1. Education's Purpose

Operations Research (OR) is closely related to political science, economics, military operations, sport science etc. The purpose of the OR course is to provide fundamental knowledge and application skills in OR. Students study probability theory, optimization theory and some OR models such as mathematical programming as foundations. In this course, students also study applications of OR, e.g. search theory, firing & combat theory, as dissertation research.

2. Faculty

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3. Research Topics

- ♦ Optimization Theory
- ♦ Game Theory
 - Search game (*refer to Appendix 1/2)
 - Inspection game (*refer to Appendix 1/2)
 - Sponsored Link Auction
 - Coalition Formation
- ♦ Search Theory
 - Search with false contacts
 - Multi-stage search game
 - Search taking account of attributes of search resource
- Firing & combat Modelling (*refer to Appendix 2/2)
- Other Methodologies on Operations Research

4. Recent Publications(2006-2008)

Publications :

R. Hohzaki, D. Kudoh, T. Komiya, An inspection game: Taking account of fulfillment probabilities of players' aims, *Naval Research Logistics*, Vol.53 (8), pp.761-771, 2006.12

R. Hohzaki, N. Ohsiro, T. Komiya and E. Fukuda, A search game with durable searching resources, *Scientiae Mathematicae Japonicae*, Vol.65 (1), pp.105-121, 2007.1.

T. Komiya, K. lida and R. Hohzaki, An optimal investigation in two stage search with recognition errors, *Journal of Operations Research Society of Japan*, Vol. 49 (2), pp.130-143, 2006.6.

E. Fukuda, S. Tijs, R. Branzei and S. Muto, Compromising in partition function from games and cooperation in perfect extensive form games, *International Game Theory Review*, 8 (3), pp.329-338, 2006.9.

Talks :

T. Komiya and M. Pholphan: Stochastic Lanchester Models Taking Account of Missile Attack and Defense Capabilities, 22nd European Conference on Operational Research, 2007.7.

Fukuda, E. and Y. Wakita: Stability and Validity of LDP-Komei Coalition Government in 2008, Asian Conference on Nonlinear Analysis and Optimization, 2008.9.

Research on Military Affairs



Inspection Game of Customs (C) vs. Smuggler (S)

What is effective patrol to deter illegal smuggling?

Formulation into a multi-stage stochastic TPZS game

Strategy of C: Patrol (P) or Non-Patrol (NP) Strategy of S: Smuggle (S) or Non-Smuggle (NS)

n: Stage #, k (or I) : Chances to patrol (or smuggle)
p₁: Prob. to capture S, p₂: Success Prob. of S
a: Reward of C on capture, 1: Reward of S on success

 $\Gamma(n, k, l)$: Stage Game at Stage n

 $= \Pr_{\mathsf{NP}} \left(\begin{array}{cc} \alpha p_1 - p_2 + (1 - p_1)\Gamma(n - 1, k - 1, l - 1) & \Gamma(n - 1, k - 1, l) \\ -1 + \Gamma(n - 1, k, l - 1) & \Gamma(n - 1, k, l) \end{array} \right)$

Optimal strategies of C and S

n	k	1=1	1=2	1=3	1=4
1	0	(0, 1)			
	1	(1, 1)			
2	0	(0, 1)	(0, 1)		
	1	(.37, .37)	(.45,.45)		
	2	(1,0)	(1,0)		
3	0	(0,1)	(0,1)	(0,1)	
	1	(.27,.27)	(.29,.50)	(.37,.57)	
	2	(.48,.18)	(.51,.23)	(.52,.24)	
	3	(1,0)	(1,0)	(1,0)	
4	0	(0,1)	(0,1)	(0,1)	(0,1)
	1	(.21,.21)	(.22,.39)	(.25,.55)	(.31,.62)
	2	(.40,.18)	(.41,.30)	(.44,.35)	(.45,.36)
	3	(.53,.10)	(.54,.13)	(.55,.13)	(.55,.13)
	4	(1,0)	(1,0)	(1,0)	(1,0)

* In case of a=2, p1=0.5, p2=0.3

6. Some Optimizations in MPA Operation

Warning & Surveillance (W&S)

What is the most efficient route for W&S?

 \rightarrow Construct the standard piece-wise linear, closed route to maximize the expected value of detected ships within an operation !





Two Stage Search (Broad Search & Investigation)

Broad search for an uncertain signal (= contact) \rightarrow Got a contact !

- \rightarrow How long should the operator investigate the contact ?
- \rightarrow The optimal investigating time τ^* depend on the pos. class and residual time.



Sonobuoy Distribution

How many sonobuoys should be distributed to a gotten contact ?

- Maximize the detection prob. of target
- Consider the residual time and buoys



Got 4 contacts at t = 300,240,180 and 120. \rightarrow Eject 2,3,4 and 4 buoys at each time