NON-MYOPIC APPROACHES TO SENSING AND SURVEYING

George Jones, Supervised by Ángel Garcia-Fernandez, Prudence Wong & Scott Page
EPSRC Centre for Doctoral Training in Distributed Algorithms, University of Liverpool, Liverpool, UK

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1. INTRODUCTION

Sensor management algorithms typically use Bayesian information theoretic approaches to evaluate the value of different sensor combinations and platform actions.

Even when these actions are considered over a single discrete time-step (myopic), the problem begins to suffer from combinatorial explosion.

Optimising over multiple time-steps (non-myopic) allows for higher long-term gain and enables mitigation of real-world challenges, such as obstacles to gathering information [1].

2. AIM

To further develop the understanding and capabilities of non-myopic approaches to sensor management.

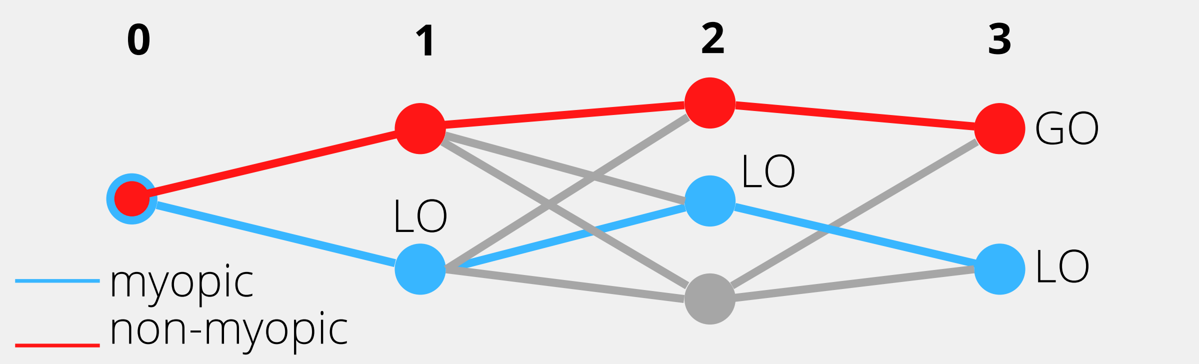
3. OBJECTIVES

The aim of the research project will be met by considering:

- Myopic algorithms for Gaussian Bernoulli
- Non-myopic algorithms for Gaussian Bernoulli
- Myopic algorithms for Gaussian Multi-Bernoulli
- Non-myopic algorithms for Gaussian Multi-Bernoulli
- Optimising these algorithms for the appropriate hardware they will be implemented on

4. VISUALISATION

Myopic approaches are greedy and will choose the local optimum (LO) at every time-step which may not result in the global optimum (GO) being reached.



5. CURRENT SCENARIO

To date, the research conducted extends to the Gaussian Bernoulli myopic planning.

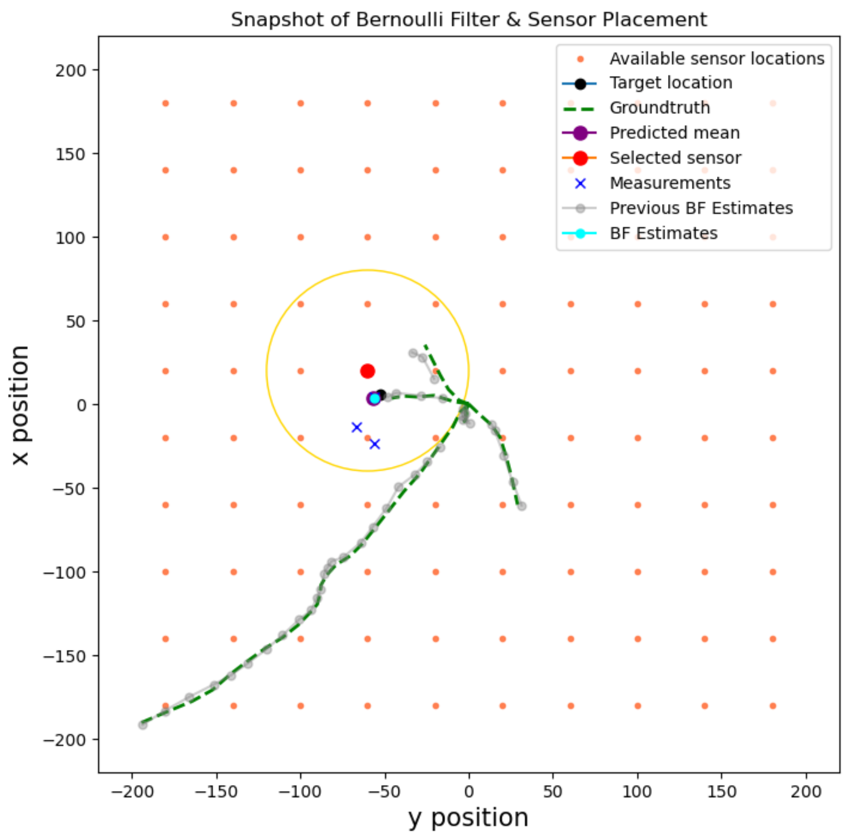
Scenario - only one object alive at any given time, 100 time-steps.

The Bernoulli filter requires the propagation of [2]:

- Probability of existence
- Means
- Covariances
- Associated weights

The figure shows time-steps 0:82(/100)

The ground-truth is a randomly generated path, born at the origin based on a transition matrix (F) & some process noise (Q).



The measurements consist of two parts, and are subject to both localisation and cardinality errors.

Detections

Desirable measurements, based on the ground-truth and use an observation matrix (H) & some measurement noise (R)

Clutter

Random measurements, amount determined by Poisson distribution. Randomly generated in FOV of sensor.

Sensor positions are discretised as shown

Sensor selected based on nearest sensor to the prediction. If there is no prediction i.e. probability of existence < 0.5, the sensor returns to the expected birth location.

6. GOSPA ERROR

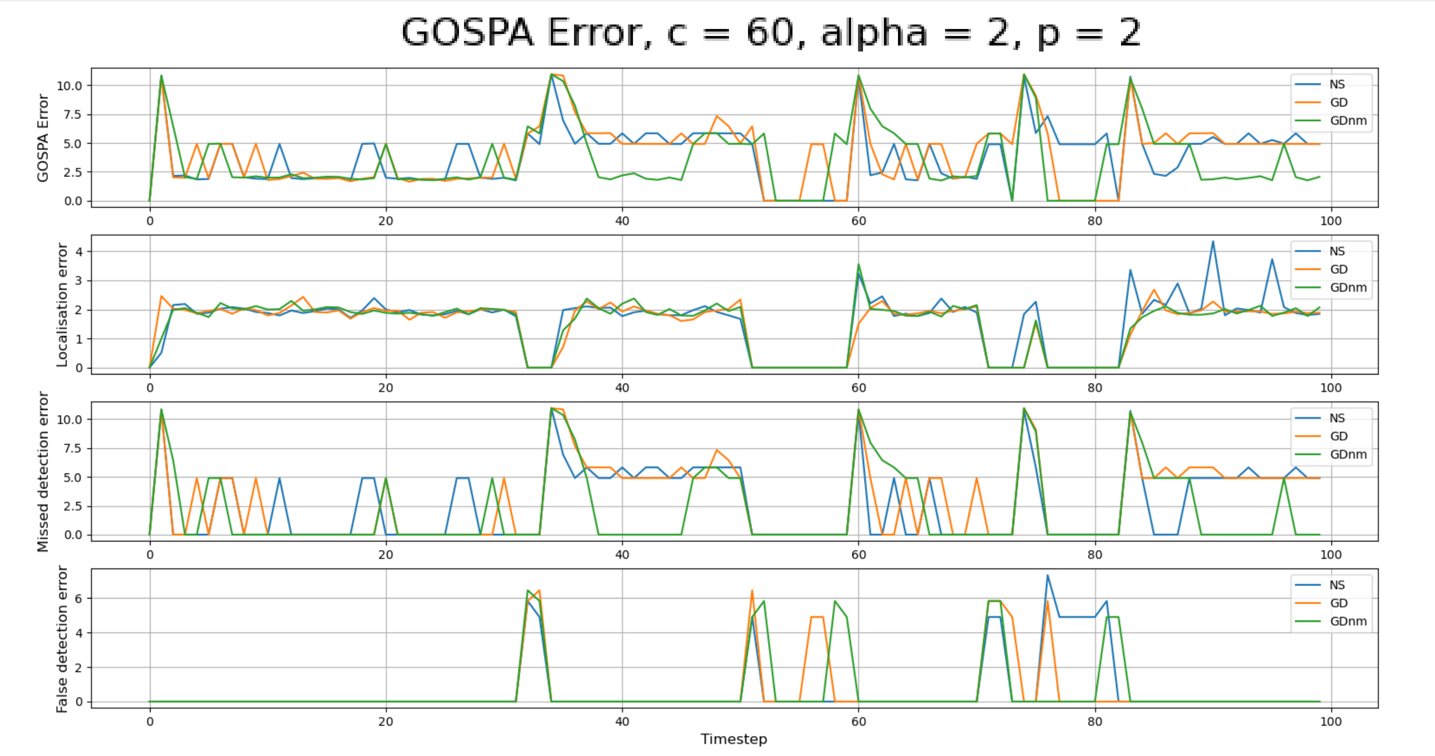
- Generalised optimal sub pattern assignment (GOSPA) is a metric which provides a 'score' of how well two sets match [3].
- It considers localisation errors, missed detections and false targets
  - All parameters of interest in target tracking.

7. GOSPA DRIVEN SENSOR MANAGEMENT

As GOSPA can be used as a performance quantifier, it makes intuitive sense to build it into the workings of the sensor management algorithm.

At each timestep, sensor management aims to take the action which minimises the expected GOSPA error. This is calculated by generating a synthetic measurement, located at the predicted mean and using GOSPA to provide an error score. The algorithm can then perform sensor management by selecting the action with the lowest associated expected GOSPA error.

The plot on the right shows the GOSPA driven algorithm benchmarked against the Nearest Sensor algorithm in a myopic setting for the scenario described in Section 5.



RELATED LITERATURE

[1] Yue, X., & Kontar, R.A. (2020). Why Non-myopic Bayesian Optimization is Promising and How Far Should We Look-ahead? A Study via Rollout. AISTATS.
[2] B. Ristic and J. Sherrah, "Bernoulli filter for detection and tracking of an extended object in clutter," 2013 IEEE Eighth International Conference on Intelligent Sensors, Sensor Networks and Information Processing, 2013, pp. 306-311, doi: 10.1109/ISSNIP.2013.6529807.
[3] Rahmathullah, Abu Sajana & García-Fernández, Ángel & Svensson, Lennart. (2017). Generalized optimal sub-pattern assignment metric. 10.23919/ICIF.2017.8009645.

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