Continuous n-Mixing: A Unifying Cutting Plane Framework

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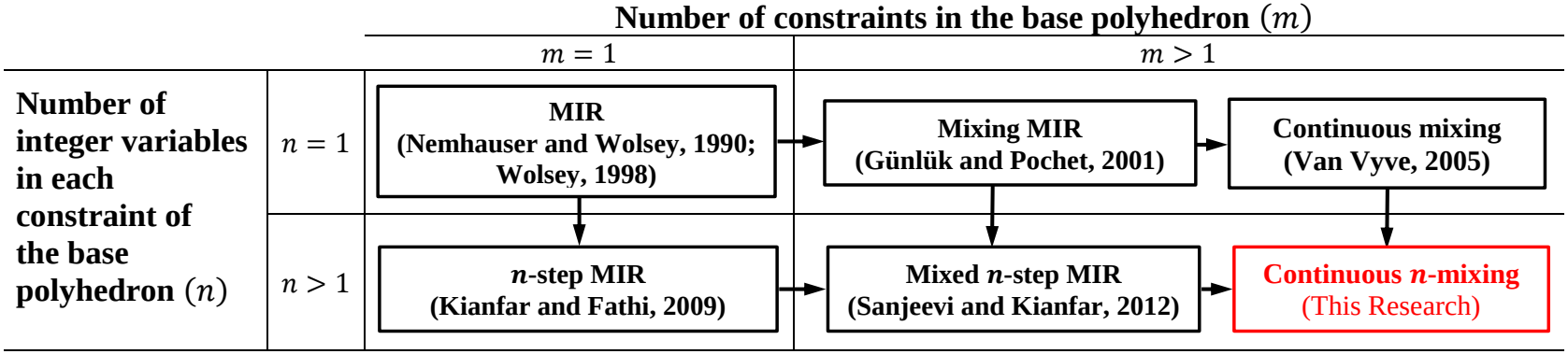
Generalizations of Mixed Integer Rounding (MIR)



Continuous n-Mixing Set

$$Q^{m,n} := \{(y, v, s) \in (\mathbb{Z} \times \mathbb{Z}_+^{n-1})^m \times \mathbb{R}_+^m \times \mathbb{R}_+ : \sum_{t=1}^{n} \alpha_t y_t^i + v_i + s \geq \beta_i, i = 1, \ldots, m\}$$

- Facets (n'-step cycle inequalities), extended formulation, and exact separation algorithm.

Generalization of Continuous n-Mixing Set

$$Y^m := \{(y, v, s) \in \mathbb{Z}_+^{m|N|} \times \mathbb{R}_+^m \times \mathbb{R}_+ : \sum\nolimits_{t \in N} a_t y_t^i + v_i + s \geq b_i, y^i \leq u, i = 1, \ldots, m\}$$

- Mingled n-step cycle inequalities: Unification of n-step cycle inequalities and n-step mingling inequalities *[Atamtürk and Günlük 2010; Atamtürk and Kianfar, 2012]*

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Problem type	Inequalities in literature	Are/can be developed by
Knapsack Set	Marchand and Wolsey (1999)	2-step Mingling
	Atamtürk (2003)	2-step Mingling
	Atamtürk and Kianfar (2012)	n-step mingling
Lot-Sizing	Barany el al. (1984)	MIR
	Pochet and Wolsey (1993)	Mixed MIR
	Sanjeevi and Kianfar (2012)	Mixed n-step MIR
Facility Location	Padberg et al. (1985)	MIR
	Leung and Magnanti (1989)	MIR
	Aardal et al. (1995)	MIR and Mixed MIR
Network Design	Magnanti and Mirchandani (1993)	MIR and 2-step MIR
	Bienstock and Günlük (1996)	MIR
	Atamtürk (2002)	MIR
	Günlük and Pochet (2001)	Mixed MIR
	Pochet and Wolsey (1995)	n-step MIR

Multi-Module Capacitated Lot-Sizing (MML) Problem

- New cuts for MML problem with(out) backlogging using n'-step cycle inequalities
- Our cuts reduce integrality gap by 86%, number of nodes by 81 times, and total time (which includes cut generation time) by 34 times in average.

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