

計算理論研究室

Theory of Computation Group

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Hirokawa (associate professor at IS)

テーマ例：理論探査 (Theory Exploration)

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x_1	x_2	x_3
x_4	x_5	x_6
x_7	x_8	x_9

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e.g.

2	9	4
7	5	3
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rules of puzzle



Theory Explorer

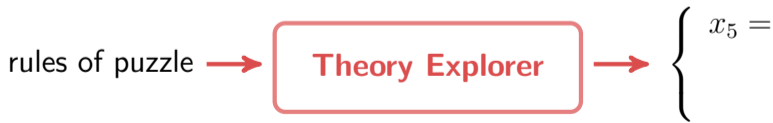


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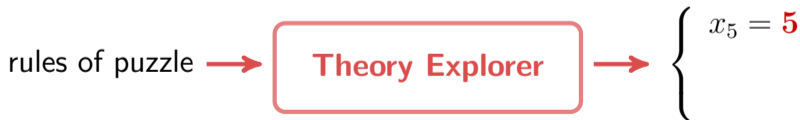


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Theory Explorer



$$\left\{ \begin{array}{l} x_5 = \mathbf{5} \\ x_1 + x_9 = \end{array} \right.$$

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$$\left\{ \begin{array}{l} x_5 = 5 \\ x_1 + x_9 = 10 \end{array} \right.$$

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Theory Explorer



$$\left\{ \begin{array}{l} x_5 = \mathbf{5} \\ x_1 + x_9 = \mathbf{10} \\ x_6 + x_8 = \mathbf{2x_1} \end{array} \right. \quad (!!!)$$

テーマ例：理論探査 (Theory Exploration)

```
def sum( $x$ ):  
     $y = 0$   
    while  $x > 0$ :  
         $y = x + y$   
         $x = x - 1$   
    return  $y$ 
```

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```
def sum( $x$ ):  
sum:   $y = 0$   
   $f_1$ :  while  $x > 0$ :  
     $f_2$ :     $y = x + y$   
     $f_3$ :     $x = x - 1$   
   $f_4$ :  return  $y$ 
```

テーマ例：理論探査 (Theory Exploration)

```
def sum( $x$ ):                                $sum(x) = f_1(x, 0)$   
sum:    $y = 0$   
f1:   while  $x > 0$ :  
f2:      $y = x + y$   
f3:      $x = x - 1$   
f4:   return  $y$ 
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$$\text{sum}(x) = f_1(x, 0)$$
$$f_1(x, y) = \begin{cases} f_2(x, y) & \text{if } x > 0 \\ f_4(x, y) & \text{otherwise} \end{cases}$$

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<code>f₁: while x > 0:</code>	
<code>f₂: y = x + y</code>	$f_2(x, y) = f_3(x, x + y)$
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テーマ例：単一化 (Unification)

<code>def sum(x):</code>	$\text{sum}(x) = f_1(x, 0)$
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テーマ例：単一化 (Unification)

$$\text{qsort}([]) = ys$$

$$\text{qsort}(x : xs) = \text{qsort}([y \mid y \in xs, y \leq x]) \# [x] \# \text{qsort}([y \mid y \in xs, x < y])$$

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$$\text{qsort}([3, x, 2]) = [1, 2, y]$$



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$$\text{qsort}([3, x, 2]) = [1, 2, y] \longrightarrow \boxed{\text{Unification Tool}} \longrightarrow \begin{cases} x = 1 \\ y = 3 \end{cases}$$

テーマ例: 計算量解析 (Complexity Analysis)

$$\text{qsort}([]) = ys$$

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配属後は数独から (Starting with Sudoku)

5	3			7				
6			1	9	5			
	9	8					6	
8				6				3
4			8		3			1
7				2				6
	6					2	8	
			4	1	9			5
				8		?	7	9

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theme: 計算と演繹 (computation and deduction)

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- プログラミング言語理論 (programming language theory)
- 定理証明 (theorem proving)

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- 定理証明 (theorem proving)
- 論理推論 (logical reasoning)