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A computational stochastic approach for determination of coordinated air defence firing strategies

Coordinated air defence involves the determination of a firing strategy across a group of air defence units employing surface-to-air missiles to counter an air raid. A key objective for a firing strategy is to achieve a desired hit probability against each threat in the raid whilst minimising total missile expenditure to counter the raid. Instrumental to this is the adoption of shoot-look-shoot firing policies where possible. The problem is subject to time and resource constraints and is further complicated by uncertainties in threat behaviours as the raid progresses. This paper presents an overview of a computational stochastic method developed for solving this problem in context of naval task group air defence. This method involves the construction of decision trees composed of firing options arising from projections of the threats through the engagement zones for the air defence units. Each firing option captures a possible engagement for a defending unit firing a salvo of one or more missiles against a threat at a specified time. Associated with each firing option is an engagement assessment performed using precomputed missile engagement zones that provide intercept times and hit probabilities for given launch conditions. The decision tree is searched to yield a Pareto efficient boundary for hit probability versus missile expenditure, from which an optimal firing strategy can be obtained. The methodology is now being applied in a fast running ship stationing model to complement physics-based Monte Carlo models for investigating task group air defence.