

# Controlling parasitic infections

**Concept.** The idea here is to limit the spread of some abstract spatial parasitic infections through the correct time-dependent resource allocation.

## 6.1 Adapting the probabilistic formalism

Let's by returning to the probabilistic formalism that we introduced earlier and noting that the covariance matrix estimate with elements  $C_{t+1}^{ij}(z)$  represents a matrix that could get very large, depending on the problem. For example; if we encoded the state of a 2-dimensional spatial field of values into the elements  $X_t^i$ , the number of elements in the covariance matrix  $C_{t+1}^{ij}(z)$  would scale as  $4N^2$  — where  $N$  here is the number of spatial points we wanted to encode.

One solution to this scaling problem is to exploit the fact that, in many spatial processes, the proximity of points can strongly determine how correlated they are. Hence, for pairwise distances further than some threshold, the covariance matrix elements should tend towards 0. If we were to place points along the diagonal of  $C_{t+1}^{ij}(z)$  in order of how close they are to each other, this threshold would then be represented as a *banded matrix*. We have illustrated such a matrix in Fig. 6.1 in which the 'bandwidth' is defined as the number of diagonals one needs to traverse from the main diagonal before encountering a diagonal of 0s.

- Full sim: fully individual-based spatial stochastic model
- Inference model: spatial mean field inference features using the probabilistic reweighting + exponentially-weighted nonlinear features
- Also use the likelihood-free inference model and amortized sim inference model.
- At some point it might be sensible to move into the Fourier domain here — at least for derivations and calculations. Probably more intuitive for the reader to keep it mostly in real space though if possible.



# Bibliography

- [1] E. Sellentin, M. Quartin and L. Amendola, *Breaking the spell of gaussianity: forecasting with higher order fisher matrices*, *Monthly Notices of the Royal Astronomical Society* **441** (2014) 1831–1840.
- [2] T. Smith, N. Maire, A. Ross, M. Penny, N. Chitnis, A. Schapira et al., *Towards a comprehensive simulation model of malaria epidemiology and control*, *Parasitology* **135** (2008) 1507–1516.
- [3] J. Đorđević, *A stochastic model for malaria and its behavior under insecticide-treated nets*, *Studies in Applied Mathematics* **149** (2022) 631–656.