Specialization and Task Allocation

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Simple Threshold Model

- No changing polyethism/specialization
- No strong task specialization within castes
- Valid only when thresholds are constant
- No ability to adapt to changing ages

Overcoming Limitations

- Two possibilities
  - Varying thresholds
  - Age based changes

Varying Thresholds

$$T_{\theta_{ij}}(s_j) = \frac{s_j^2}{s_j^2 + \theta_{ij}^2}$$

If *i* performs task *j*:

$$\theta_{ij} \leftarrow \theta_{ij} - \xi \Delta t$$

If *i* does not perform task *j*:

$$\theta_{ij} \leftarrow \theta_{ij} + \varphi \Delta t$$

Overall:

$$\theta_{ij} \leftarrow \theta_{ij} - x_{ij}\xi\Delta t + (1 - x_{ij})\varphi\Delta t$$

$$\partial_t \theta_{ij} = [(1 - x_{ij})\varphi - x_{ij}\xi]\Theta(\theta_{ij} - \theta_{\min})\Theta(\theta_{\max} - \theta_{ij})$$

Varying Thresholds

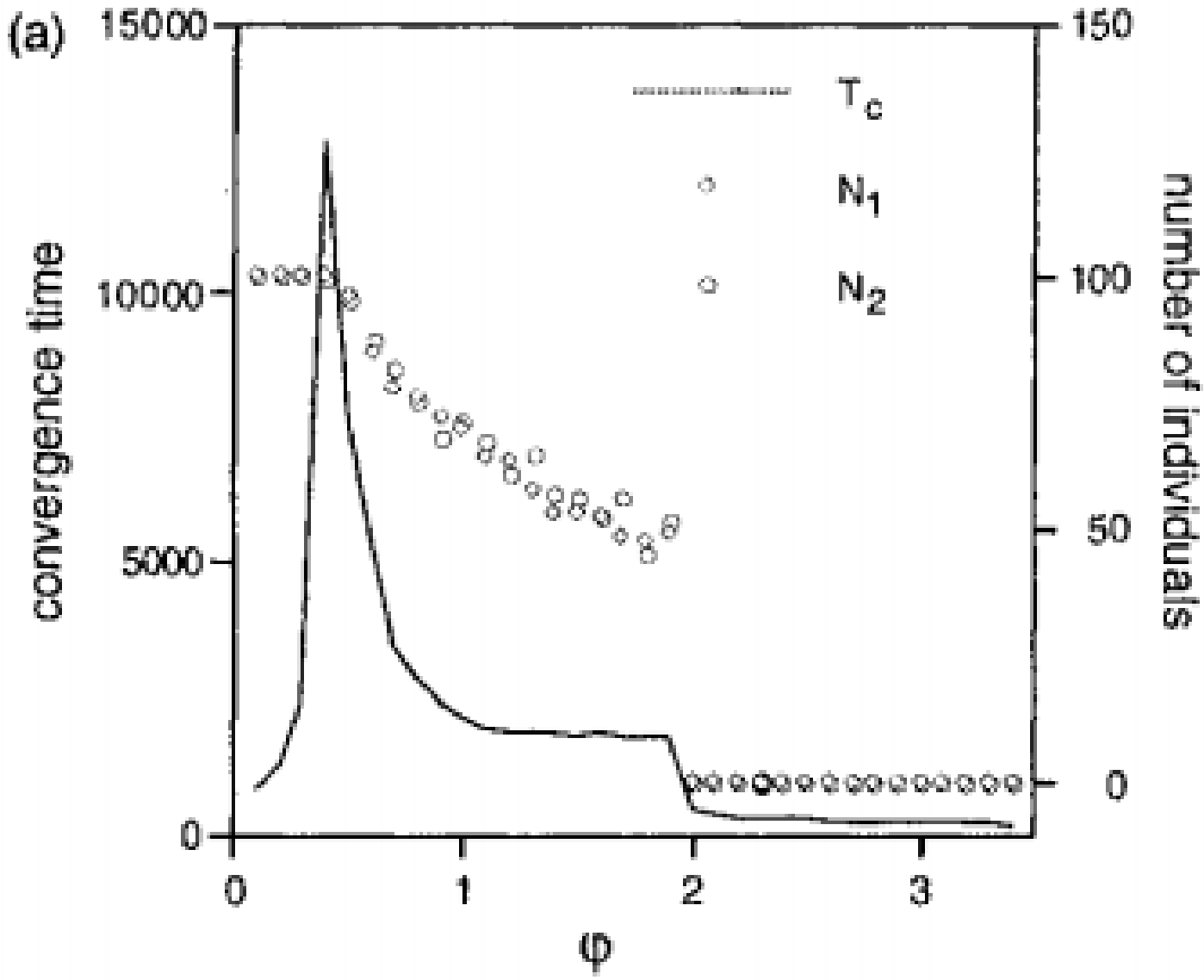
Change in time taken for a task:

$$\partial_t x_{ij} = T_{\theta_{ij}}(s_j)\left(1 - \sum_{k=1}^{m} x_{ik}\right) - p x_{ij} + \psi(i,j,t)$$

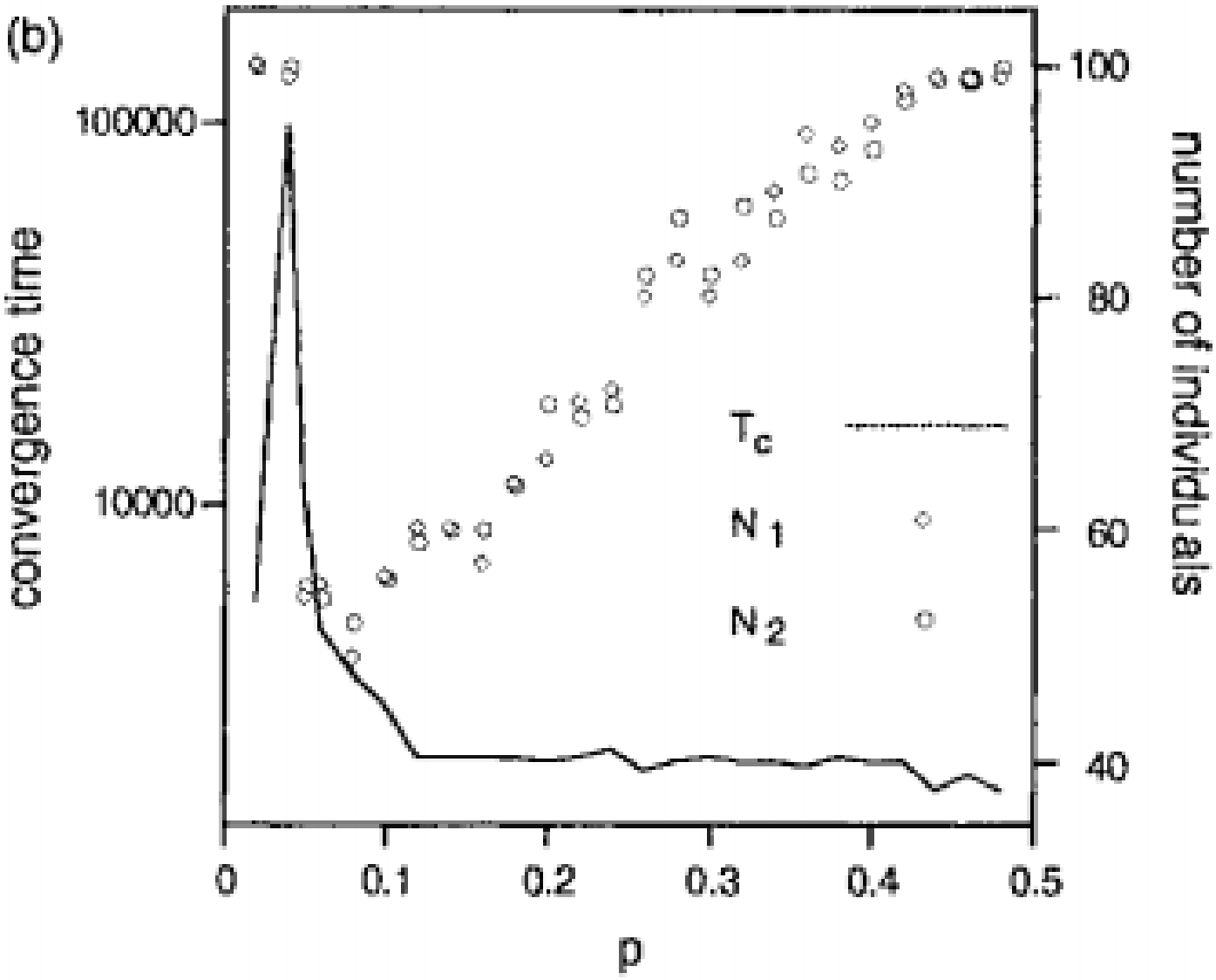
Change in stimuli:

$$\partial_t s_j = \delta - \frac{\alpha_j}{N}\left(\sum_{i=1}^{N} x_{ij}\right)$$

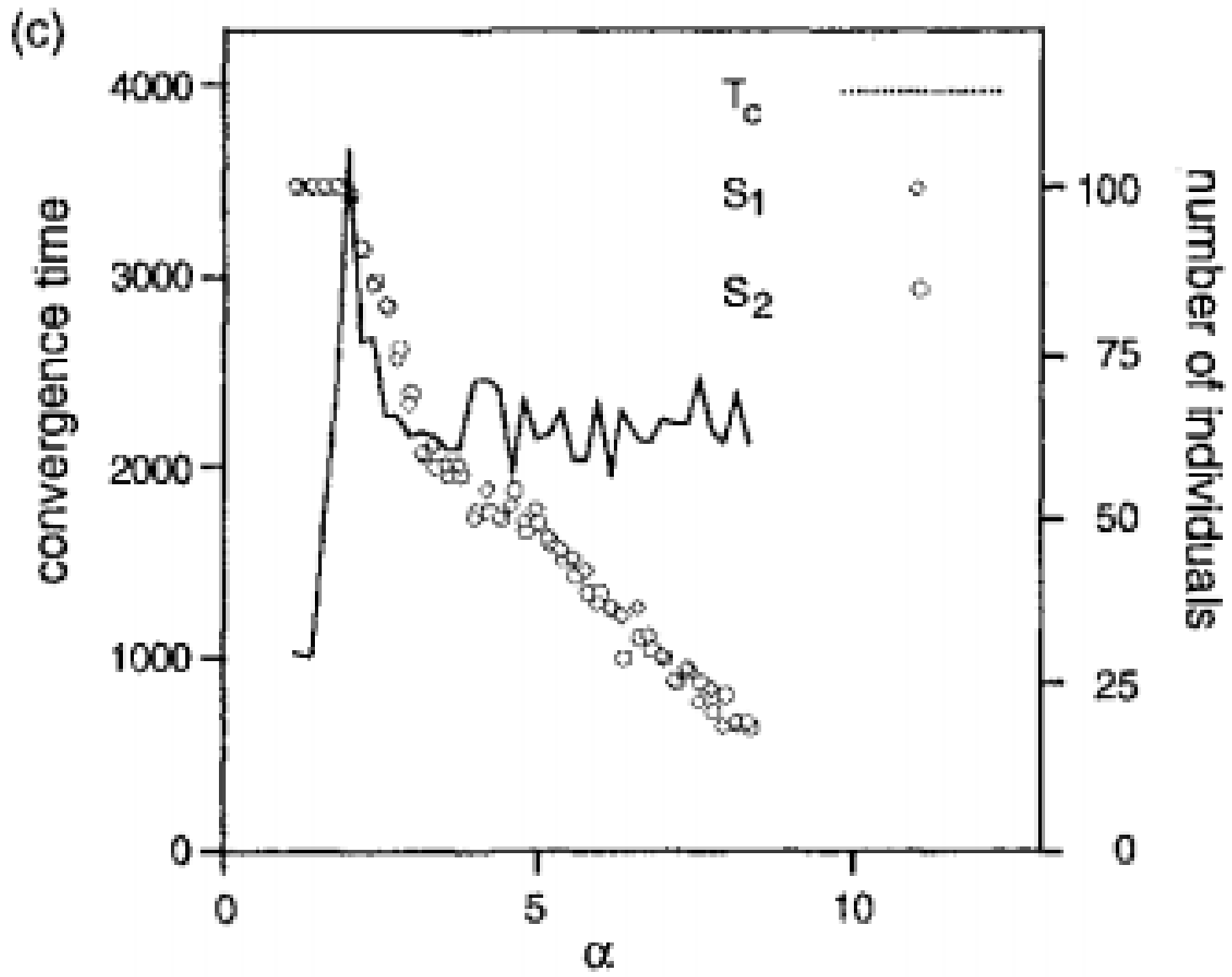
Convergence Time vs Forgetting Factor



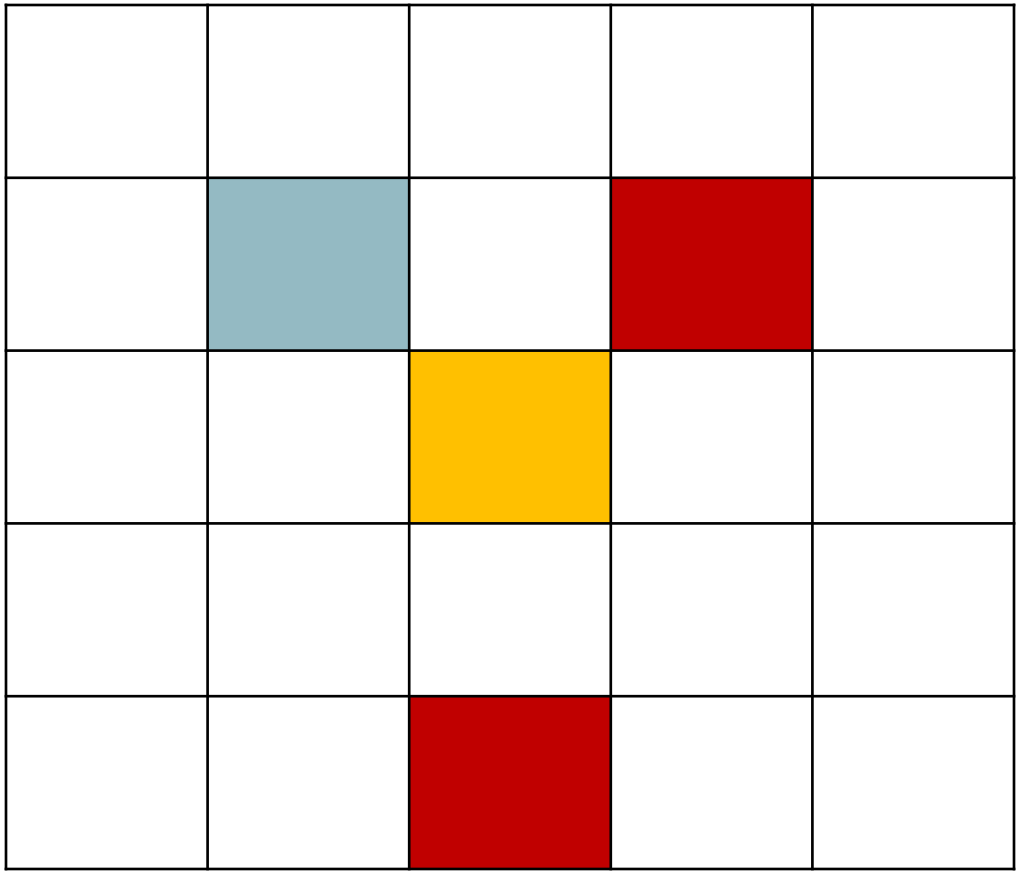
Convergence Time vs Nap Constant



Convergence Time vs Efficiency



The Mailman Problem



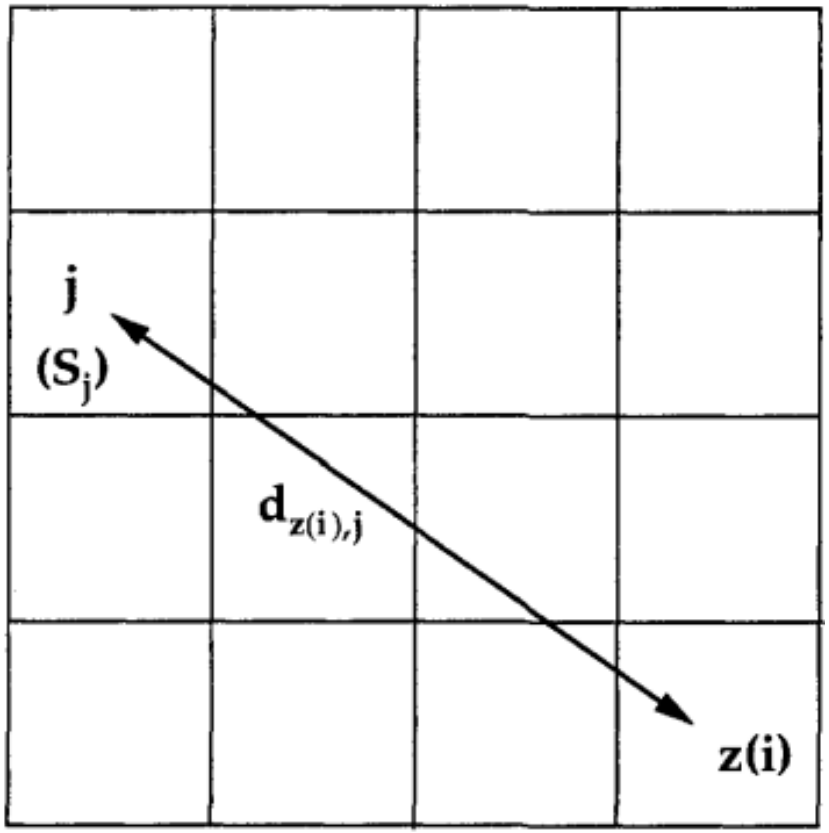
The Mailman Problem

Chance to switch zones:

$$P_{ij} = \frac{S_j^2}{S_j^2 + \alpha\theta_{i,j}^2 + \beta d_{z(i),j}^2}$$

Threshold Variance:

$$\begin{aligned} \theta_{i,j} &\leftarrow \theta_{i,j} - \xi_0\,, \\ \theta_{i,n(j)} &\leftarrow \theta_{i,n(j)} - \xi_1,\ \forall n(j)\,, \\ \theta_{i,k} &\leftarrow \theta_{i,k} + \varphi \text{ for } k \neq j, k \notin \{n(j)\} \end{aligned}$$



Bidding Algorithms

1. Try to take another truck the same color as the current
2. Take important jobs
3. Take any job to stay busy
4. Don't take a job if paint booth is down or queue is large