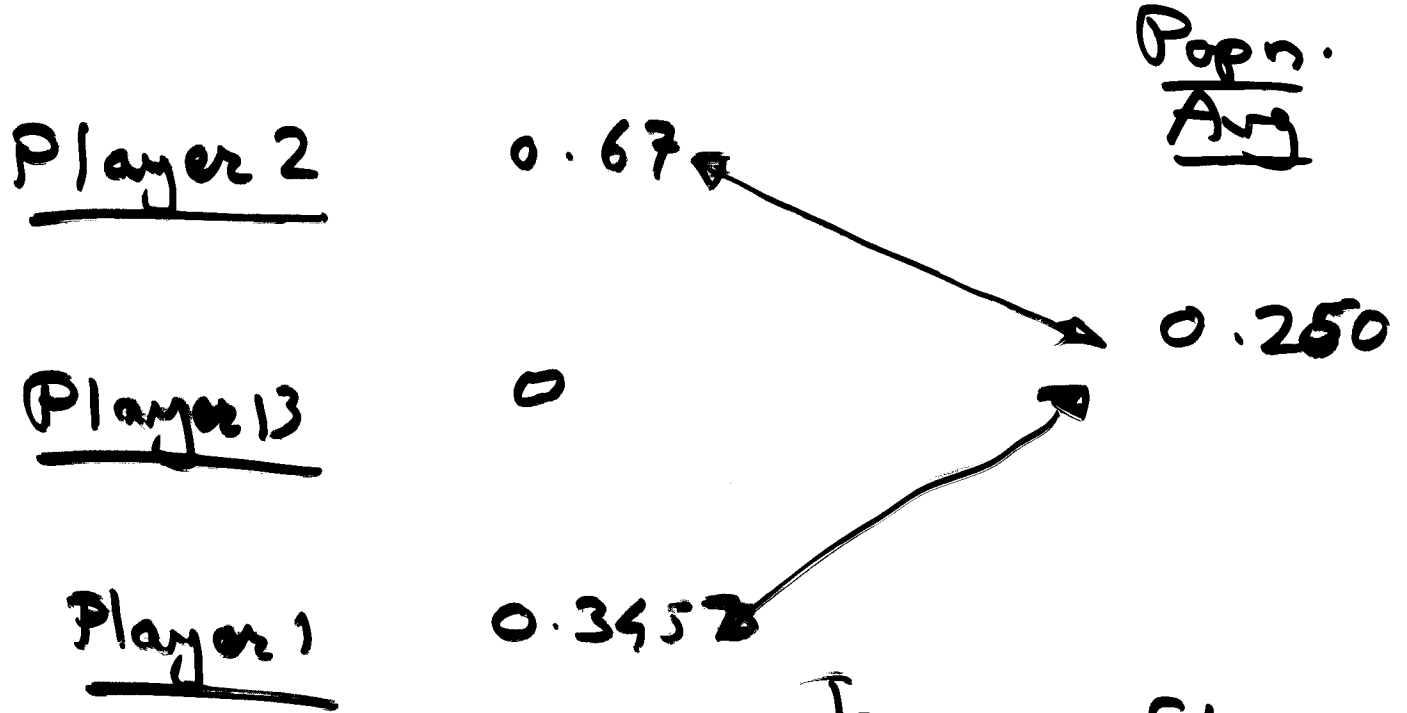
# Baseball management

| | # bats | Batting average |
|---|---|---|
| Player 1 | 100 | 0.345 |
| Player 2 | 3 | 0.666 |
| | 25 | 0.400 |
| | ⋮ | ⋮ |
| | 5 | 0 |
| Player 13 | 75 | 0.100 |
| Player 14 | | |




James-Stein

Shrinkage estimator

# Animal breeding

## Disease mapping

**Data:** $Y_i$ : # of cases of cancer

$N_i$ : Population of the location i area

**Rate at area 'i' :** $\frac{Y_i}{N_i}$

# Household Survey

| Canton | % $\hat{p}$ | Logit $\hat{\theta}$ |
|---|---|---|
| 1 | $\hat{p}_{11}$ | $\hat{\theta}_{11}$ |
| 2 | $\hat{p}_{12}$ | . |
| 3 | $\hat{p}_{13}$ | . |
| . | . | . |
| . | . | . |
| . | . | . |
| 79 | $\hat{p}_{179}$ | $\hat{\theta}_{179}$ |
| 80 | | |
| 81 | | |

HHS $\hat{\theta}_{it}$ ⟶ Census $\theta_{i0}$

## Model:

1) $\hat{\theta}_{it} \mid \theta_{it} \sim N(\theta_{it}, \psi_{it})$

$\psi_{it}$: sampling error (Known)

2) $\theta_{it} \mid \theta_{i0} \sim N(\theta_{i0}, \sigma^2)$

$$\tilde{\theta}_{it} = \left(\frac{\sigma^2}{\sigma^2+\psi_{it}}\right)\hat{\theta}_{it} + \left(\frac{\psi_{it}}{\sigma^2+\psi_{it}}\right)\theta_{i0}$$

# Bivariate Normal Distribution

$$\begin{pmatrix} \hat{\theta}_{it} \\ \theta_{it} \end{pmatrix} \sim N\left( \begin{pmatrix} \theta_{i0} \\ \theta_{i0} \end{pmatrix}, \begin{pmatrix} \sigma^2+\psi_{it} & \sigma^2 \\ \sigma^2 & \sigma^2 \end{pmatrix} \right)$$

$$E(\theta_{it} \mid \hat{\theta}_{it}) = \theta_{i0} + \frac{\sigma^2}{\sigma^2+\psi_{it}} (\hat{\theta}_{it} - \theta_{i0})$$

$$= \left(\frac{\psi_{it}}{\sigma^2+\psi_{it}}\right) \theta_{i0} + \left(\frac{\sigma^2}{\sigma^2+\psi_{it}}\right) \hat{\theta}_{it}$$

$$\text{Var}(\theta_{it} \mid \hat{\theta}_{it}) = \sigma^2 - \left(\frac{\sigma^4}{\sigma^2+\psi_{it}}\right)$$

$$\tilde{\theta}_{it} = \left( \frac{\sigma^2}{\sigma^2 + \psi_{it}} \right) (\hat{\theta}_{it})$$

$$+ \left( \frac{\psi_{it}}{\sigma^2 + \psi_{it}} \right) (\theta_{i0})$$

$$\frac{\sigma^2}{\sigma^2 + \psi_{it}} = \frac{1}{1 + \frac{\psi_{it}}{\sigma^2}}$$