Non-linear Spatio-temporal modelling using the Integro-Difference Equation

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Abstract

Index Terms

Dynamic spatio-temporal modelling, Integro-Difference Equation (IDE), ...

Non-linear Spatio-temporal modelling using the Integro-Difference Equation

I. Introduction

Non-linear spatio-temporal behaviour...

II. Neural Field Model

III. State space Representation of the Spatio-temporal Non-linear IDE

The dynamics of the pth order non-linear, stochastic, spatio-temporal IDE is described by

$$\epsilon_t(\mathbf{r}) = \int_\Omega w(\mathbf{r},\mathbf{r}')f(v_{t-p}(\mathbf{r}'))d\mathbf{r}' + \mathbf{e}_{t-p}(\mathbf{r}) \tag{1}$$

where $\epsilon_t(\mathbf{r})$ is a lag polynomial defined as

$$\epsilon_t(\mathbf{r}) = (1 + \sum_{i=1}^{p} \varphi_i L_i) v_t\,(\mathbf{r}) \tag{2}$$

where $v_t(\mathbf{r})$ denotes the spatial field at time t and spatial location $\mathbf{r}$, $f(.)$ is some nonlinear function, and $w(.)$ is the spatial kernel. Here we consider the case where $p = 1$, therefore we have

$$v_t(\mathbf{r}) + \varphi_1 v_{t-1}(\mathbf{r}) = \int_\Omega w(\mathbf{r},\mathbf{r}')f(v_{t-1}(\mathbf{r}'))d\mathbf{r}' + \mathbf{e}_{t-1}(\mathbf{r}) \tag{3}$$

IV. Estimation of the Non-linear Spatio-temporal IDE Model

A. *Unscented Kalman Filter*

B. *Unscented RTS Smoother*

C. *Parameter Estimation*

D. *Computational Complexity*

V. Example

VI. Conclusion

Appendix

Lemma 1:

Proof:

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