Learning spatio-temporal trajectories from manifold-valued longitudinal data
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### Understanding 𝑡, 𝛾

The temporal learning hierarchical trajectory with measurements across the population. Noting that the MCMC-SAEM requires the model to belong to the curved exponential family. However, the multivariate logistic curves model does not belong to this family. The model can be made exponential by considering each parameters as realizations of independent Gaussian random variables.

The parameters of the generic spatio-temporal model are \( \theta = (\theta_0, \theta_1, \ldots, \theta_n, \nu, \Xi, \alpha, \beta, \kappa) \).

**Summary**

- **Theoritical results regarding the convergence of the algorithm have been proved in [Delyon et al., 1999, Allassonnière et al., 2010]**.

**Overview of the MCMC-SAEM for the multivariate logistic curve model**

- **Initialization**
  - \( \theta = \theta_0^{(0)}, \theta^{(0)} \rightarrow \) random, \( S = 0 \), \((\theta_0^{(i)}, \theta^{(i)}))_i \). sequence of positive step-sizes \( \eta \rightarrow \) until convergence

**Simulation**

- **Hasting-Metropolis within Gibbs sampler**
  - Compute the sufficient statistics \( S_{\mathbf{X}}^{(i)}, S_{\mathbf{y}}^{(i)}, S_{\mathbf{w}}^{(i)}, S_{\mathbf{i}}^{(i)} \): MCMC-SSEM
  - **Stochastic approximation**
    - \( S_{\mathbf{X}}^{(i)} = S_{\mathbf{X}}^{(i)} + \frac{1}{S_{\mathbf{X}}^{(i)}} \delta (\mathbf{x}^{(i)}) \)
    - **Maximization**
      - \( \theta^{(i+1)} = \argmax_{\theta^{(i)}} \left\{ \log p \left( \mathbf{x}, \mathbf{y}^{(i)} \mid \theta^{(i)} \right) \right\} : \) closed-form updates end repeat

**Data**

- Normalized cognitive score groups divided into four categories (biomarkers) : memory (5 items), language (5 items), praxis (2 items), concentration (1 item).

Data collected from the ADNI database for 248 MCI patients who converted to AD. Each observation is a point in \( \mathbf{K} = [0,1]^n \).

**Experimental results**

- The plot of longitudinal data on rank annuals data shows that the time effects correspond well with the signs which individuals experienced by \( \mathbf{H} \).

**Future**

- Experiments on the effect of the assumption of independence for longitudinal data. Using the subject-specific model, \( \theta^{(i)} \), in the context of clinical trials. The results may be presented in the future.

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**Introduction**

- **Model**: the progression of neuro-degenerative diseases

- **Temporal learning hierarchical trajectory**

- **Biomarkers**

- **Longitudinal measurements**

- **Temporal progression of a family of \( N \) biomarkers**

**Three particular cases of our generic spatio-temporal model**

- **Straight lines model**
  - \( M = \mathbb{R} \) equipped with the canonical metric
  - Geodesics are straight lines

- **Logistic curves model**
  - \( M = [0,1] \), equipped with the logistic metric
  - Geodesics are logistic curves

**References**


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**Generic spatio-temporal model for longitudinal data**

- **Summary**: we propose a generic mixed-effects model for longitudinal manifold-valued data. The model is studied in the temporal progression of a family of univariate biomarkers.

- **Objective**: we want to study the temporal progression of a family of \( N \) biomarkers.

**Average trajectory**

- \( \tau = \gamma(x) \)

**Trajectory of the \( i \)-th individual**

- \( y_i = \phi_i(x_i) + \epsilon_i \)

**Observations**

- \( \epsilon \sim \mathcal{N}(0, \Sigma) \)

**A hierarchical model**

- **Model**: the progression of neuro-degenerative diseases

- **Longitudinal measurements**

- **Temporal progression of a family of \( N \) biomarkers**

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**References**

