

# Hierarchical models

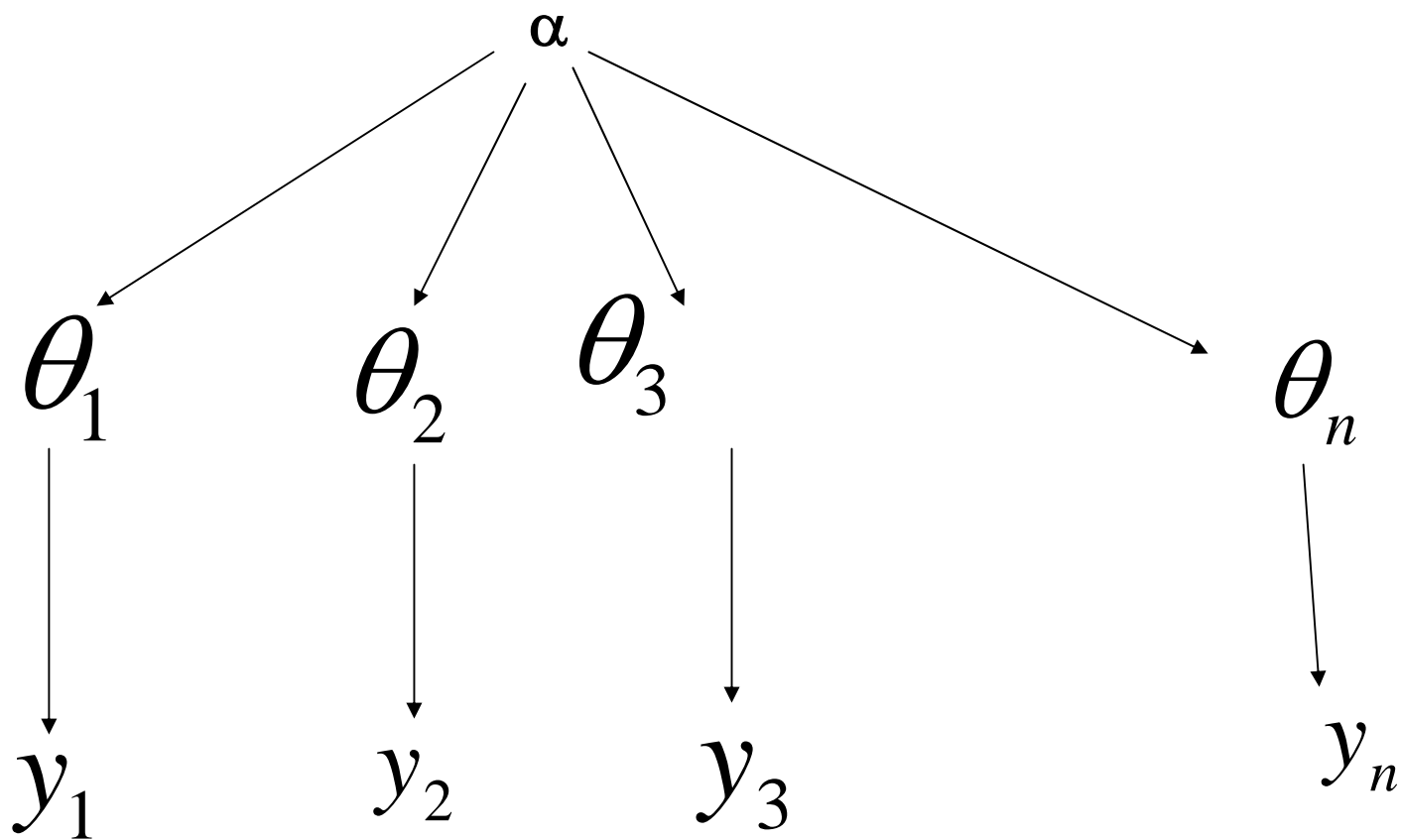
# Parameters are related in some way---

- Joint distribution of individuals

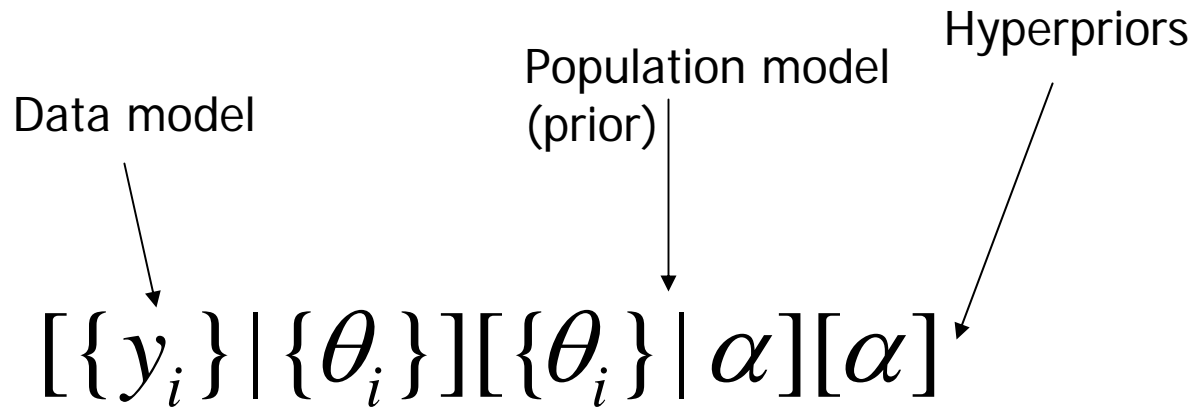
$$- [\theta_1, \theta_2, \dots, \theta_n]$$

- Use a prior distribution to model at the “population” level

# Example: binomial, multiple populations



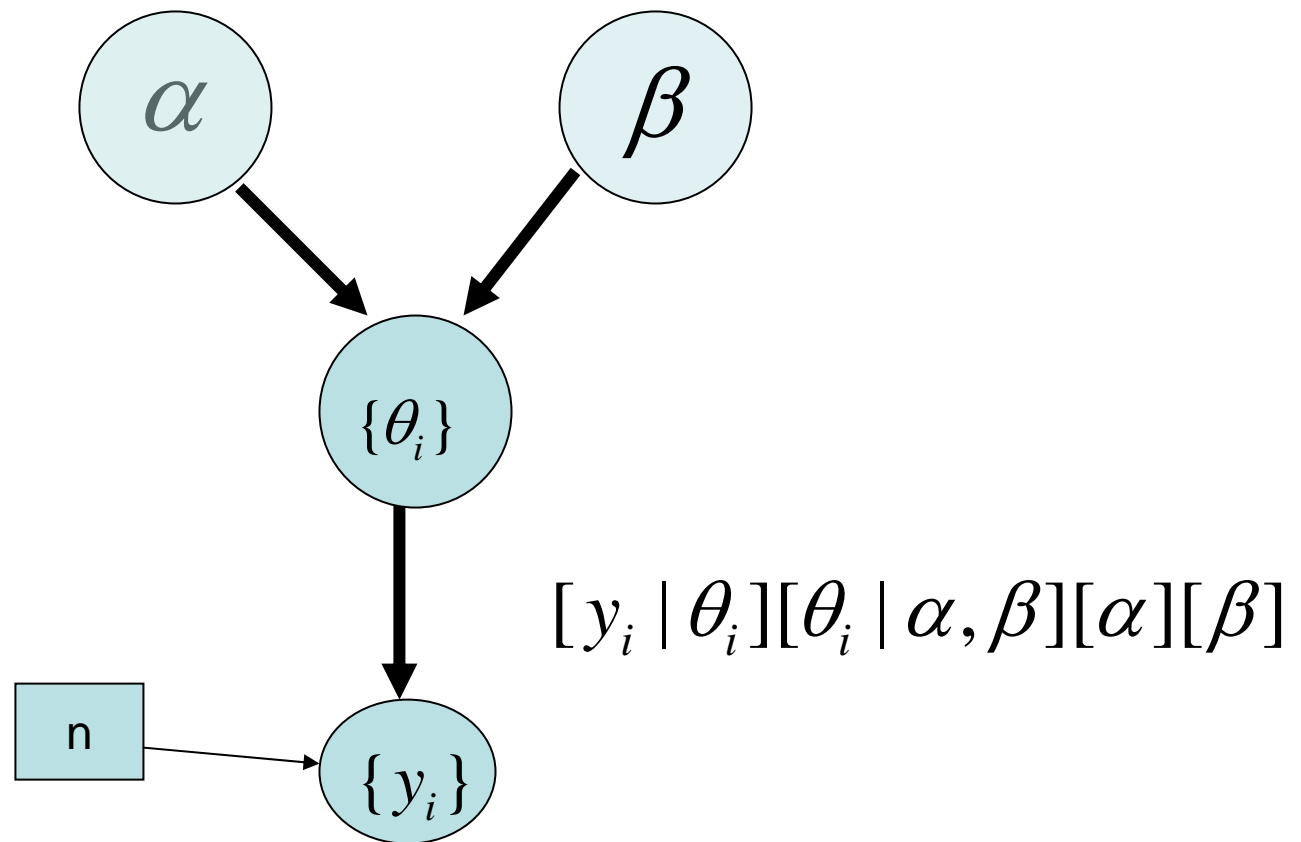
# Potentially > parameters than observations!



# Examples

- Multi-sample binomials, beta hyper distribution
- Multi-sample binomials, logit normal
- Multi-sample binomials, logit normal random effects+ linear trend
- Multiple-year CMR
  - Hidden (latent) structure on N

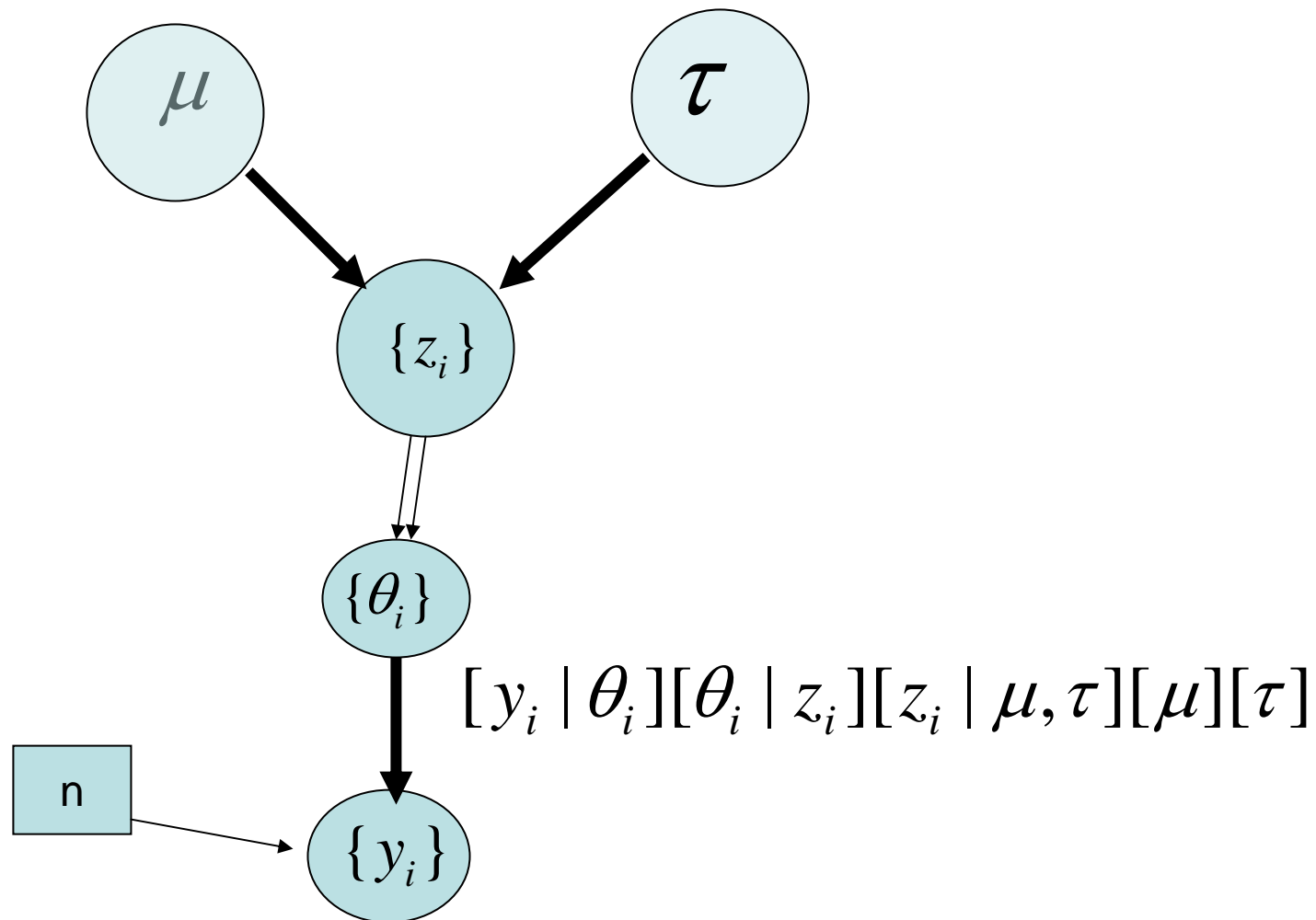
# Multi-sample binomials, beta hyper distribution



# WINBUGS implementation

[binomial\\_hier1.odc](#)

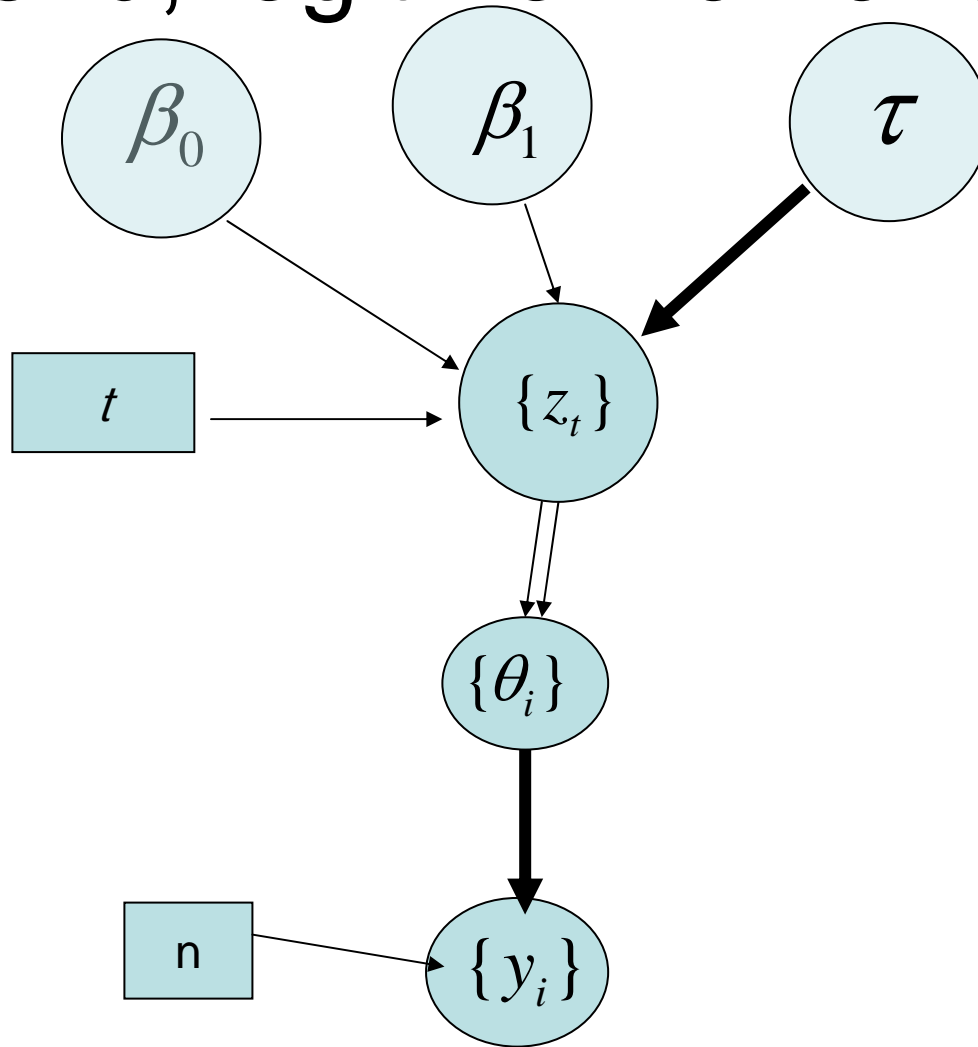
# Multi-sample binomials, logit-normal distribution



# WINBUGS implementation

[binomial\\_hier2.odc](#)

# Multi-sample binomials, linear trend, logit-normal random effect



$$[y_t | \theta_t][\theta_t | z_t][z_t | \beta_0, \beta_1, \tau, t][\beta_0][\beta_1][\tau]$$

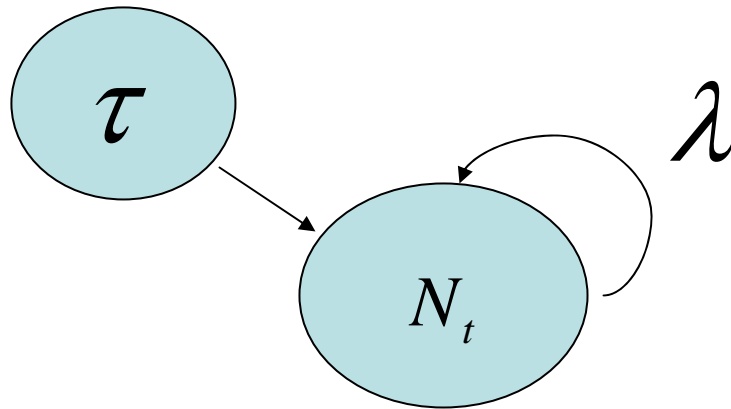
# WINBUGS implementation

[binomial\\_hier3.odc](#)

# Multiple-year CMR

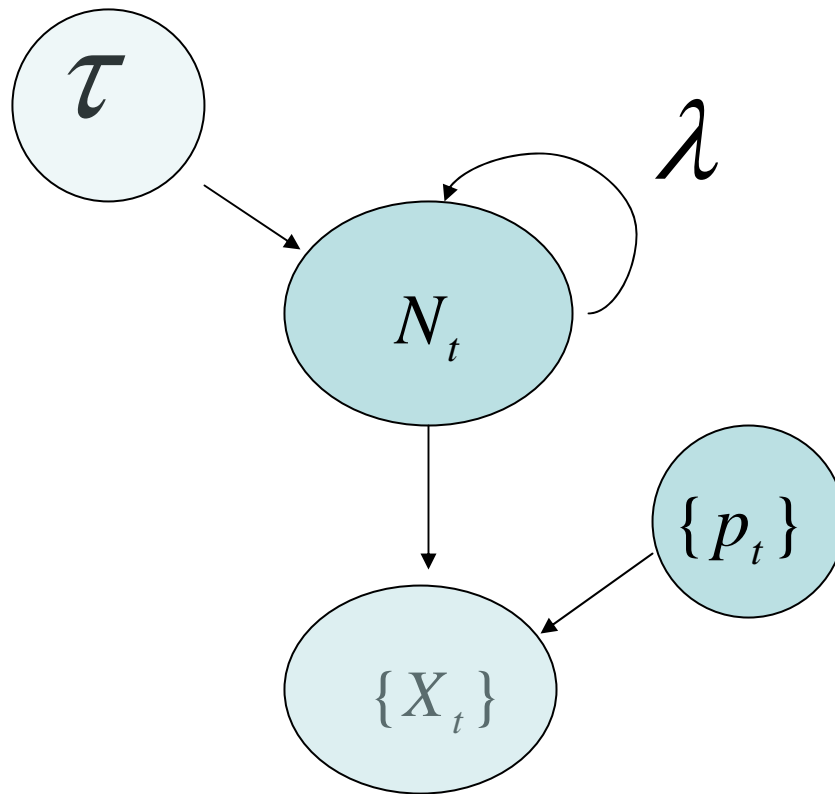
Hidden (latent) structure on  $N$

# Model on N



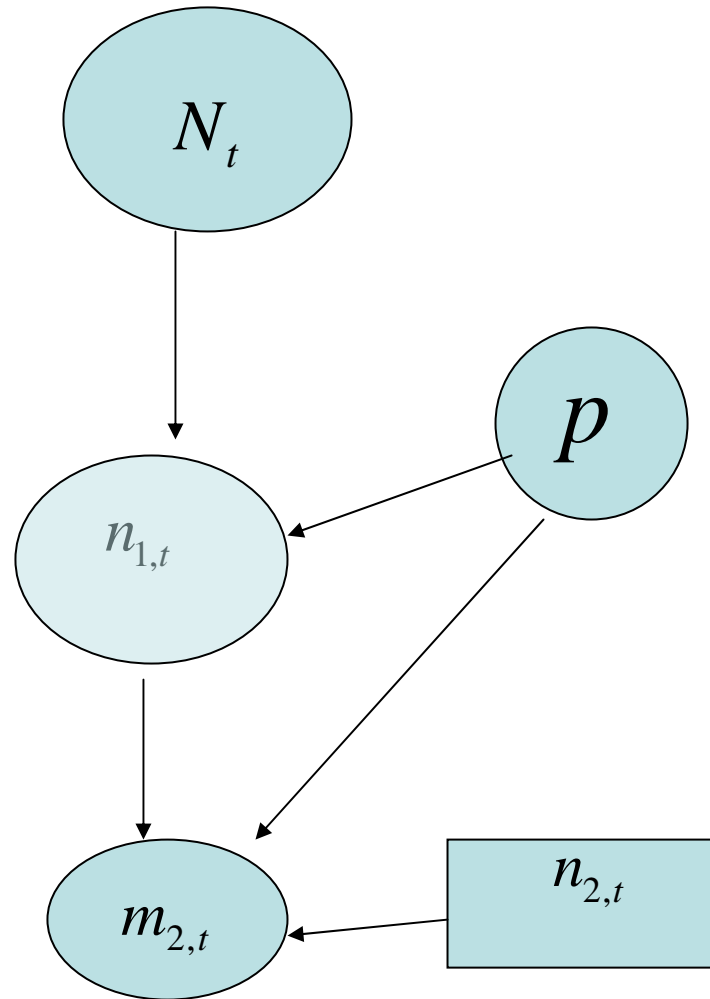
$$[N_t | \lambda, \tau][N_0][\lambda][\tau]$$

# Model with data



$$[N_t | \lambda, \tau][\{X_t\} | N_t, \{p_t\}][N_0][\lambda][\tau][\{p_t\}]$$

# Model with data (detail)



# WINBUGS implementation

pop\_hier.odc