56:270
Linear Programming

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author

Instructor

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Course Description

This is a course in linear optimization and extensions, including topics in model formulation and analysis, variations of the simplex method for LP, interior-point methods for LP, and duality theory.

Prerequisite

introduction to linear programming, especially the simplex algorithm for LP, such as typically seen in an introductory Operations Research course (e.g., 56:171)

- Review of simplex & revised simplex algorithms
- Upper-bounding & generalized upper-bounding techniques
- Representation of the basis inverse (product form, basis factorization, etc.)
- Duality theory of LP
- Dual simplex algorithm
- Sensitivity analysis & parametric programming
- Decomposition of large problems (e.g., Dantzig-Wolfe decomposition)
- Column-generation algorithms
- Separable (piecewise-linear) programming
- Stochastic LP (chance-constrained LP, and 2-stage stochastic LP with recourse)
- Complementary pivoting algorithm for LP and Quadratic Pgmg.
- Interior-point (polynomial-time) algorithms for LP

Topics

Text

Wayne Winston, *Operations Research: Algorithms and Applications*

Class notes (Hypercard stacks) will also be available to students.

Computer software

Languages:

- APL
- Fortran, Pascal, or C (to interface with subroutine library)

LP packages:

- LINDO
- MPSX
- LP_SOLVE
- CPLEX 6.5

Modeling Languages:

- LINGO
- AMPL
- MPL

APL

"Array Processing Language"

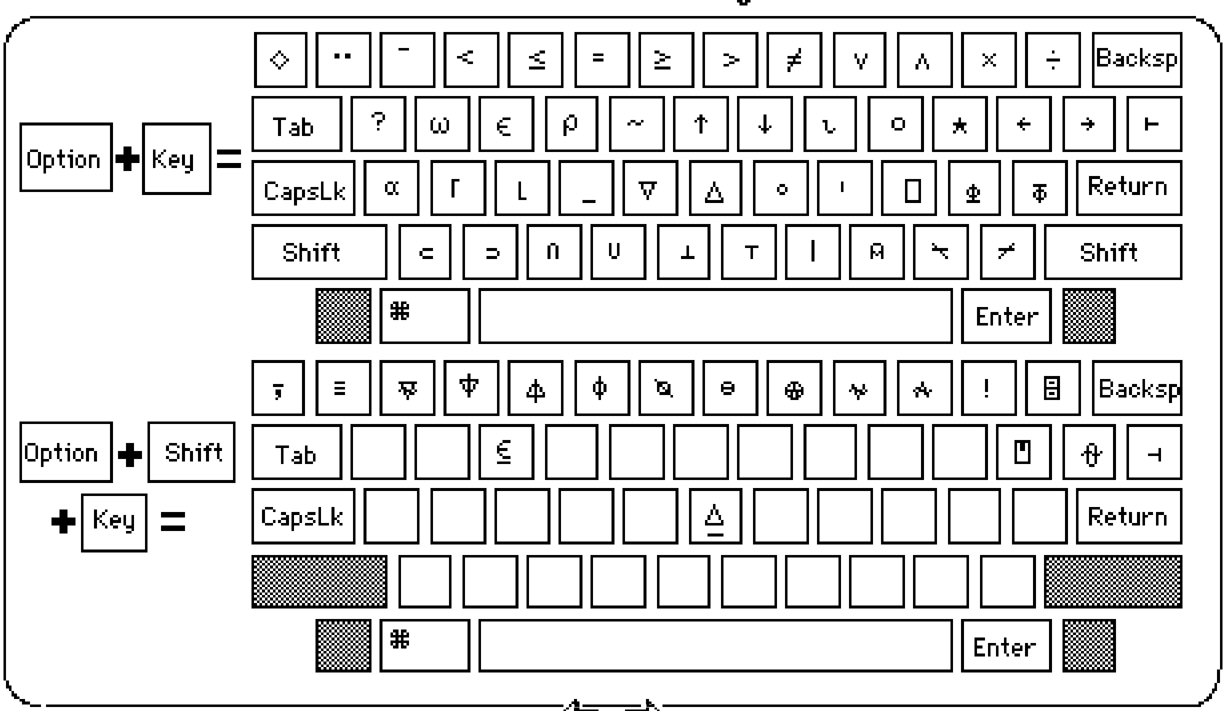
- a concise mathematical notation
- oriented towards manipulation of arrays
- an interactive computer language

APL symbols include many not found on ordinary keyboards.

These are typed by use of the "option" or "option-shift" combination, together with one of the regular keys:

For example, option + H = ∆

APL*PLUS Unified Keyboard



Example

DeMorgan has shown that π can be computed by the following alternating series:

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \ \ldots$$

Approximation of π by first N terms of series:

```
PI ← 4 × -/ ÷ ¯1 + 2 × ⍳ N
```

Example

```
U ← 5 2 8
V ← 1 0 3 7
U ∘.× V
```

vectors

generalized outer product

$$\begin{bmatrix} 5 & 0 & 15 & 35 \\ 2 & 0 & 6 & 14 \\ 8 & 0 & 24 & 56 \end{bmatrix}$$

for example, U[2]×V[4]

Example

Let X[i] and Y[i] be the (x,y) coordinates of point #i

```
X ← 10  30  50
Y ← 40  50  20
```

Computing a Euclidean distance matrix:

```
( ((X∘.-X)*2) + (Y∘.-Y)*2 )*0.5
```

$$\begin{bmatrix} 0 & 22.361 & 44.721 \\ 22.361 & 0 & 36.056 \\ 44.721 & 36.056 & 0 \end{bmatrix}$$

i.e., $\sqrt{(X_i-X_j)^2+(Y_i-Y_j)^2}$ *is in row #i, column #j*

Rather than to present the APL language in the regular class lectures, I will schedule several (optional) out-of-class sessions.

Tentative Grading Scheme

Programming, Lab Exercises	10 %
HW	30 %
Quizzes	30 %
Final Exam	30 %

Quizzes may be given on days that homework is due, and will be short, multiple-choice, true/false, etc.

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- Students will be allowed two 8.5x11-inch "crib sheets" for the final exam.

(It is intended that the exam will test for comprehension of the concepts and mastery of modeling techniques, and not memorization of formulae, etc.)

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- Homework assignments, projects, the course syllabus, etc. will generally be placed on the world-wide-web at the URL

  http://www.alf.ie.engineering.uiowa.edu/bricker/lp_index.html

- Hypercard stacks will usually be used to present the lecture material.
  These stacks will also be placed on the WWW.

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- APL.68000 "workspaces" of computer software for solving various classes of problems will be available over the ICAEN fileserver.
- If you have not already done so, obtain an ICAEN account from the ICAEN office (Rm. 3133 EB).
- If you cannot find me in my office, questions may be addressed to me via e-mail. I will try to reply to these questions the day that they are received, or suggest a time to meet in my office.

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- In order that I can quickly get information to the class between class meetings (e.g., a correction to a homework assignment), please send me your e-mail address, using my address:

    dennis-bricker@uiowa.edu

or, if you are on the ICAEN network, simply

    dbricker