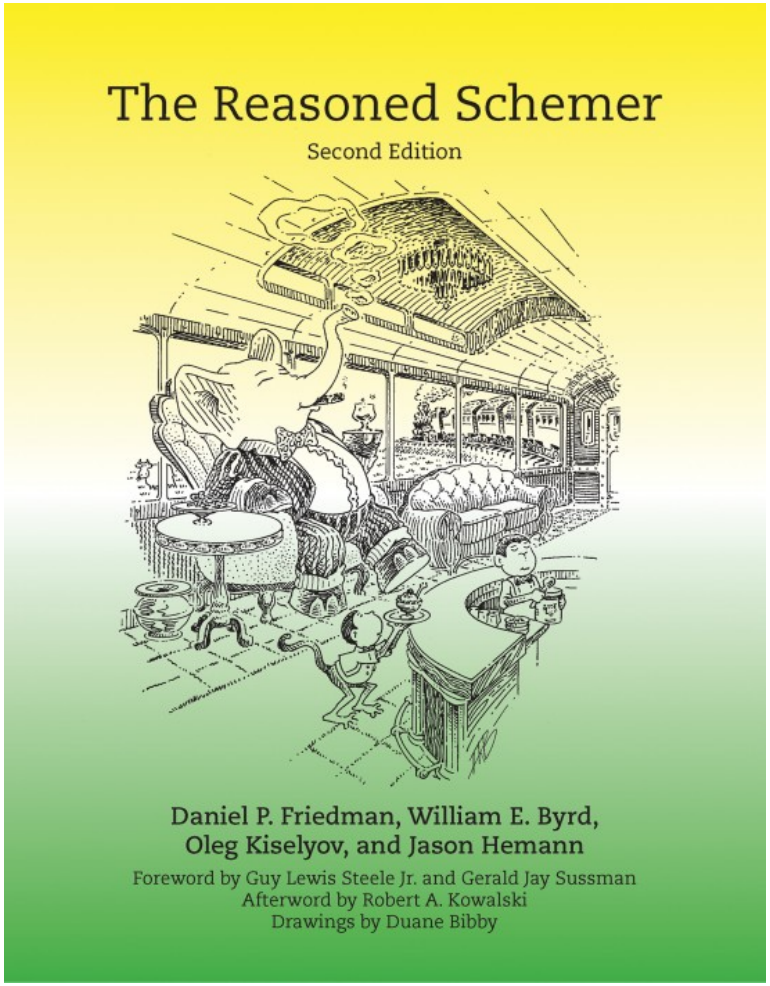
Towards a miniKanren with fair search strategies

Kuang-Chen Lu

Weixi Ma

Daniel P. Friedman

Where to start?



What is fairness?

- fairness in disjunctions (fair, almost-fair, unfair)
- fairness in conjunctions (fair, unfair)

Examples

`(repeat° x xs)` relates `x` with one or more `x` s.

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`(repeat° x xs)` relates `x` with one or more `x` s.

```
> (run 3 q
    (repeat° 'λ q))

 '((λ) (λ λ) (λ λ λ))
```

Fairness in Disjunctions

```
> (run 9 q
    (condᵉ
      [(repeatᵒ 'λ q)]
      [(repeatᵒ '🐑 q)]
      [(repeatᵒ '🐏 q)]))
```

unfair (current search strategy)

```
'((λ) (λ λ) (🐑)
  (λ λ λ) (🐏)
  (λ λ λ λ) (🐑 🐑)
  (λ λ λ λ λ) (🐏 🐏))
```

Fairness in Disjunctions

```
> (run 9 q
    (condᵉ
      [(repeatᵒ 'λ q)]
      [(repeatᵒ '🐑 q)]
      [(repeatᵒ '🐏 q)]))
```

almost-fair

```
'((🐑) (λ)
  (🐑 🐑) (🐏)
  (🐑 🐑 🐑) (λ λ)
  (🐑 🐑 🐑 🐑) (🐏 🐏)
  (🐑 🐑 🐑 🐑 🐑))
```

Compare fair and almost-fair

```
> (run 15 q
    (condᵉ
      [(repeatᵒ 'λ q)]
      [(repeatᵒ '🐑 q)]
      [(repeatᵒ '🐏 q)]
      [(repeatᵒ '🐄 q)]
      [(repeatᵒ '🐕 q)]))
```

unfair

```
'((λ) (λ λ) (🐑) (λ λ λ) (λ λ λ λ)
  (🐑 🐑) (λ λ λ λ λ) (🐏) (λ λ λ λ λ λ)
  (🐑 🐑 🐑) (λ λ λ λ λ λ λ) (λ λ λ λ λ λ λ λ)
  (🐑 🐑 🐑 🐑) (λ λ λ λ λ λ λ λ λ) (🐏 🐏))
```

Compare fair and almost-fair

```
> (run 15 q
    (condᵉ
      [(repeatº 'λ q)]
      [(repeatº '🐑 q)]
      [(repeatº '🐏 q)]
      [(repeatº '🐄 q)]
      [(repeatº '🐕 q)]))
```

almost-fair

```
'((🐑) (🐏) (🐄) (λ)
  (🐑 🐑) (🐏 🐏) (🐄 🐄) (🐕)
  (🐑 🐑 🐑) (🐏 🐏 🐏) (🐄 🐄 🐄) (λ λ)
  (🐑 🐑 🐑 🐑) (🐏 🐏 🐏 🐏) (🐄 🐄 🐄 🐄))
```

Fairness in Disjunctions

```
> (run 9 q
    (condᵉ
      [(repeatᵒ 'λ q)]
      [(repeatᵒ '🐑 q)]
      [(repeatᵒ '🐏 q)]))
```

fair

```
'((λ) (🐑) (🐏)
  (λ λ) (🐑 🐑) (🐏 🐏)
  (λ λ λ) (🐑 🐑 🐑) (🐏 🐏 🐏))
```

(Search) Space

Space ::= Null | (Pair State Space) | (→ Space)

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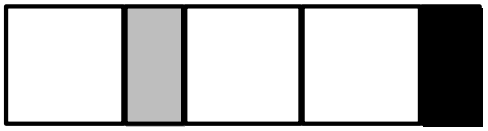
`Space ::= Null | (Pair State Space) | (→ Space)`

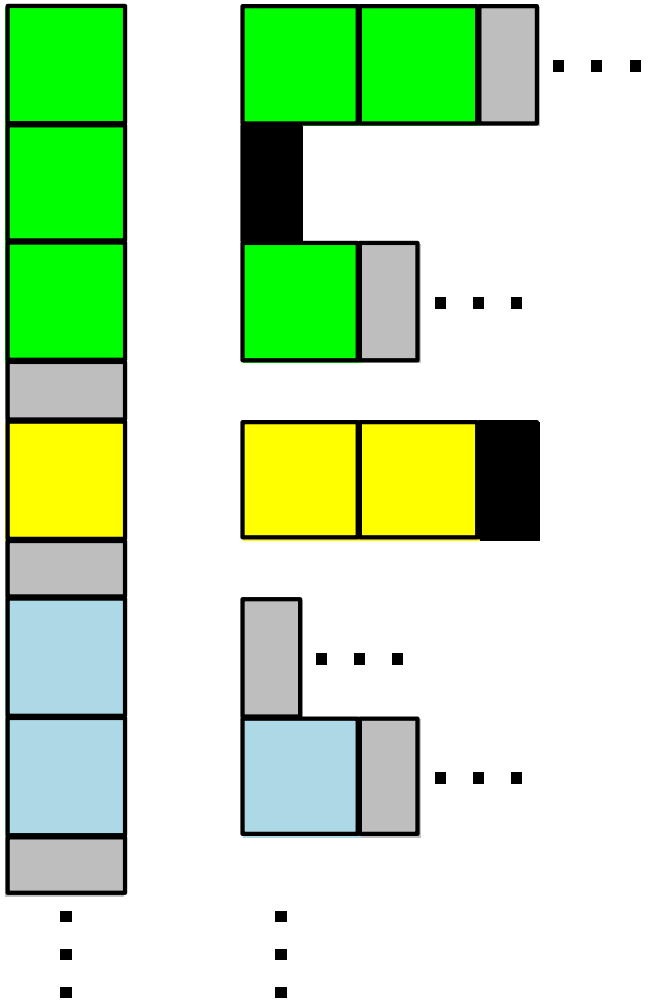
a space with three states



a space with possibly infinite states

Fairness in Conjunctions

Fairness in Conjunctions



Search Strategies

strategy	disj	conj
interleaving DFS	unfair	unfair
balanced interleaving DFS	almost-fair	unfair
fair DFS	fair	unfair
BFS[1]	fair	fair

[1] Seres, Silvija, J. Michael Spivey, and C. A. R. Hoare. "Algebra of Logic Programming." ICLP. 1999.

Why fairness?

- produce answers in a more natural order
- performance is resistant to permuting **`cond`**$^{\mathbf{e}}$ clauses
  - less pitfalls for beginners
  - one definition for many running modes

Q & A