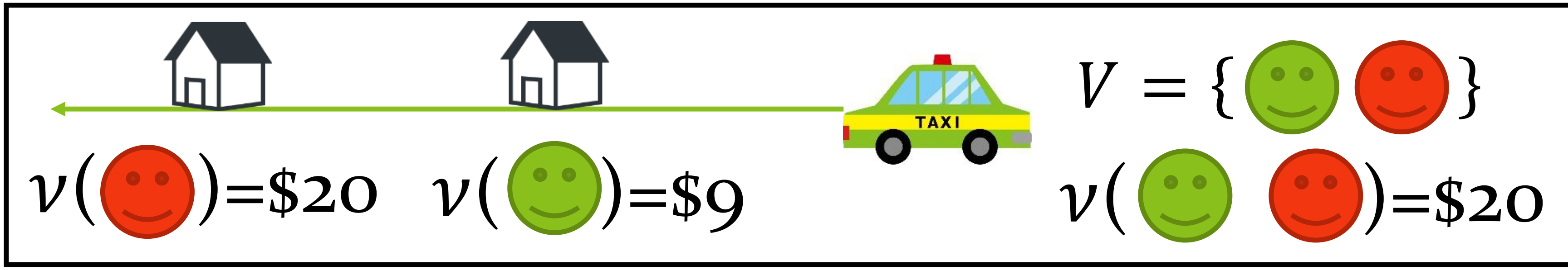
Computing Least Cores of Supermodular Cooperative Game (AAAI-2017)

Daisuke Hatano(NII) and *Yuichi Yoshida*(NII, PFI)

Cooperative game



Core: A value division $x \in \mathbb{R}^V$ is in the core if $x(S) \leq v(S)$ for all $S \subseteq V$ and $x(V) = v(V)$

$x(\ ) = \$9, x(\ ) = \$11$ is in the core

$x(\ ) = \$10, x(\ ) = \$10$ is not in the core

Computing Least Cores of Supermodular Cooperative Game **(AAAI-2017)**

Daisuke Hatano(NII) and *Yuichi Yoshida*(NII, PFI)

Supermodular cooperative game

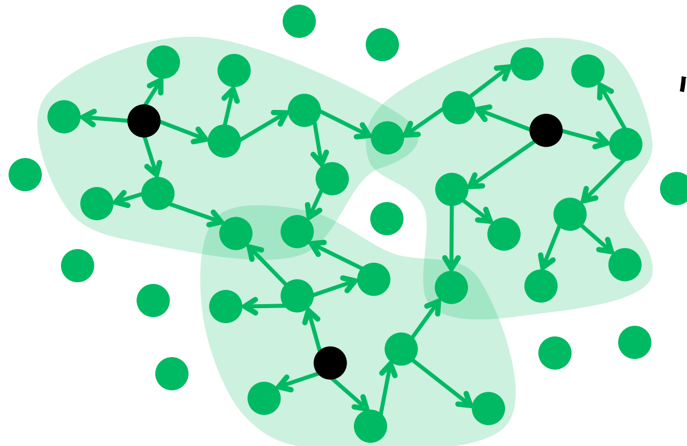
- A characteristic function ν is supermodular
- The Core of a supermodular game is nonempty

Our contributions

- Analyze the following solution concepts
  - **Strong least core**
  - **Weak least core**
- Derive explicit and concise formulations for the strong and weak least core values

Coarsening Massive Influence Networks for Scalable Diffusion Analysis

大坂直人 (東京大学)
<u>薗部知大 (NII)</u>
藤田澄男 (ヤフー株式会社 Yahoo! JAPAN 研究所)
河原林健一 (NII)



情報拡散の単純な表現形式

Q. 最も影響力の高い集団をどのように発見するか?

e.g. マーケット戦略

||

影響最大化 (Influence maximization)

辺確率グラフ上のアルゴリズム

我々の貢献

簡略化戦略

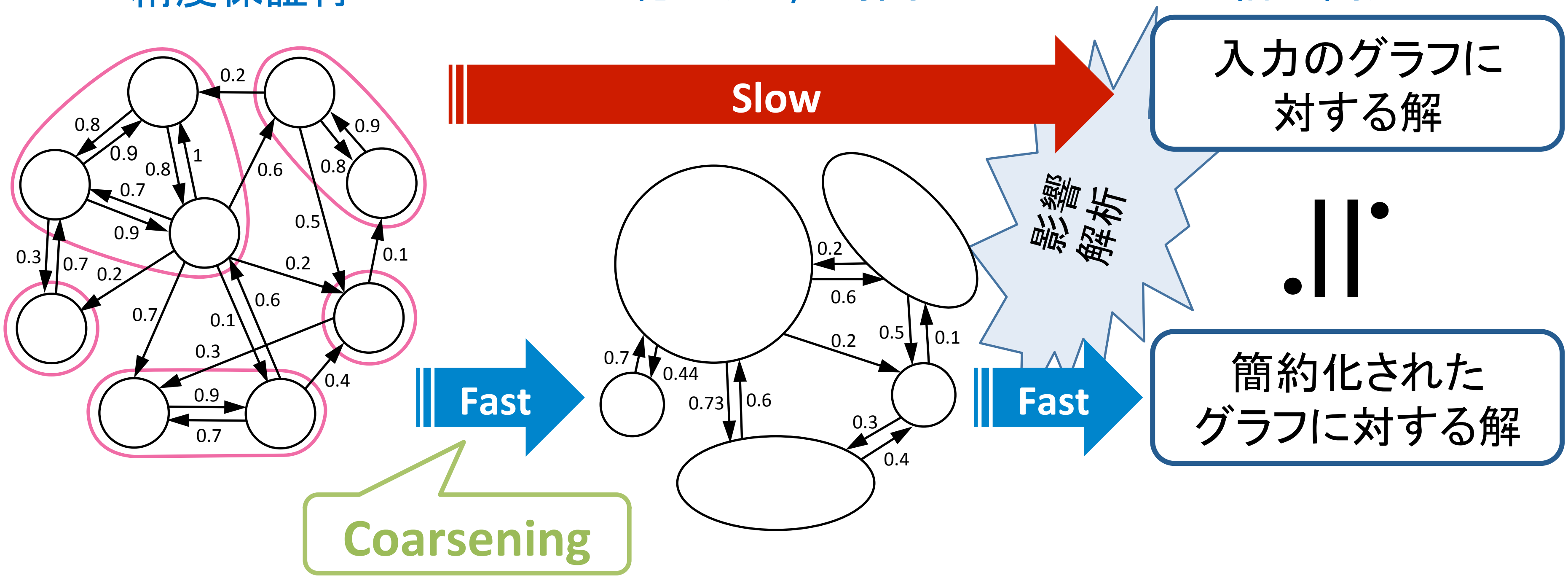
精度保証付

スケーラブルなアルゴリズム

10億エッジ/1時間

解析フレームワーク

2－30倍の高速化

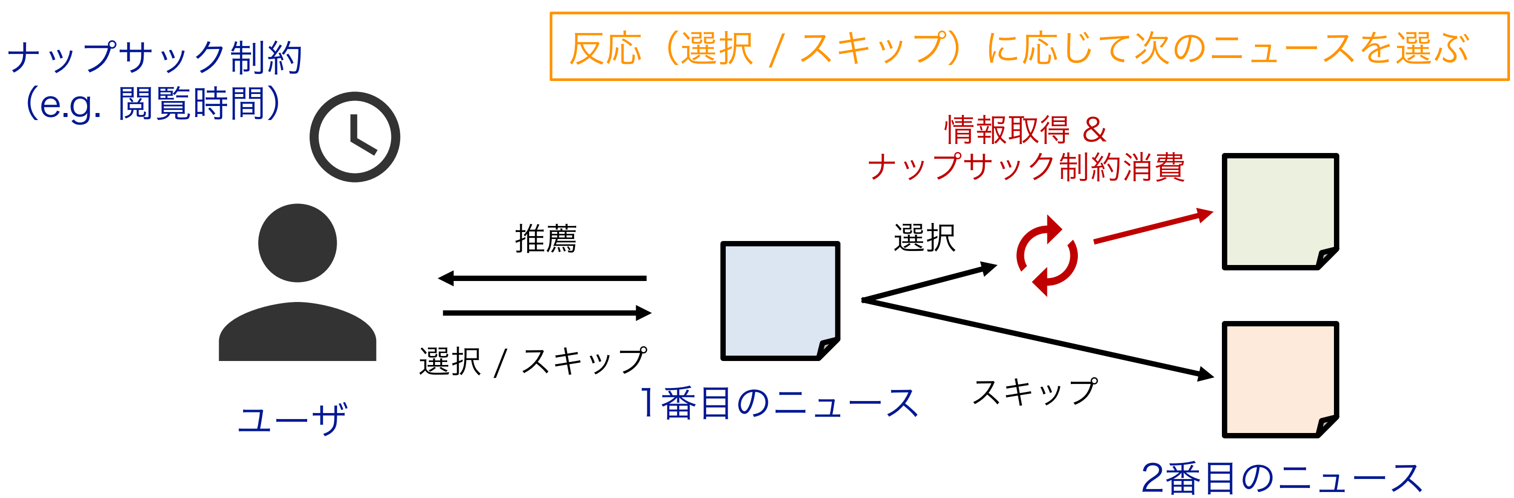


確率的劣モジュラ関数の適応的最大化とそのニュース推薦への応用

小西 卓哉（NII）

共同研究者：福永 拓郎（JSTさきがけ） 藤田 澄男（ヤフー） 河原林 健一（NII）

- **問題**：ナップサック制約付き単調劣モジュラ関数の最大化
  - 各アイテムが確率的に決まる状態をもつ
  - 状態によって目的関数とナップサック制約への貢献の両方が決まる
- **本研究**：理論保証がある適応的な近似アルゴリズムの提案
  - ユーザの反応を考慮したニュースリストの推薦に応用



On Estimation of Conditional Mode Using Multiple Quantile Regressions

Hirofumi Ohta [1] Satoshi Hara [2]

[1]The University of Tokyo, Graduate School of Economics, Department of Statistics, M2.

[2]Osaka University, The Institute of Scientific and Industrial Research.

2017/12/26, Winter-Festa Ep.3 @NII.

Keywords: modal/quantile regression, semi-parametric estimation, dimensionality reduction.

Problem

- A regression analysis for $Y \in \mathbb{R}$ and $X \in \mathbb{R}^p$.
- Estimation of Conditional mode of Y given $X = x$, say, *modal regression*.

Method

- Estimate the conditional density by solving linear quantile regressions multiple times.
- Modal regression function is estimated by finding the quantile which gives the maximum of conditional densities.

Contribution

- New semi-parametric modeling for modal function via conditional quantile function.
- Advantages:
  - computationally stable:
    no initial parameter dependencies and QR can be solved by convex linear programming.
  - statistically efficient with a fast convergence rate: QR has $\sqrt{n}$-consistency.

Multiple zeta values in number theory and Bell polynomials in set partition

（ERATO 河原林プロジェクト　理論 G　町出智也）

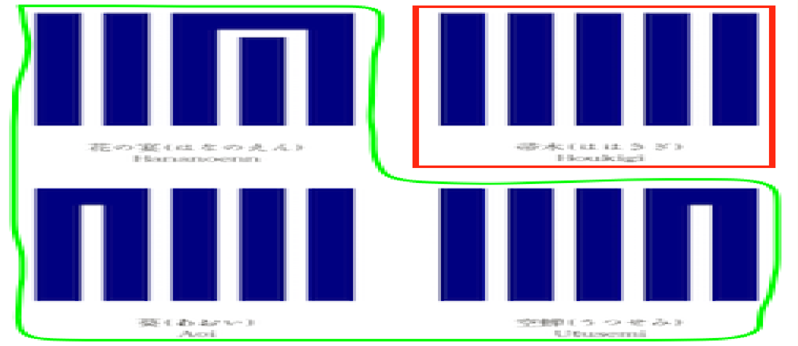
Bell 数 と Bell 多項式

- Bell 数 $B_{r,k}$： r 個の物を k 個に分ける方法の総数
- Bell 多項式 $B_{r,k}(x_1, \ldots, x_{r-k+1})$：ベル数の一般化

$$B_{r,k}(1, \ldots, 1) = B_{r,k}.$$

ベル数と源氏香の図

Wikipedia (https://ja.wikipedia.org/wiki/香の図) から転載



$$B_{5,5} \quad = \quad \text{【帚木（ははらぎ）】} \quad = \quad 1$$

$$B_{5,4} \quad = \quad \text{【空蝉、花の宴、葵、}\ldots\text{】} \quad = \quad 10$$

$$B_5 \quad = \quad B_{5,5} + B_{5,4} + B_{5,3} + B_{5,2} + B_{5,1} \quad = \quad 52$$

多重ゼータ値

- Euler (1707 - 1783) により始めて研究された実数
- 多項式への一般化 （※ 繰り込みの手法により）

$$\zeta^\star_*(k_1, k_2, \ldots, k_r; T)$$

結果

- $$\sum_{\sigma \in S_r} \zeta^\star_*(k_{\sigma(1)}, k_{\sigma(2)}, \ldots, k_{\sigma(r)}; T)$$ （S_r ：対称群）
- ベル多項式との関係

$$5!\zeta^\star_*(1,1,1,1,1;T) = B_5\left(T,\, \zeta^\star(2),\, 2\zeta^\star(3), 6\zeta^\star(4), 24\zeta^\star(5)\right)$$

ちなみに $$r! = B_r\left(0!,\, 1!,\, \ldots,\, (r-1)!\right)$$

Submodular maximization with uncertain knapsack capacity

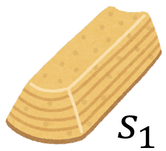
Yasushi Kawase (TITech, RIKEN AIP)
Hanna Sumita (NII, ERATO)
Takuro Fukunaga (RIKEN AIP)

The knapsack constraint is uncertain

$$\max.\ f(X) \qquad \mathrm{s.t.}\ \sum_{i \in X} s_i \le C$$

monotone submodular

capacity is uncertain

 $s_1 = 180$(yen)  $s_2 = 140$ 

$s_3 = 100$  $s_4 = 150$

I want to choose an item set X maximizing my utility
But I do not know the capacity C

oracle

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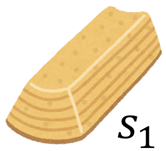
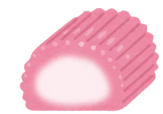
 $s_1 = 180$(yen)  $s_2 = 140$  $s_3 = 100$  $s_4 = 150$

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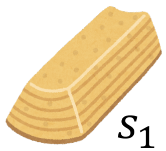 $s_1 = 180$(yen)  $s_2 = 140$  $s_3 = 100$  $s_4 = 150$

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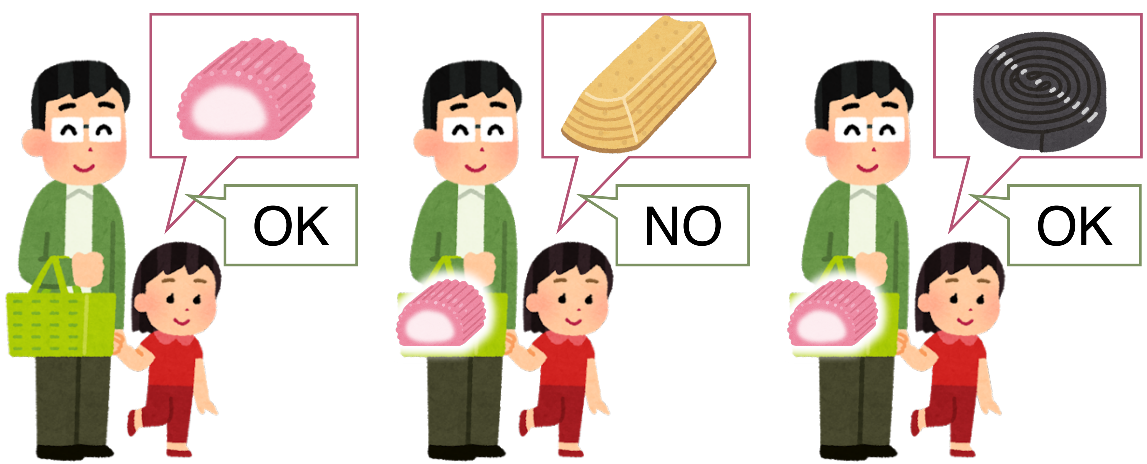

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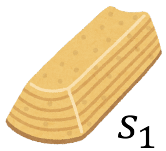 $s_1 = 180$(yen)  $s_2 = 140$ 

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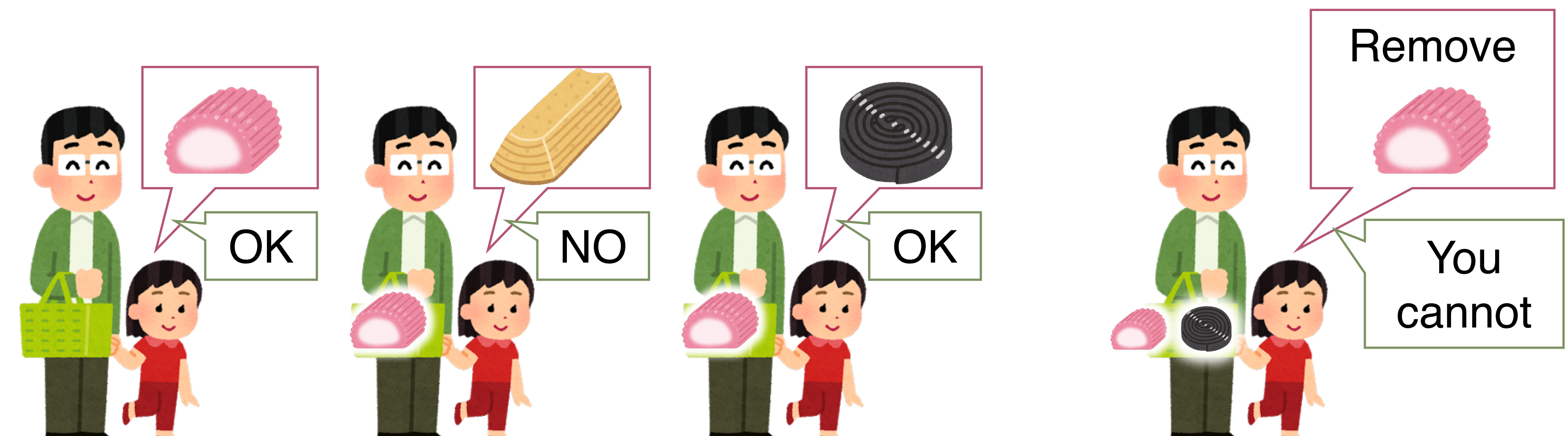
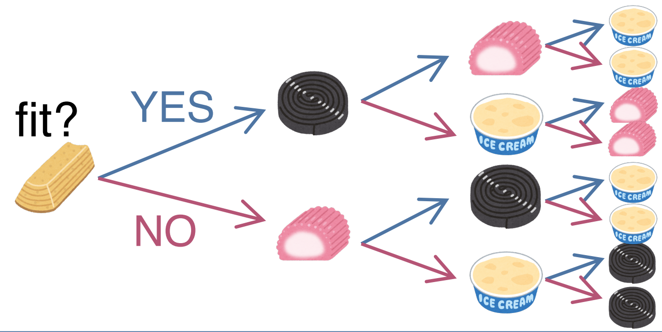


Main results

In what order should we add the items?

policy
(decision tree)



◆ C is **unknown:** deterministic policy s.t.

$$\frac{\text{output}}{\text{optimal value } (C\text{: known})} \geq 2(1 - 1/e)/21$$ for any capacity

◆ C is **stochastic:** a randomized algorithm s.t.

$$\frac{\mathbb{E}_C[\text{output}]}{\mathbb{E}_C[\text{optimal value}]} \geq (1 - 1/\sqrt[4]{e})/4 - \varepsilon$$

Note: all policies & algos run in poly. time

Related work: C is known but size s_i is unknown, …

Indexing Search Trees and Applications

Sankar Deep Chakraborty

National Institute of Informatics (NII)

December 19, 2017

Joint work with Kunihiko Sadakane from The University of Tokyo

Problem Definition

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- Easy! $O(1)$ time solution when $O(n)$ words or $O(n \log n)$ bits are available in the word-RAM model.
- What happens with less space i.e., $o(n)$ words? Can we still get $O(1)$ time query or report correctly at all?

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- Can be extended for other fundamental graph theoretic questions along with generalizing to produce time/space trade off results.
- Main technique: Space efficient construction of tree partioning and time effcient algorithms for tree traversal.
- Open Problem: Can we go $o(n)$ bits with efficient (polylog) query time?

Thank You.

Approximation Algorithms for Hub-and-Spoke Network Design Problems and Metric Labeling Problems

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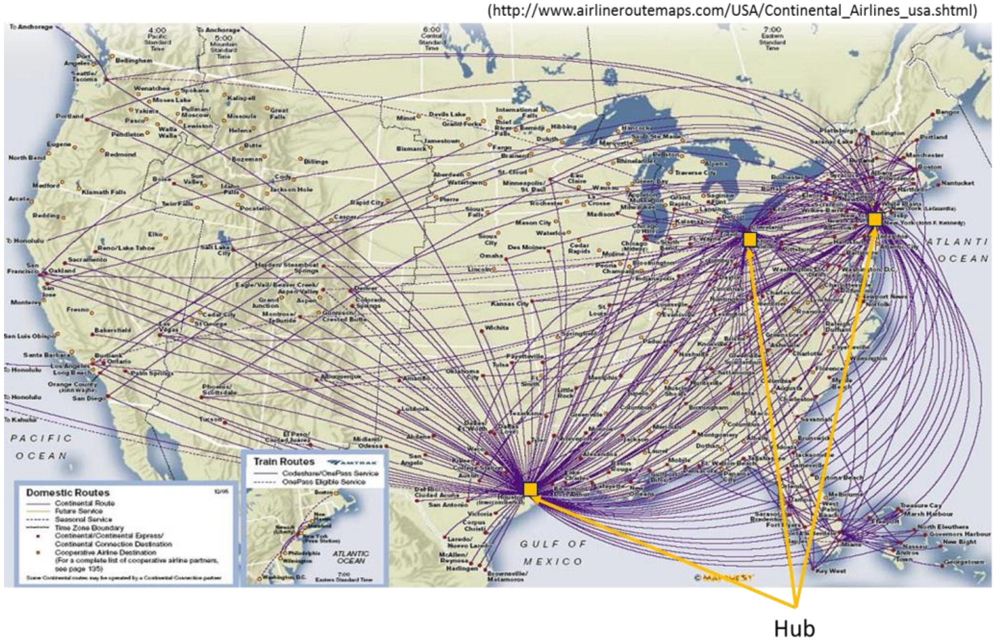
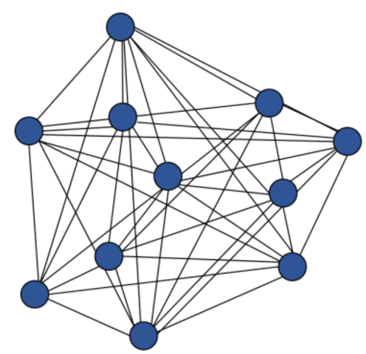
Tokyo Institute of Technology

情報系 WINTER FESTA 2017/12/26

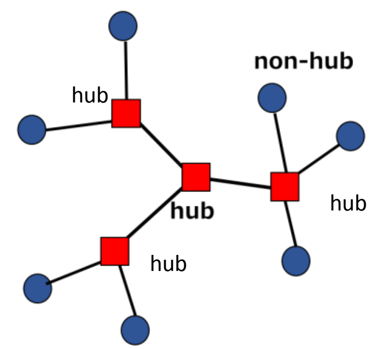
Key words:
operations research,
combinatorial optimization,
approximation algorithms

(http://www.airlineroutemaps.com/USA/Continental_Airlines_usa.shtml)





Point-to-Point



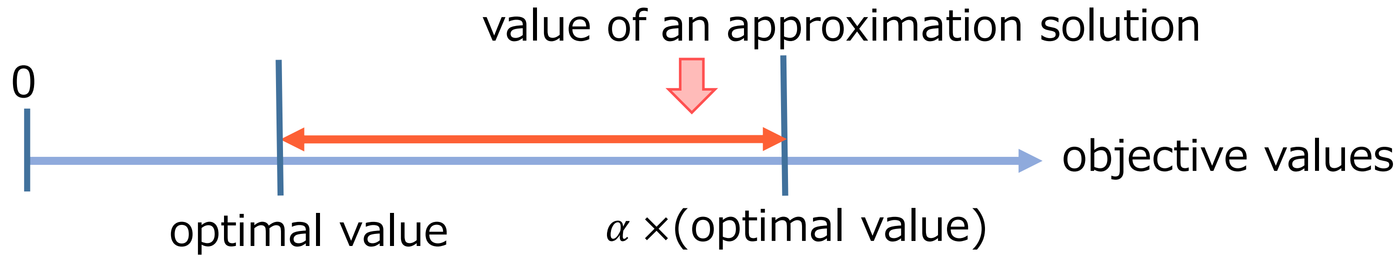
Hub-and-Spoke

Hub-and-Spoke Network arises in real world situations such as:

・airline network
・telecommunication network

We discuss a problem to find an assignment of non-hubs to hubs that minimizes total costs.

We propose polynomial time constant ratio **approximation algorithms** for hub-and-spoke network design problems and metric labeling problems.



Hub-and-Spoke Network Design Problems

Objective function (minimization)

$$\sum_{(p,q)\in N^2} \underline{w_{pq}\left(\sum_{i\in H} c_{pi}x_{pi} + \sum_{j\in H} c_{qj}x_{qj}\right.} + \underline{\left.\sum_{i\in H}\sum_{j\in H} c_{ij}x_{pi}\,x_{qj}\right)}$$

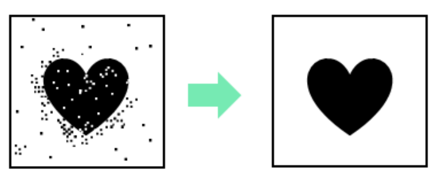
Constraints $\sum_{i\in H} x_{pi} = 1 \quad (\forall p \in N),$

$x_{pi} \in \{0,1\} \quad (\forall (i,p) \in (H \times N))$

Metric Labeling Problems [Kleinberg and Tardos,2002]

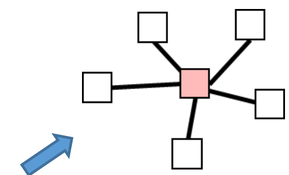
set P of n objects
set L of k possible labels

A labeling function $f : P \to L$



$$Q(f) = \sum_{p\in P} c(p, f(p)) + \sum_{e=(p,q)\in E} w_e d(f(p), f(q)).$$

Main Result



Star-Metric Case

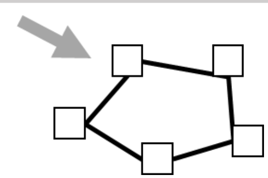
$\min\{\frac{r-1}{\log r}\left(2+\frac{r^2+1}{r^2-1}\right) | r > 1\}$-approx. alg.

$(\approx 5.2809 \text{ at } r \approx 1.91065)$

Cycle-Metric Case

- $2(1-\frac{1}{h})$-approx. alg. (h #hubs)
- $(\frac{3}{2}-\frac{1}{2(h-1)})$- approx. alg.

(under the assumption of triangle inequality)



A tractable class of binary VCSPs via M-convex intersection

平井 広志（東大）
岩政 勇仁（東大D2）
室田 一雄（首都大）
Stanislav Živný（Oxford）

情報系 Winter Festa Episode3@一橋講堂
2017/12/26

A tractable class of binary VCSPs via M-convex intersection

Binary VCSPs

finite set

Given: $F_p : D_p \to \mathbf{R} \quad (p \in [r])$

$F_{pq} : D_p \times D_q \to \mathbf{R} \quad (p, q \in [r])$

$[r] := \{1, 2, \ldots, r\}$

Problem:

Minimize

$$F(X_1, X_2, \ldots, X_r) := \sum_{1 \leq p \leq r} F_p(X_p) + \sum_{1 \leq p < q \leq r} F_{pq}(X_p, X_q)$$

$$((X_1, X_2, \ldots, X_r) \in D_1 \times D_2 \times \cdots \times D_r)$$

A tractable class of binary VCSPs via M-convex intersection

Binary VCSPs

どのような F なら多項式時間で解けるか？

Give

$$F_{pq} : D_p \times D_q \to \mathbf{R} \qquad (p, q \in [r])$$

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A tractable class of binary VCSPs via M-convex intersection

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$F_{pq} : D_p \times D_q \to \mathbf{R}$ $\quad (p, q \in [r])$ $\quad [r] := \{1, 2, \ldots, r\}$

Problem:

Minimize

$F(X_1,$ … $_q(X_p, X_q)$

… $\times D_r)$

どのような F なら多項式時間で解けるか？

離散凸性（M凸性）を用いて
新しい多項式時間可解なクラスを構築