(科目名) (英 訳)	オペレーションズリサーチ概論 Introduction to Operations Research	(所属部局) 総合生存学館		(職 名) 准教授	(氏 名) 趙 亮

(配当学年) 1回生以上	(単位数) 2単位	(開講年度・開講期) 2024・前期

(曜時限) 火4	(教室) 東一条館020セミナー室	(授業形態) 講義（対面授業科目）

(使用言語) 日本語及び英語

(授業の概要・目的)

Operations Research (OR) is the application of advanced analytical methods to help make optimal or better decisions. This lecture introduces some fundamental methods in OR including game theory, graph/network, linear programming, integer programming, support vector machine (SVM), artificial neural network (ANN). The aim is to develop basic ability to mathematically model real problems and solve them with an appropriate approach.

The lecture will be given in English (Japanese is possible as well).

(到達目標)

1. Get used to think real issues with mathematical models.
2. Understand the fundamental methods introduced in this lecture and can use them to model and solve real problems.

(授業計画と内容)

1. Introduction
2. Game theory: Prisoner's dilemma, Nash equilibrium, Rational pigs
3. Graph and a network traffic game
4. Pareto efficiency, incentive compatibility, graph/network introduction
5. Top Trading Cycle algorithm: an example of graph theory in economics
6. Computation, scheduling, graph search and trees
7. Linear programming and the duality
8. Integer programming, branch-and-bound algorithm, dynamic programming
9. Practice in solving mathematical programming: solvers
10. Practice in solving graph problems: shortest path
11. Network analysis
12. Machine learning
13. Support vector machine
14. Artificial neural network
15. Feedback

(履修要件)

* Undergraduate level of mathematics including calculus and linear algebra
* Experience in programming

(成績評価の方法・観点)

class participation (30%) + mini tests (30%) + final report (40%)

including discussion, not just attendance

(教科書)
使用しない

(参考書等)
授業中に紹介する

Also maybe after a lecture.

(授業外学修（予習・復習）等)

Usually at the beginning of a lecture there is mini test on the last lecture. So please always review the last lecture carefully before coming.

Ex1. A horse racing game (about BC 300)

田忌赛马 in Chinese. See a movie on Youtube.

https://www.youtube.com/watch?v=cLpi-f4j4bM

Quick Chinese Idioms Ep2: Tian Ji's horse race 田忌赛马

531 views · Jul 10, 2020   👍 17   👎 0   ↪ SHARE   ☰+ SAVE   ···
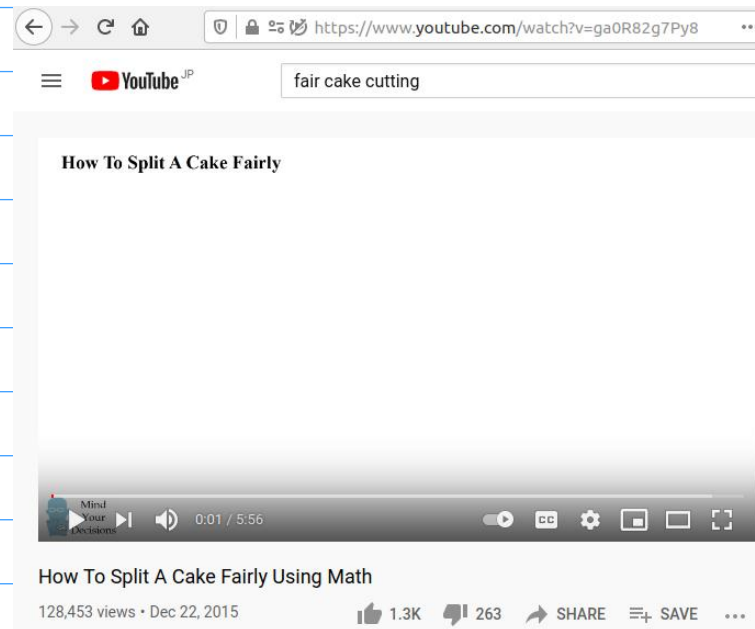
Points of this story:

1. Power is important; strategy is also important.

2. This leads to Game Theory (also with fairness concept).

Ex2. Fair cake division (about BC ??)

How to cut a cake "fairly", i.e., envy-free?

=> https://www.youtube.com/watch?v=ga0R82g7Py8

The divide-and-choose method was first mentioned in the Bible.
It is widely used including the UN Convention on the Law of the
Sea (went into effect since 1994 with 157 signatories).

The United Nations Convention on the Law of the Sea applies a procedure similar to divide-and-choose for allocating areas in the ocean among countries. A developed state applying for a permit to mine minerals from the ocean must prepare two areas of approximately similar value, let the UN authority choose one of them for reservation to developing states, and get the other area for mining:[4][5]

"Each application... shall cover a total area... sufficiently large and of sufficient estimated commercial value to allow **two** mining operations... of equal estimated commercial value... Within 45 days of receiving such data, the Authority shall designate which part is to be reserved solely for the conduct of activities by the Authority through the Enterprise or in association with developing States... The area designated shall become a reserved area as soon as the plan of work for the non-reserved area is approved and the contract is signed."[6]

https://en.wikipedia.org/wiki/Divide_and_choose

Ex3. Morse code (about 1840)

How to efficiently transfer message to remote place?
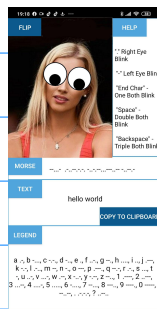
=> https://www.youtube.com/watch?v=iy8BaMs_JuI

How Does Morse Code Work?
331,167 views • Aug 5, 2019
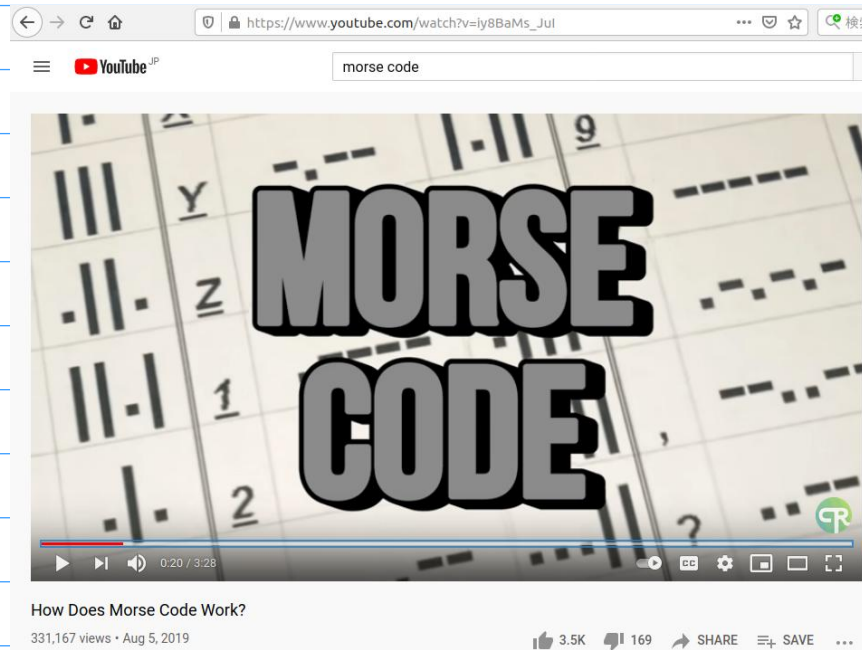
Important points of Morse code

1. Correctness
2. Efficiency

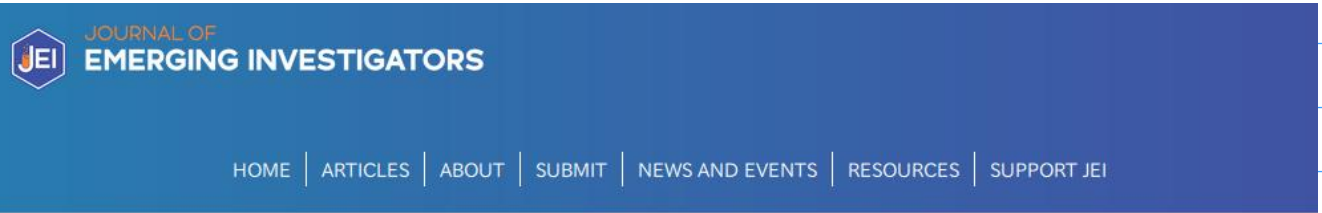Some stories on Morse code:

1. Japanese version
2. Blink to speak

https://ja.wikipedia.org/wiki/モールス符号

現行の和文モールス符号 [編集]

イロハ [編集]

いろは順に欧文モールス符号を当てたものが基本となっている。

拗音および促音については規定されておらず、通常の文字として表現する。

文字	符号	文字	符号
イ	・—	ノ	・・——
ロ	・—・—	オ	・—・・・
ハ	—・・・	ク	・・・—
ニ	—・—・	ヤ	・——
ホ	—・・	マ	—・・—
ヘ	・	ケ	—・——
ト	・・—・・	フ	——・・

https://apkpure.com/eyes-blink-morse-code-type-text/com.shevchuk.eyesmorseblink

Ex4. Deficit reduction by printing with different fonts

https://www.emerginginvestigators.org/articles/a-simple-printing-solution-to-aid-deficit-reduction

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A Simple Printing Solution to Aid Deficit Reduction

Suvir Mirchandani (1) and Peter Pinko (2)

(1) Fox Chapel Area Senior High School, Pittsburgh, Pennsylvania, (2) Dorseyville Middle School, Pittsburgh, Pennsylvania

Mar 09, 2014

14-years old

The printing-related expenditure that is budgeted in 2014 for U.S. Federal agencies is $1.8 billion. Even though printing expenditure has been decreasing in recent years, it continues to be high and a small percentage decrease in printing expenditure due to a font change could result in substantial monetary savings. A sample of five publically available documents produced by various federal agencies is

Total Federal, State and Local Savings ($ in millions)

Percent Coverage Ratio Decrease	% Ink Cost Relative to Total Printing and Reproduction Expenditure		
	20%	25.96%	32%
10%	62	80	99
15%	92	120	148
20%	123	160	197
25%	154	200	246
29.24%	180	234	288
35%	216	280	345
40%	246	320	394

Observations

1. Channel purfume No. 5: $▨▨▨/Oz

2. HP printer ink: $▨▨▨/Oz

3. Different fonts consume different volume of printer ink to print.

Proposal

Times New Roman -> Garamond

Ex5. Numbers are essential (Battle of the Atlantic)

www.familyheritage.ca/Articles/victory1943.html   120%   🔍 検索

"Numbers are Essential": Victory in the North Atlantic Reconsidered, March-May 1943

by Rob Fisher

https://en.wikipedia.org/wiki/Battle_of_the_Atlantic

Introduction

The Germans conceded defeat in the North Atlantic towards the end of May 1943 after sustaining heavy U-boat losses in a string of convoy battles since the beginning of the month. Allied forces destroyed forty U-boats during May after averaging only fourteen per month from January to April 1943.[1] The U-boat men called it "Black May"; others have called it the "Stalingrad at Sea". The magnitude of the German defeat was all the more surprising because February and March had witnessed several dramatic victories for the wolf packs against elite British and American escort groups.

What happened in the North Atlantic between March and May 1943 to cause this dramatic

U-boat (wolfpack)
            vs
            Allied convoy (merchant ships + escort vessels)

Question on the size of a convoy:

small => faster and difficult to be caught

large => more warships to fight against attacks

Include 2 future Nobel prize winners and other preeminent staffs

Answer by the British CC-ORS
(Coastol Command's Operations Research Section):

"The losses depends largely on the number of escort vessels present, not the size of the convoy."

E.g., 60 merchant + 12 escort is better than 2 x (30 m. + 6 e.).

Modern OR after WWII

According to J. Operations Research:

* Computing and information technologies

* Financial engineering

* Manufacturing, service sciences, and supply chain management

* Policy modeling and public sector work

* Revenue management

* Simulation

* Stochastic models

* Transportation

Mini Report