# A Compendium of Chinese-Rings-Like Puzzles 

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## http://puzzles.schwandtner.info/compendium

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## Chinese Rings



Interesting puzzle - but:

A whole compendium for one puzzle?

## Agenda

1. Introduction - Chinese Rings
2. Puzzles of Various Kinds in the Compendium
3. Definition "CR recursive"
4. How to solve these puzzles?
5. Number of moves and solution length
6. Recent Developments
7. Compendium entries

## Chinese Rings Variants



## SpinOut, Crazy Elephant Dance



Crymer de polvil

## Maze Puzzles

高 돕들


## Puzzle Locks



## Tower of Hanoi Variants



## Sliding Piece Puzzles / 2D Burrs



## Burrs



## Puzzle Boxes



## Puzzle "Devices"



## Disentanglement Puzzles



## Definition: CR recursive puzzles

A CR recursive (or $n$-ary) puzzle is a puzzle that

- contains $m$ special similar pieces (with $m \geq 1$ ) and
- the puzzle can be generalized to other values of $m \geq 1$ and
- each special piece has $n$ different positions (e.g. $0, \ldots, n-1$, with $n \geq 2$, Arity $n$ ) and
- there is a uniform condition stating that a special piece can only move between some positions if the other special pieces are in certain positions.


## Example 1: Chinese Rings



## Example 1: Chinese Rings

Condition to move a ring, the green ring in the following example:
depending on all rings to the left

Def CR recursive:

- m special pieces
- n different positions
- generalizable
- uniform condition:



## Example 2: Crazy Elephant Dance



Def CR recursive:
-m special pieces

- n different positions
- generalizable
- uniform condition
- 5 Elephants
- Positions 0, 1, 2
- (others: See Markus Götz' Homepage)
-Condition: ?


## Example 2: Crazy Elephant Dance



Elephant can move between 0 and 1 if:

All right of it are in position 2

Elephant can move Between 1 and 2 if:

Right neighbor is in position 0 All further right are in position 2


## How to Solve?

- Move pieces depending on other pieces positions (uniform condition)
- How to implement solution based on this?
- Recursion!


## Recursion Example 1: Tower



## Recursion Example 2: CR



## Number of Moves - Solution Length

- Number of moves for specific puzzle or as function $s(m, n)$ of parameters $m, n$.
- Typically with growth like $n^{m}$

Chinese Rings:
$n=2$
$s(m, n)=\left[2^{m+1} / 3\right]$
moves: 21


Kugellager:
$n=5$
$s(m, n)=2^{*} 5^{m}$
moves: 1250


Die Welle:
$n=5$
$s(m, n)=5^{m}-1$
moves: 124


## Ternary or Binary?

Not always does arity $n$ from definition and base of solution length function coincide!

Example:
Crazy Elephant Dance is ternary ( $n=3$ ), but has solution length $3 \cdot\left(2^{m}-1\right)-2 \cdot m$

Why?
Not all configurations are used in the solution of the puzzle:


## Recent Developments



Kugellager 7

$\mathrm{n}=7$; 4802 moves


## Data Contained in Compendium

| CR060 | Name | Die Welle |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Designer |  | Manufacturer | Year |
|  | Jean-Claude Constantin |  | Jean-Claude Constantin | 2010 |
|  | Arity | No of pieces Piece type | Solution length function | Number of moves |
|  | 5 | 3 balls | $5^{m}-1$ | 124 |
|  | Remarks |  |  |  |
|  | References | $[1]$ |  |  |


| CR074 | Name | Dispersed | GC Lock |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Designer |  |  | Manufacturer | Year |
|  | Namick Salakhov |  |  | Namick Salakhov | 2013 |
| \%0.0.0.0 | Arity | No of pieces | Piece type | Solution length function | Number of moves |
|  | 2 | 9 | Switches |  | 92 |
|  | Remarks |  |  |  |  |
| [1] [2] [3] [4] | References [1], [2] |  |  |  |  |
| CR014 | Name | Electro 1 |  |  |  |
|  | Designer |  |  | Manufacturer | Year |
|  |  |  |  | Tenyo |  |
|  | Arity | No of pieces | Piece type | Solution length function | Number of moves |
|  | 3 | 5 | pairs of loops |  | 26 |
|  | Remarks | The second CR068, CR0 | picture shows 069, CR070, CF | an unknown variant. R075 | ants: CR030, CR067, |
| [11 [2] | References | [1] |  |  |  |

## Thank you

# Compendium of Chinese-Rings-Like Puzzles: 

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