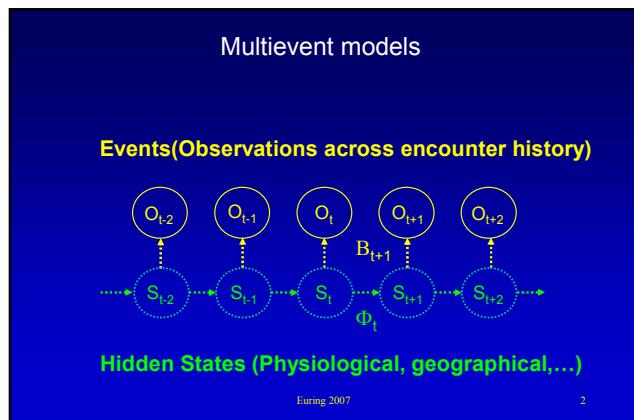


Program E-SURGE: Three multievent examples

Rémi Choquet, Lauriane Rouan.
 CEFÉ, UMR 5175, Montpellier, France.

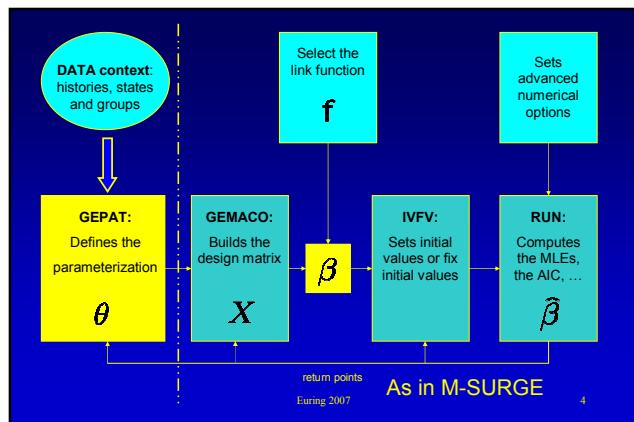
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Purpose of E-SURGE

- Fit by Maximum Likelihood a large set of multievent models
 - Plug-in into the framework of generalized linear model: $f(\Theta) = X\beta$
- Two main tools:
 - A tool to define the general model and its parameterization: GEneralizer of PAttern matrices (GEPAT)
 - A tool to set constraints GEneralizer of MAtrices of COnstraints (GEMACO) based on :
 - a language to describe models
 - an interpreter to build constrained matrices
- Advanced models: Age, time and group effects,

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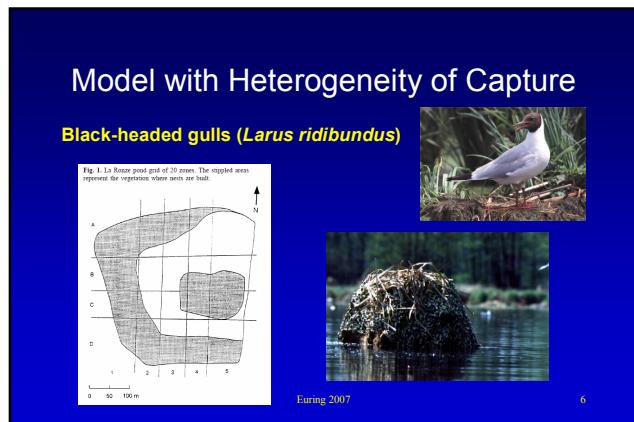
Some applications

- When events match states (Multistate)

CAS and JMV models

 - Combined and separated formulation,
 - Other formulations: Settlement (Grosbois et al.(2003)),...
 - Different sources of mortality (Schaub et al.(2004))
- When events don't match states (Multievent)
 - Heterogeneity of capture (2 classes of capturability, Pledger(2003)),
 - Memory model (Hestbeck(1991), Brownie et al.(1993), Pradel(2005)),
 - Sex uncertainty (Nichols et al.(2004)),
 - and much more ...

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Model with Heterogeneity of Capture

- Events (Observations):
{'not seen', 'seen'}
- States:
{ belongs to class 1 (C1), belongs to class 2 (C2), Dead(D) }

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Initial state probabilities vector

$$\Pi = (\pi_{C1}, \quad \pi_{C2})$$

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SURVIVAL(-TRANSITION) MATRIX

$$\Phi = \begin{pmatrix} C1 & C2 & D \\ C1 & \phi_{C1}, 0, 1 - \phi_{C1} \\ C2 & 0, \phi_{C2}, 1 - \phi_{C2} \\ D & 0, 0, 1 \end{pmatrix}$$

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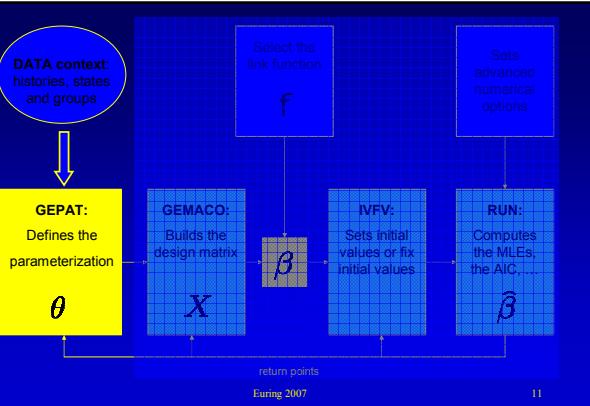
9

Encounter matrix

$$B = \begin{pmatrix} 'not seen' & 'seen' \\ C1 & 1 - p_1, p_1 \\ C2 & 1 - p_2, p_2 \\ D & 1, 0 \end{pmatrix}$$

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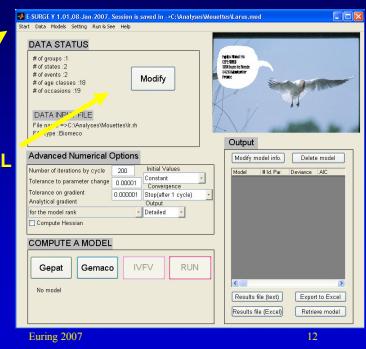
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Main screen of E-SURGE

OPEN A SESSION, READ DATA,

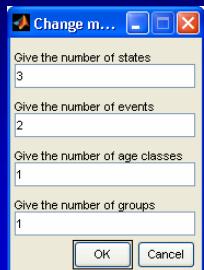
DEFINITION OF A GENERAL MODEL(STEP 1)



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DEFINITION OF A GENERAL MODEL(STEP 1)

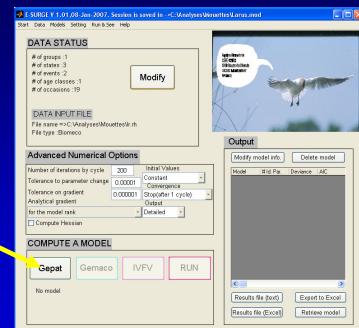


$\rightarrow \{ C_1, C_2, D \}$
 $\rightarrow \{ \text{'not seen'}, \text{'seen'} \}$

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DEFINITION OF A GENERAL MODEL(STEP 2)



INVOKE GEPAT
(GENERATOR OF PATTERN)

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DEFINITION OF EACH MATRIX STRUCTURE BY A MATRIX PATTERN

- For each kind of parameter, where are
 - the parameters of interest (estimated)
 - the complementary
 - the null values

Syntax:

(Any letter) Parameter
 (*) Complementary
 (-) Probability = 0

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INITIAL STATE PATTERN VECTOR

- Initial State vector
 $\Pi=(\pi_{C_1}, 1-\pi_{C_1})$
- Initial State pattern vector

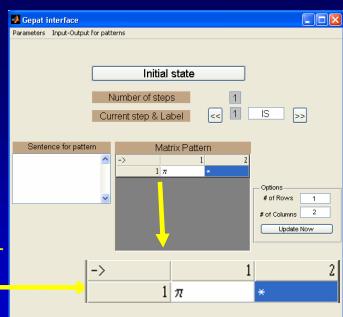
$\Pi\Pi=(\pi, *)$

(Any letter) Parameter
 (*) Complementary

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GEPAT interface



Initial State pattern vector
 $\Pi\Pi=(\pi, *)$

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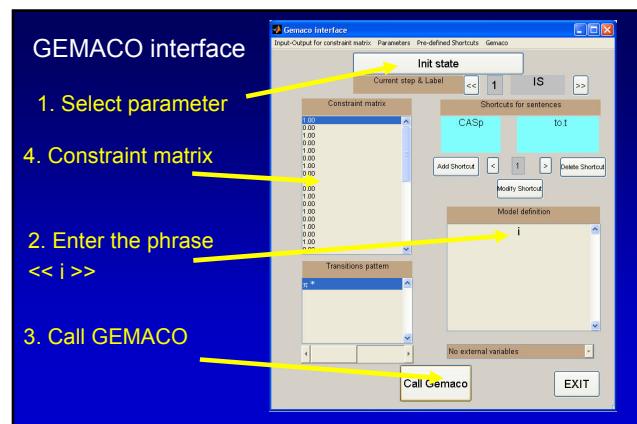
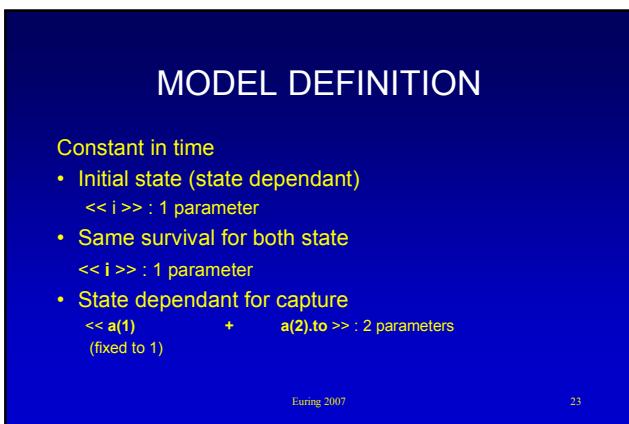
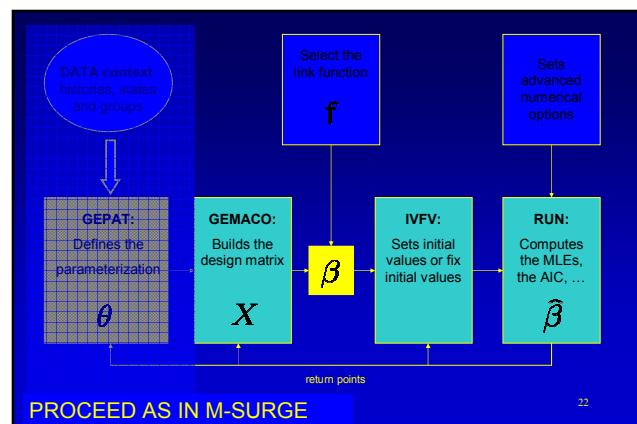
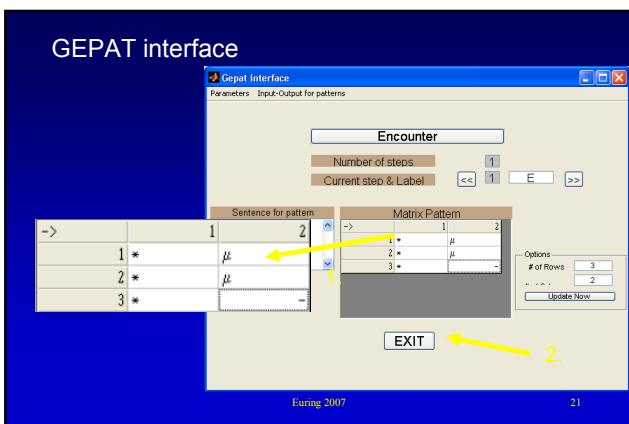
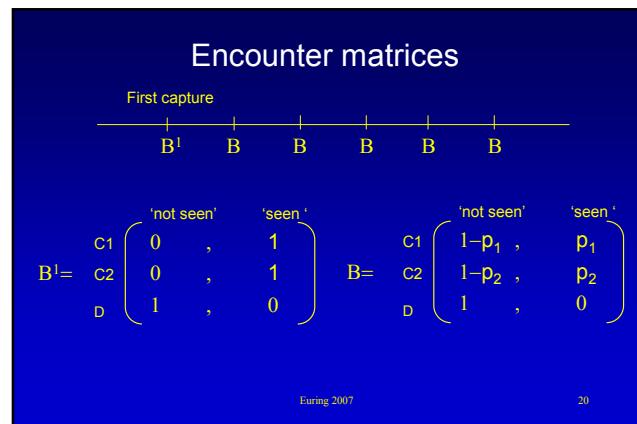
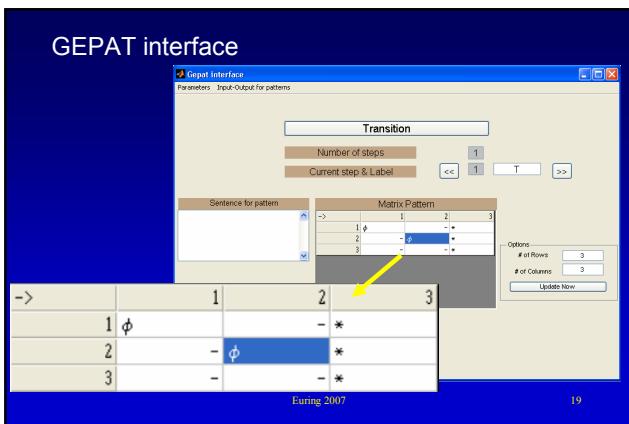
17

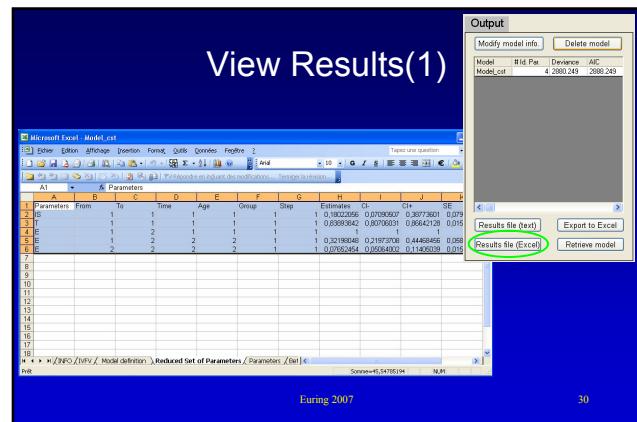
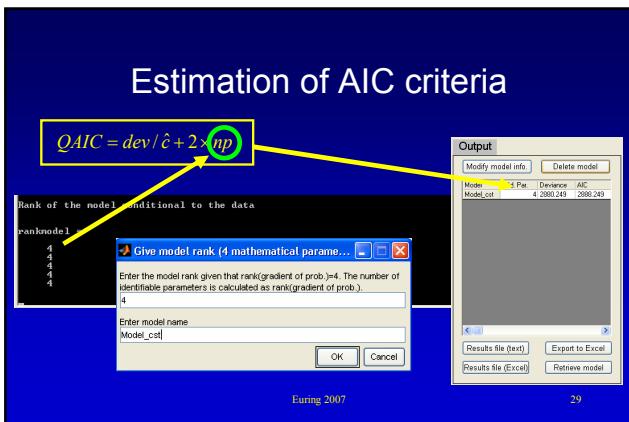
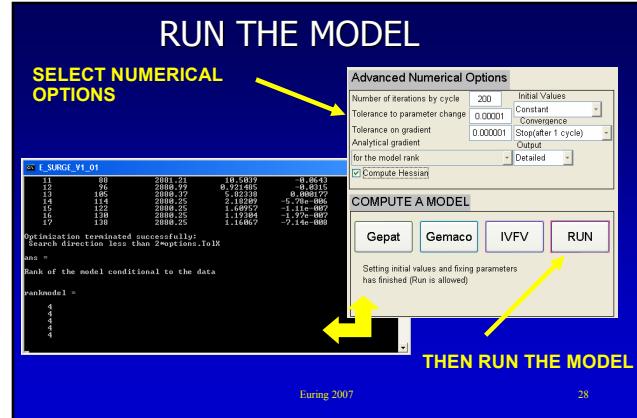
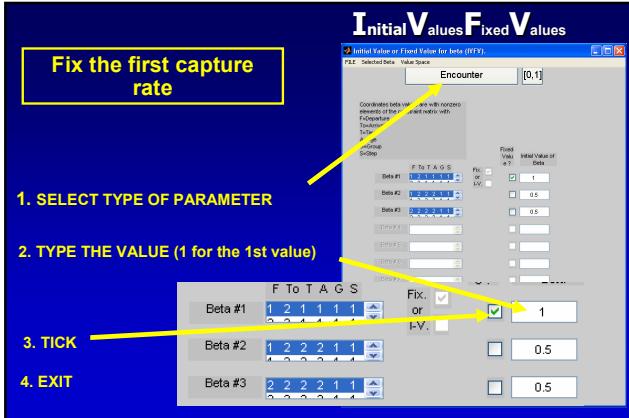
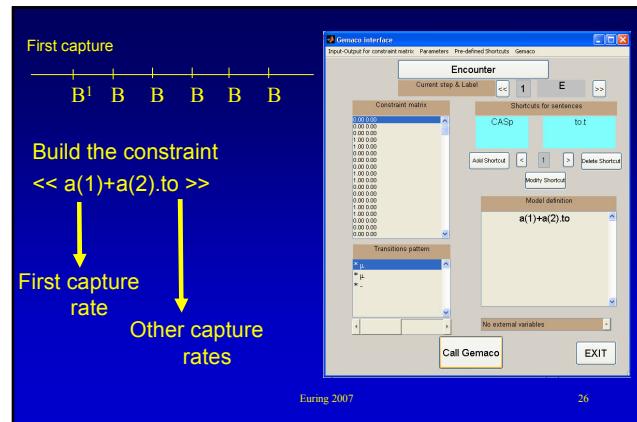
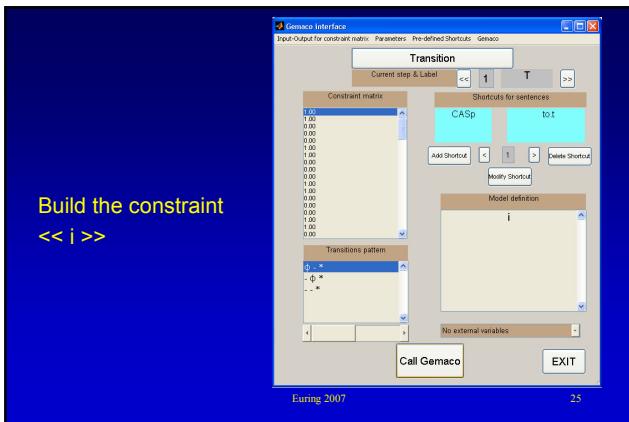
SURVIVAL(-TRANSITION) MATRIX

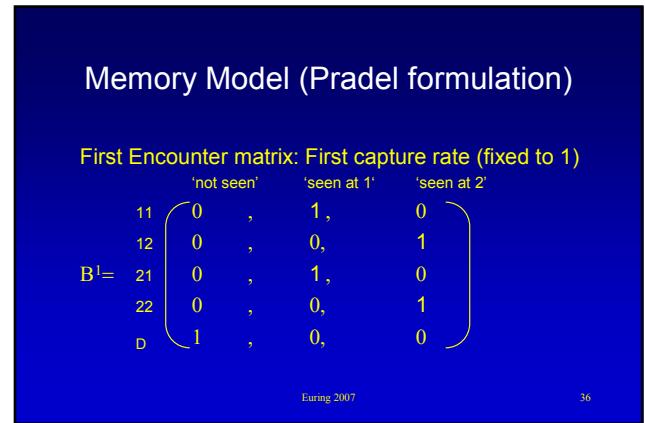
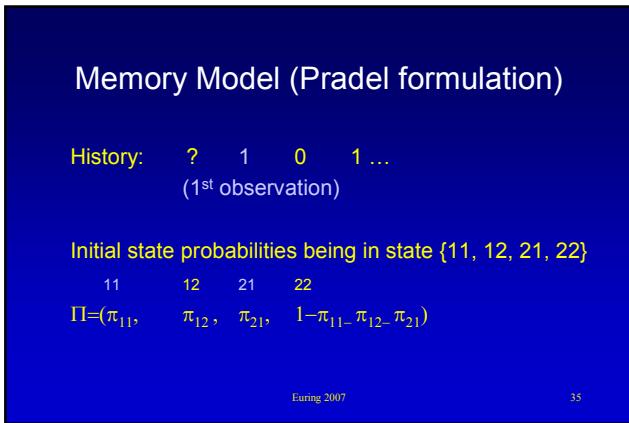
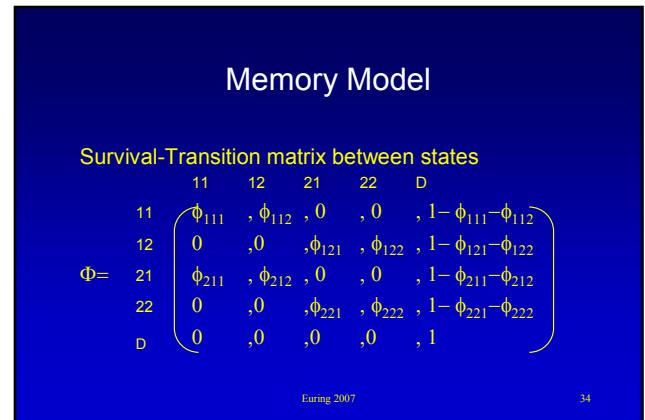
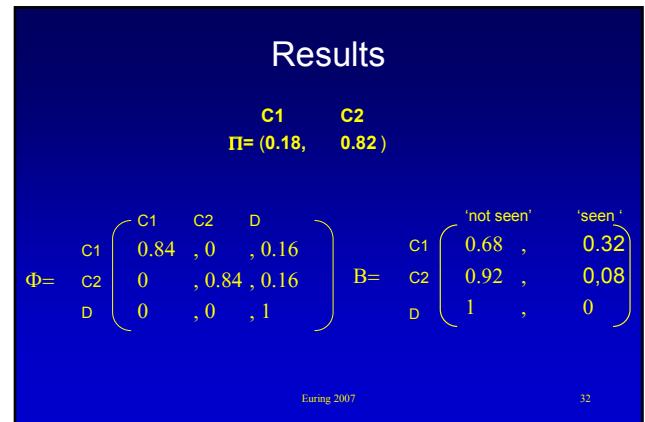
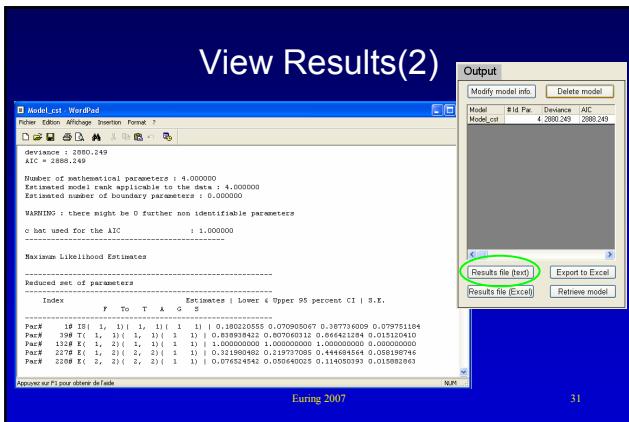
$$\Phi = \begin{pmatrix} C_1 & C_2 & D \\ C_1 & \phi_{C_1} & , 0 & , 1 - \phi_{C_1} \\ C_2 & 0 & , \phi_{C_2} & , 1 - \phi_{C_2} \\ D & 0 & , 0 & , 1 \end{pmatrix}$$

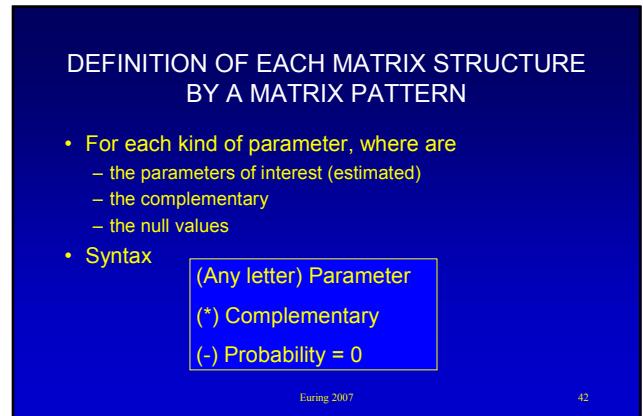
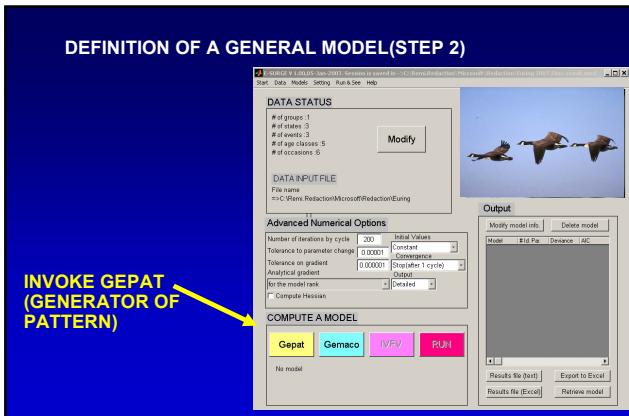
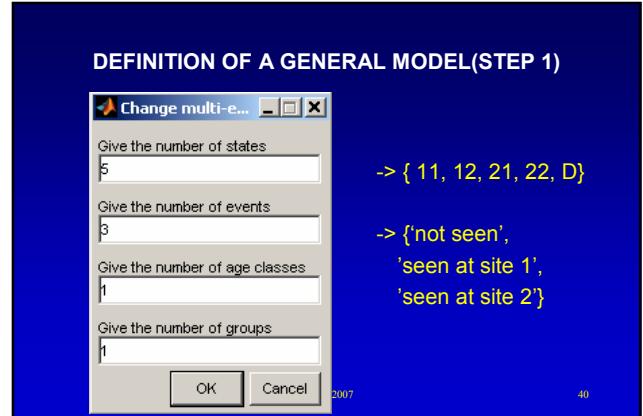
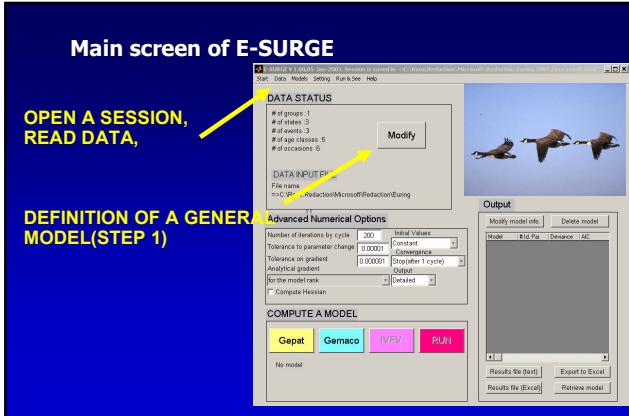
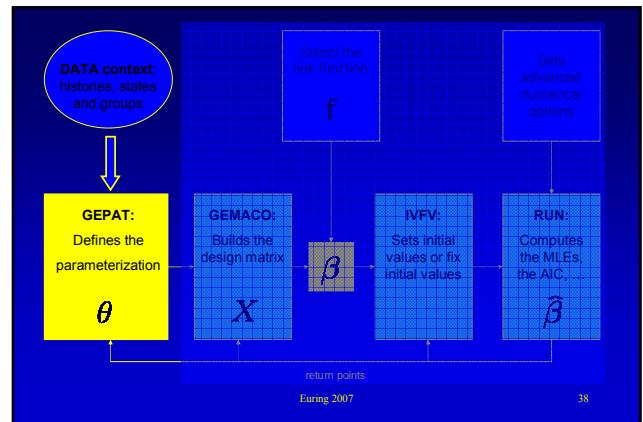
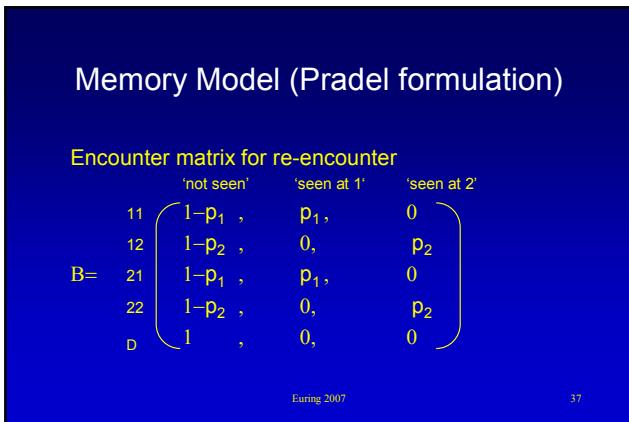
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INITIAL STATE PATTERN VECTOR

- Initial State vector

$$\Pi = (\pi_{11}, \pi_{12}, \pi_{21}, 1 - \pi_{11} - \pi_{12} - \pi_{21})$$

- Initial State pattern vector

$$P\Pi = (\pi, \pi, \pi, *)$$

(Any letter) Parameter
(*) Complementary
(-) Probability = 0

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GEPAT interface: initial state

The screenshot shows the GEPAT interface with the 'Initial state' tab selected. The 'Matrix Pattern' table has four columns labeled 1, 2, 3, 4. The first row contains the values $\pi, \pi, \pi, *$. The 'Options' section indicates 1 row and 4 columns.

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TRANSITION MATRIX

$$\Phi = \begin{pmatrix} 11 & 12 & 21 & 22 & D \\ 11 & \phi_{111}, \phi_{112}, 0, 0, 1 - \phi_{111} - \phi_{112} \\ 12 & 0, 0, \phi_{121}, \phi_{122}, 1 - \phi_{121} - \phi_{122} \\ 21 & \phi_{211}, \phi_{212}, 0, 0, 1 - \phi_{211} - \phi_{212} \\ 22 & 0, 0, \phi_{221}, \phi_{222}, 1 - \phi_{221} - \phi_{222} \\ D & 0, 0, 0, 0, 1 \end{pmatrix}$$

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GEPAT interface: survival-transition

The screenshot shows the GEPAT interface with the 'Transition' tab selected. The 'Matrix Pattern' table has five columns labeled 1, 2, 3, 4, 5. The first row contains the values $\psi, \psi, -, -, *$. The 'Options' section indicates 5 rows and 5 columns.

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Encounter matrix

$$B = \begin{pmatrix} 'not seen' & 'seen at 1' & 'seen at 2' \\ 11 & 1 - p_1, p_1, 0 \\ 12 & 1 - p_2, 0, p_2 \\ 21 & 1 - p_1, p_1, 0 \\ 22 & 1 - p_2, 0, p_2 \\ D & 1, 0, 0 \end{pmatrix}$$

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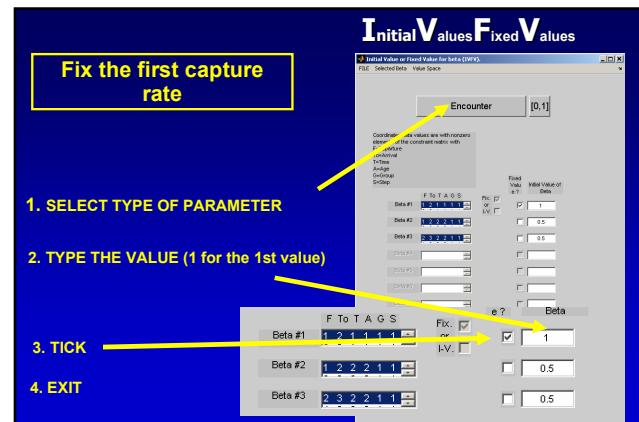
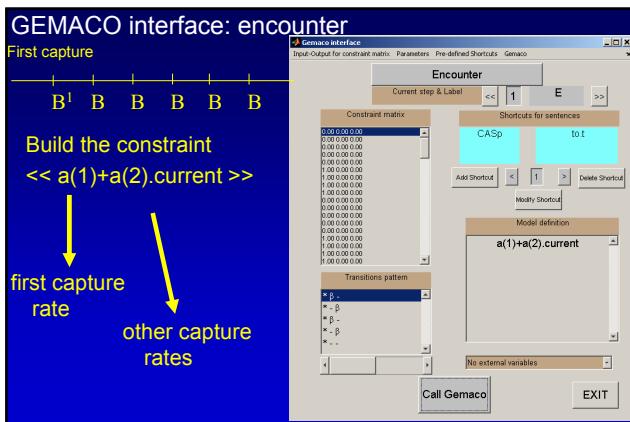
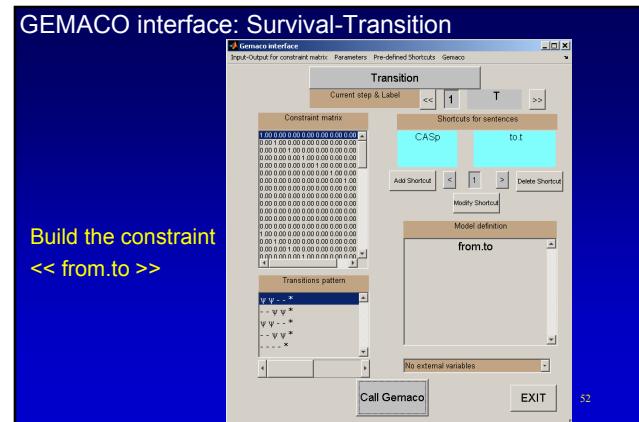
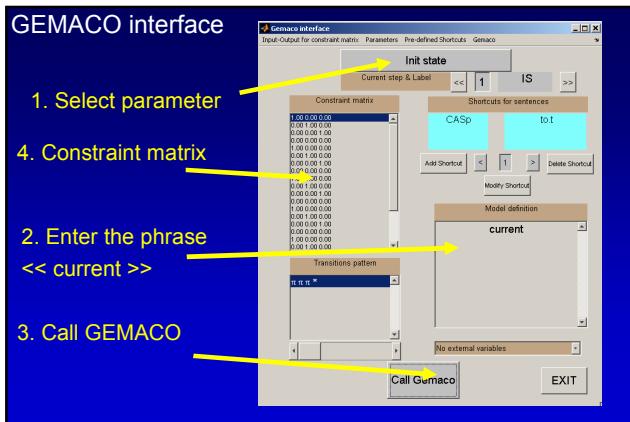
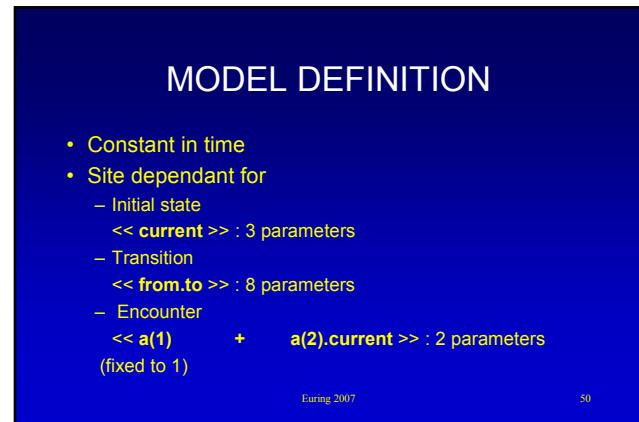
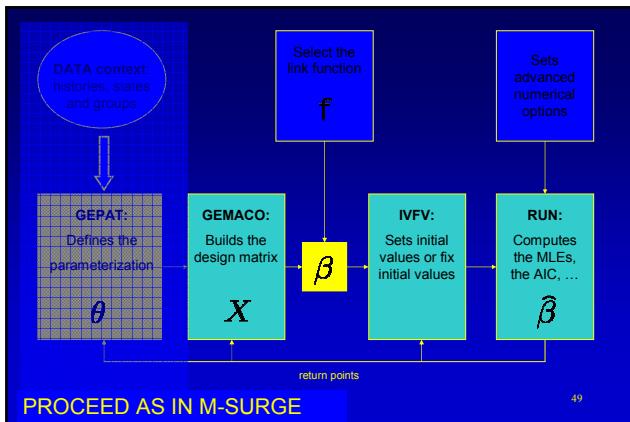
47

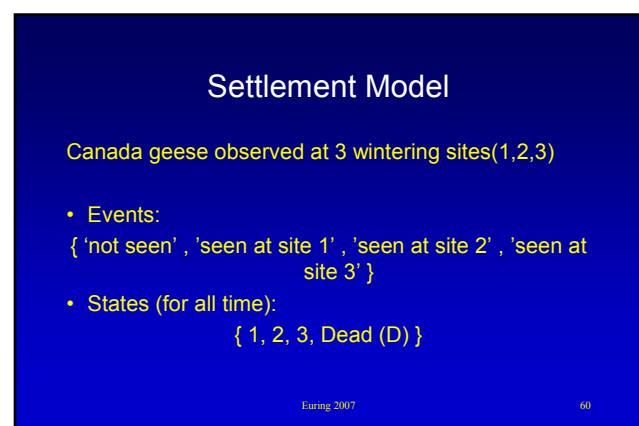
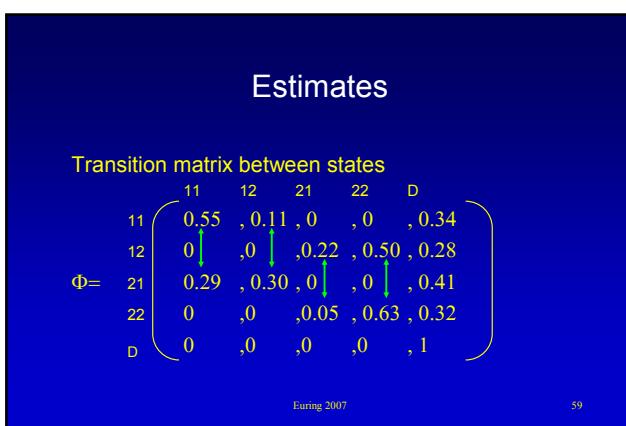
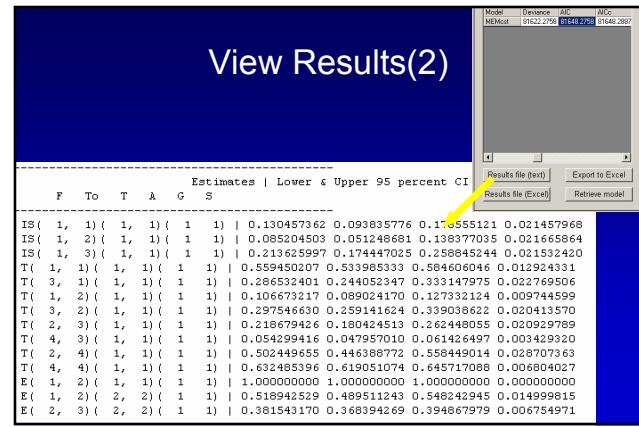
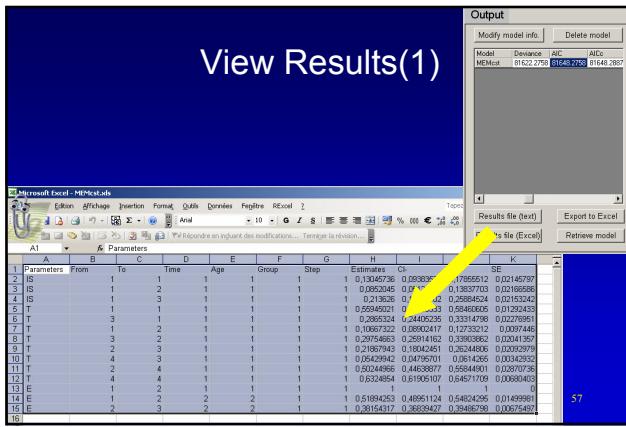
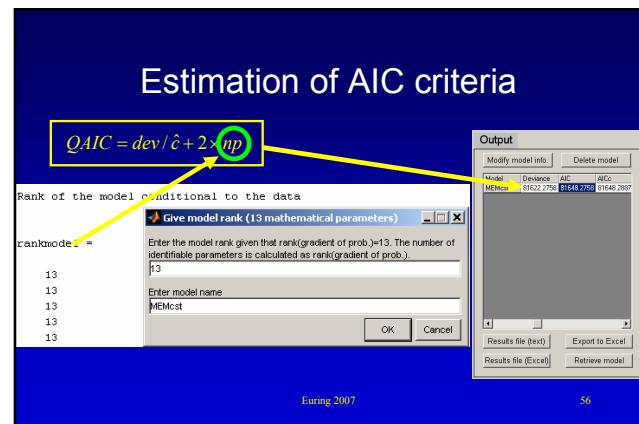
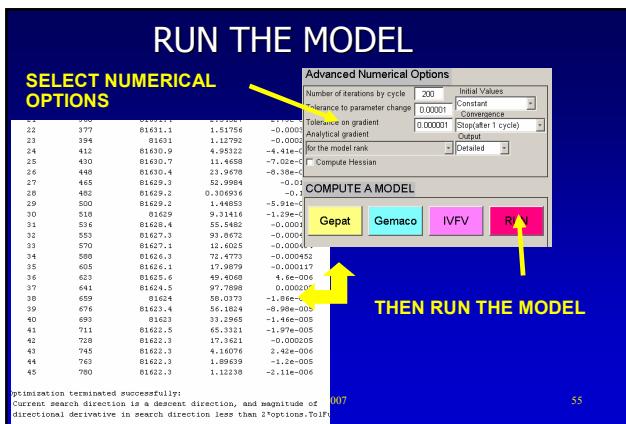
GEPAT interface: encounter

The screenshot shows the GEPAT interface with the 'Encounter' tab selected. The 'Matrix Pattern' table has five columns labeled 1, 2, 3. The first row contains the values $\beta, \beta, -, -, *$. The 'Options' section indicates 5 rows and 3 columns.

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Settlement model

Survival-Transition matrix between states

$$\Phi = \begin{pmatrix} 1 & 2 & 3 & D \\ s_1 f_1 & s_1(1-f_1) \psi_{12} & s_1(1-f_1) \psi_{13} & 1-s_1 \\ 2s_2(1-f_2) \psi_{21} & s_2 f_2 & s_2(1-f_2) \psi_{23} & 1-s_2 \\ 3s_3(1-f_3) \psi_{31} & s_3(1-f_3) \psi_{32} & s_3 f_3 & 1-s_3 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

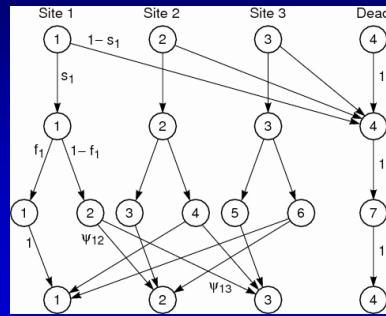
s : survival

f : fidelity conditional to survival

Ψ : movement conditional to leaving

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Diagram for the Settlement model



Survival

Fidelity

Movement

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Step 1: Survival matrix

$$\Phi^{(1)} = \begin{pmatrix} 1 & 2 & 3 & D \\ s_1 & , 0 & , 0 & , 1-s_1 \\ 0 & , s_2 & , 0 & , 1-s_2 \\ 0 & , 0 & , s_3 & , 1-s_3 \\ 0 & , 0 & , 0 & , 1 \end{pmatrix}$$

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Step 2: Fidelity matrix

After leaving, we must keep the memory of the sites previously occupied

Intermediate set of states {Staying in 1(S1)', Leaving 1(L1)', staying in 2(S2)', Leaving 2(L2)', Staying in 3(S3)', Leaving 3(L3)’}

$$\Phi^{(2)} = \begin{pmatrix} S1 & L1 & S2 & L2 & S3 & L3 & D \\ f_1 & 1-f_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & f_2 & 1-f_2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & f_3 & 1-f_3 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

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Step 3: Movement matrix

The memory of the sites previously occupied is now used {S1', L1', S2', L2', S3', L3'} for movement

$$\Phi^{(3)} = \begin{pmatrix} 1 & 2 & 3 & D \\ S1 & 0 & 0 & 0 \\ L1 & 0 & \psi_{12} & 1-\psi_{12} & 0 \\ S2 & 0 & 1 & 0 & 0 \\ L2 & \psi_{21} & 0 & 1-\psi_{21} & 0 \\ S3 & 0 & 0 & 1 & 0 \\ L3 & \psi_{31} & 1-\psi_{31} & 0 & 0 \\ D & 0 & 0 & 0 & 1 \end{pmatrix}$$

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Settlement Model

Initial state probabilities being in site {1, 2, 3}

$$\Pi = (\pi_1, \pi_2, 1-\pi_1-\pi_2)$$

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