Inventor 2001: Evolutionary Design Support Tool for Steel Skeleton Structures

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Inventor 2001

- Evolutionary design and research tool for designing steel skeleton structures in tall buildings
- Produces both design concepts and detailed designs
- Uses process of evolution to search through the design space
Planar transverse designs of steel skeleton structures in tall buildings

- 3-bay structures
- 16-36 stories
- 6 types of bracings
- 2 types of joints between beams and columns
- 2 types of ground connections
Design Representation Space

- Bay width: 20-26 feet
- Story height: 10-14 feet
- 4 types of element connections
- Constraints:
  - braced bays
  - vertical trusses
  - horizontal trusses
- Symmetry
Design Representation Space

- Types of bracings

- Types of joints between beams and columns

- Types of ground connections
EA Characteristics

- EA used: \((\mu + \lambda)\)-ES, and \((\mu, \lambda)\)-ES
- Representation: 100-220 multi-value attributes
  \[7, 2, 7, 2, 7, 2, 7, 2, 7, 2, 7, 2, 7, 2, 7, 2, 7, 2, 7, 7, 7, 7, 7, 7, 7, 7, 7, 1, 1, 1, 1\]
- Evolved elements: bracings, joints, and ground connections
- Selection: truncation selection
- Genetic operators: mutation and uniform parameterized crossover
EA Characteristics

- Fitness function: \textit{total weight of the steel structure}
- Additional 25 evaluation criteria:
  - weight of beams
  - weight of columns
  - no. of diagonals
  - no. of K bracings
  - weight of K bracings
  - …
Inventor 2001: Example of a Generated Design
Experimental Results – Emergent Patterns

Already well-known (sub-)optimal design
(one of the initial parents for Inventor 2001)

Slight mutation of this design produced by Inventor 2001

Completely different design of a tall building produced by Inventor 2001
References


