

09

Enumeration of Tiling Patterns

- An Efficient Algorithm for Finding Exact Covers -

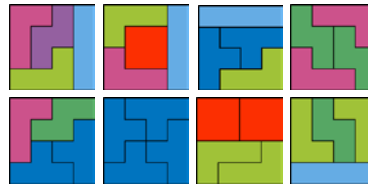
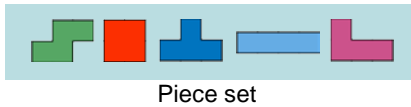
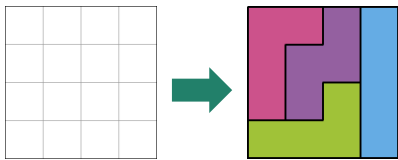


Abstract

We show an efficient algorithm for finding all solutions of an exact cover problem. Several practical tasks including floor planning and layout designing of electric circuits can be solved as exact cover problems. Our method is **10,000 times faster** than baseline methods. Moreover, we can **store the set of all solutions** by compressing it and then efficiently picking up solutions that satisfies additional constraints. The key of the technology is the use of data structure that **represents the set of all solutions as a directed graph**. Our technology supports users to find good tiling patterns. For example, it helps to find layouts of electric circuits with low power consumption and floor plans of a condominium that matches to the owner's requirement.

Exact Cover Problem

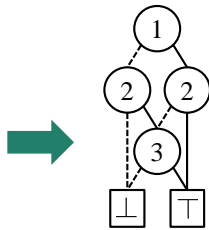
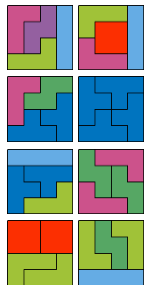
Find all ways to fill a board with the given pieces



There are huge numbers of solutions!

Board size	Numbers of solutions
4x4	117
8x8	19,077,209,438
12x12	13,664,822,582,333,502,156,627,512

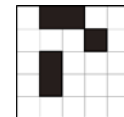
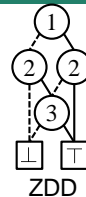
Finding All tiling patterns



Graph representation (ZDD)

- Constructing a graph (ZDD) representing the set of all solutions while conducting search. → Can avoid to solve the same sub problems
- **10,000 times** faster than baseline methods

Pick Up Desired Solutions



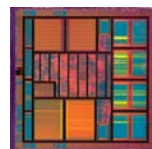
Query possible tiling patterns



Outputs a pattern

- Storing the set of solutions as a ZDD enables to efficiently pick up desired solutions.

Applications



Electric circuits design

Photo by PeterJohnBishop



Floor planning

Photo by 箱坂

※This exhibition is a joint work with Hokkaido university.

References

- [1] M. Nishino, N. Yasuda, S. Minato, M. Nagata, "Dancing with decision diagrams: a combined approach to exact cover," in Proc. the 31st AAAI Conference on Artificial Intelligence (AAAI), pp. 868-874, 2017.

Contact

Masaaki Nishino Linguistic Intelligence Research Group, Innovative Communication Laboratory
Email : nishino.masaaki(at)lab.ntt.co.jp