

Automatos celulares

O que são autômatos celulares?

- Propostos na década de 40 por John von Neumann
 - Representar matematicamente a evolução de um sistema complexo
 - Desenvolver máquinas de auto-replicação através de regras matemáticas simples
 - Auto-organização em sistemas complexos
- Máquinas abstratas
- Definidas em espaços celulares
- Tempo discreto
- Regras baseadas na vizinhança
- Pode levar a comportamentos complexos - emergência

O que são autômatos celulares

- Redes de células cujos estados são alterados no tempo (discreto) com regras que dependem do estado anterior e da vizinhança
- Características importantes e comuns
 - Homogeneidade (todas as células obedecem ao mesmo conjunto de regras)
 - Estados discretos (conjunto finito de estados para cada célula)
 - Interações locais
 - Processo dinâmico

Automatos celulares elementares

- Reticulado unidimensional
- Estados $\{0,1\}$ (morta, viva)
- Primeiros vizinhos $i-1$ e $i+1$

Função de transição

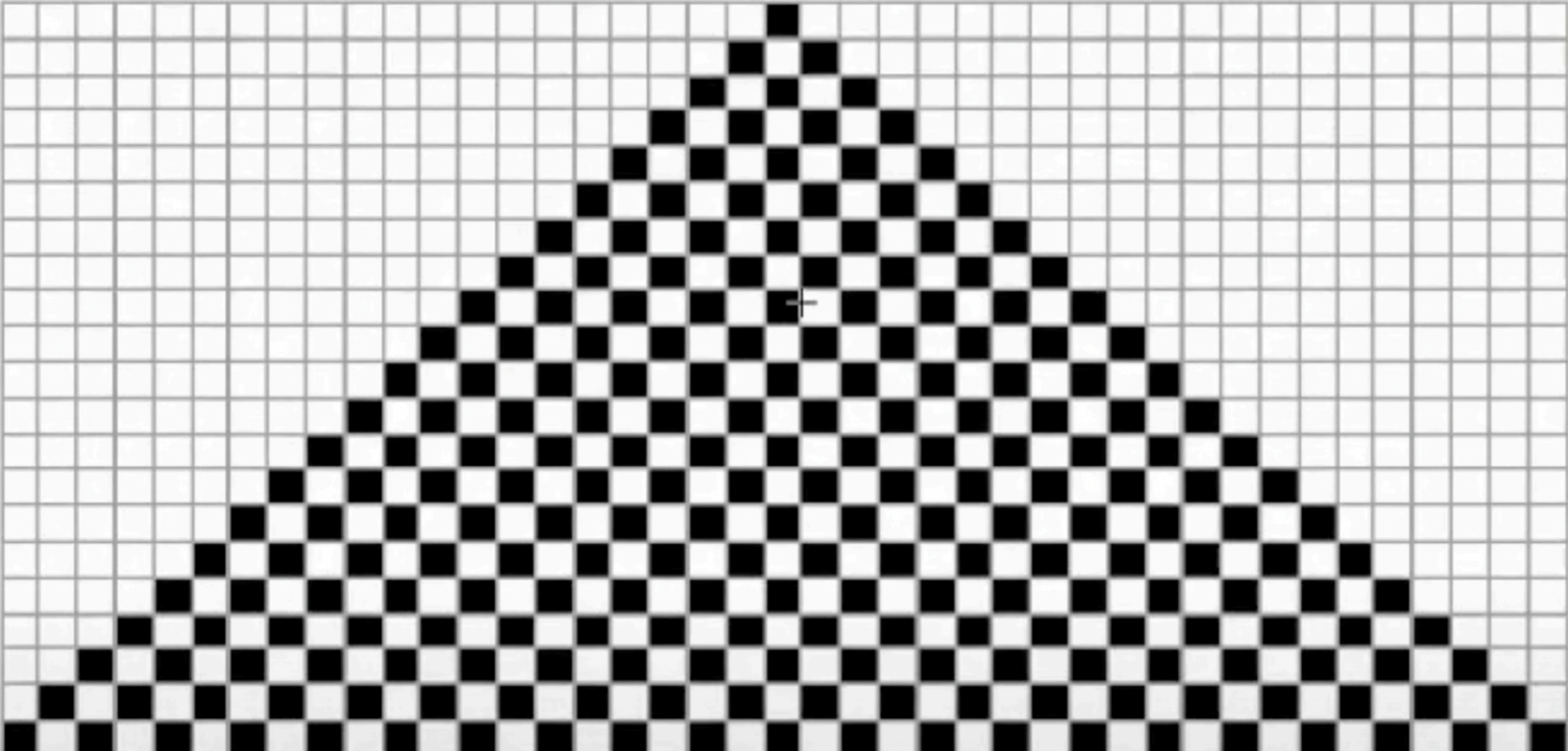
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0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

Função de transição

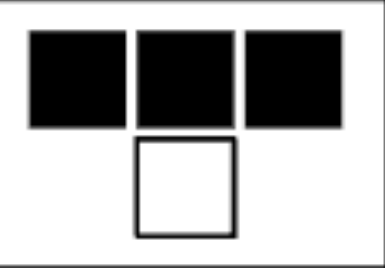
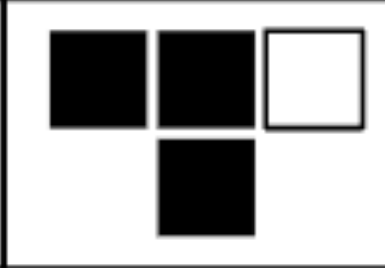
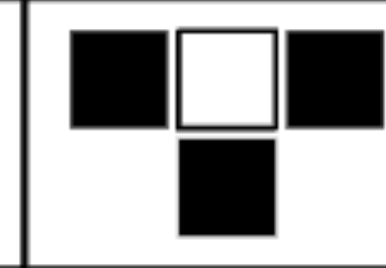
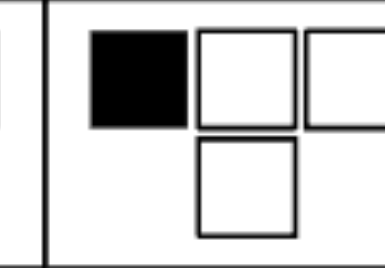
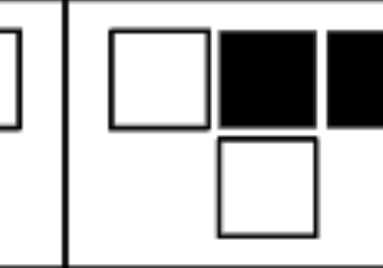
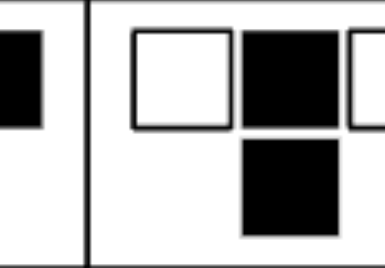
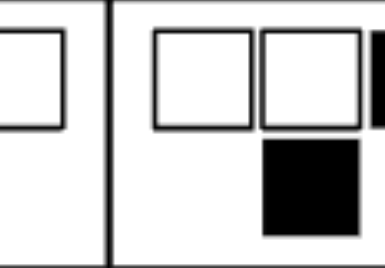
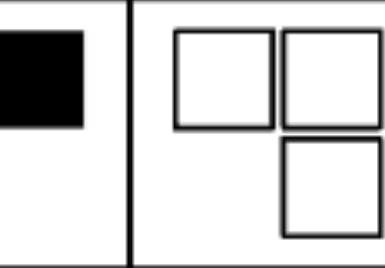
$x_t(i-1)$	$x_t(i)$	$x_t(i+1)$	$x_{t+1}(i)$
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

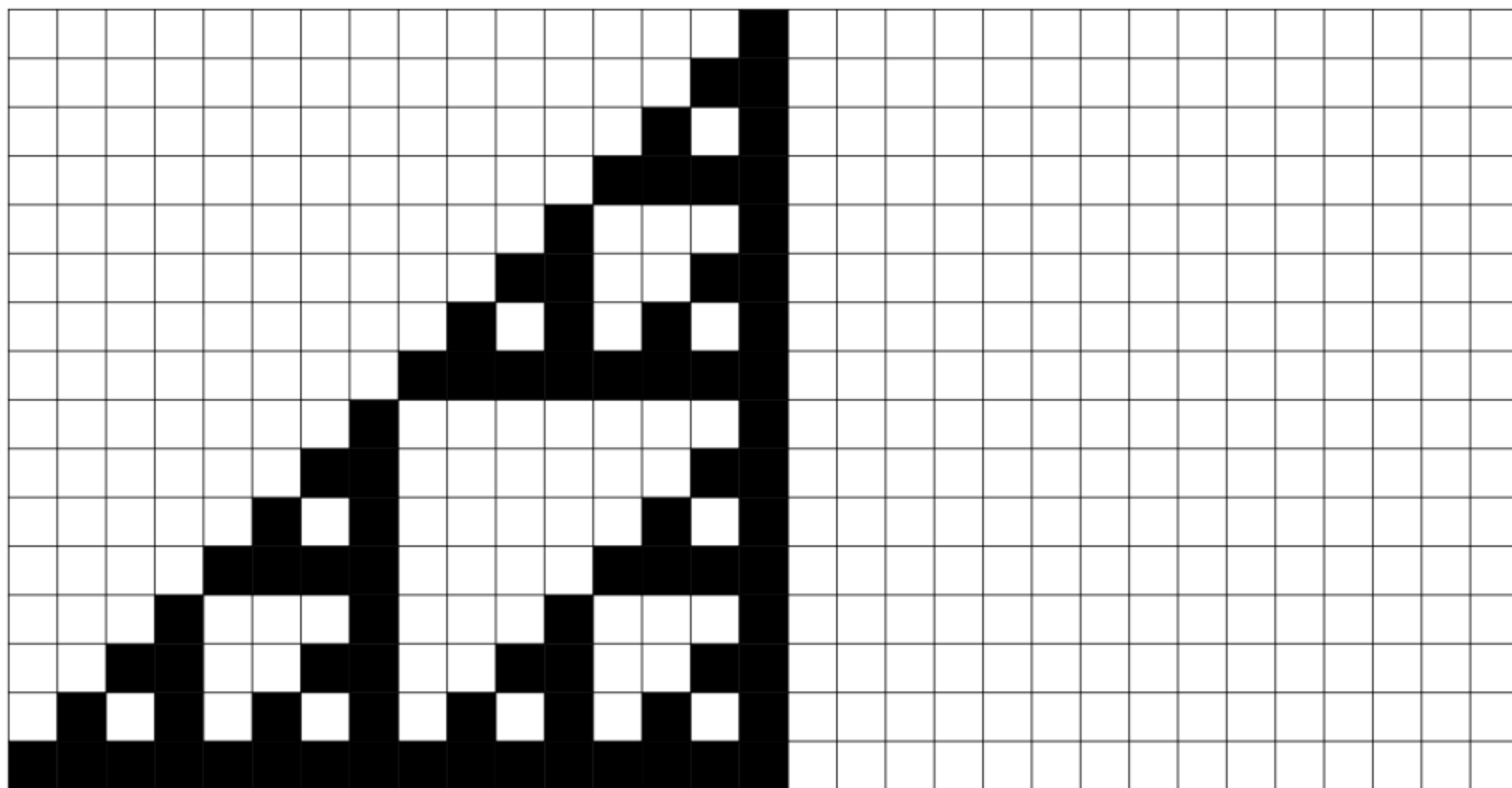
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Regra 50



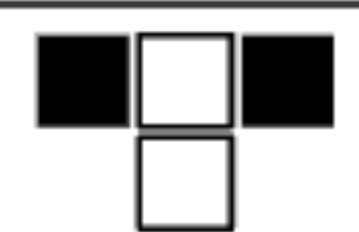
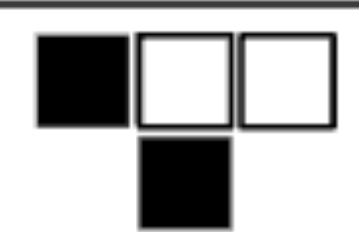

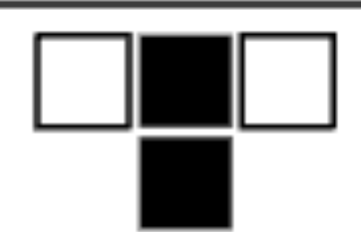

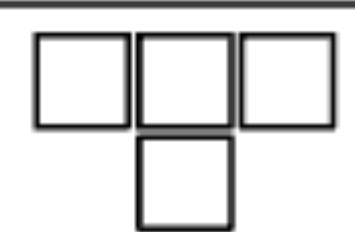


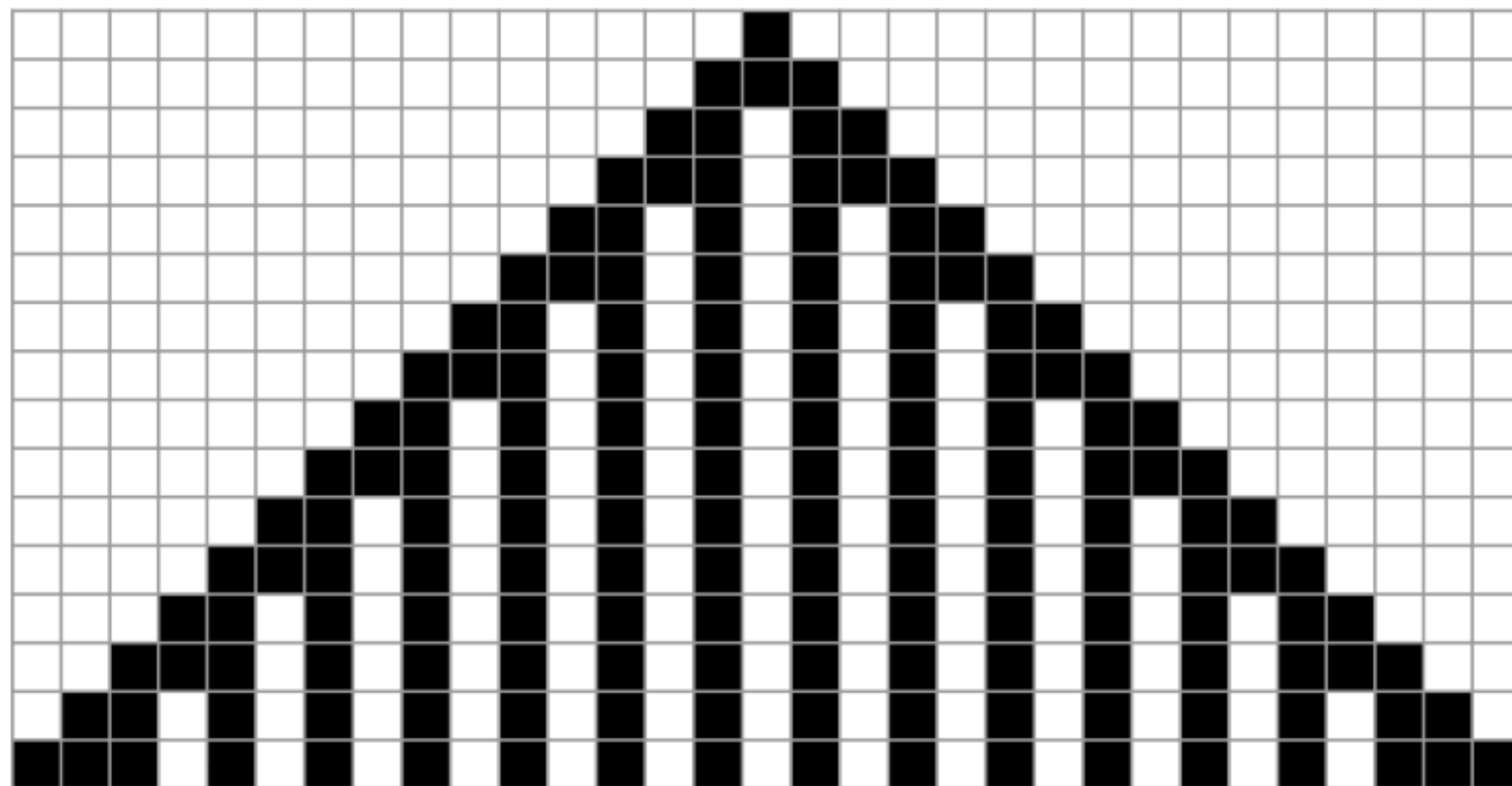
rule 102

							
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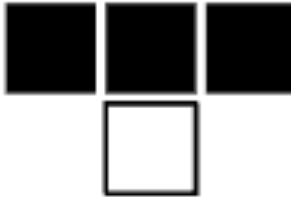

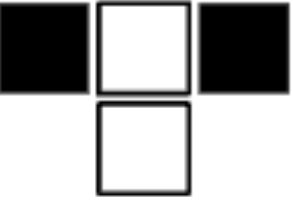
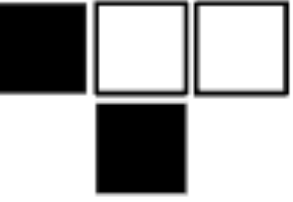
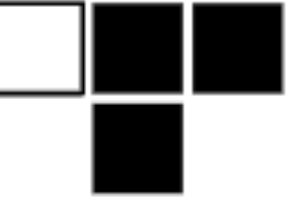
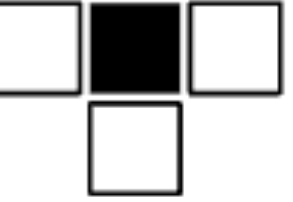
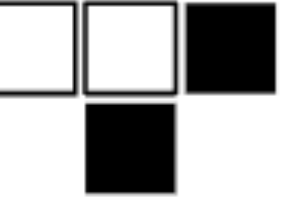
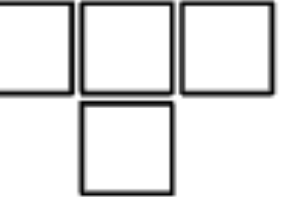


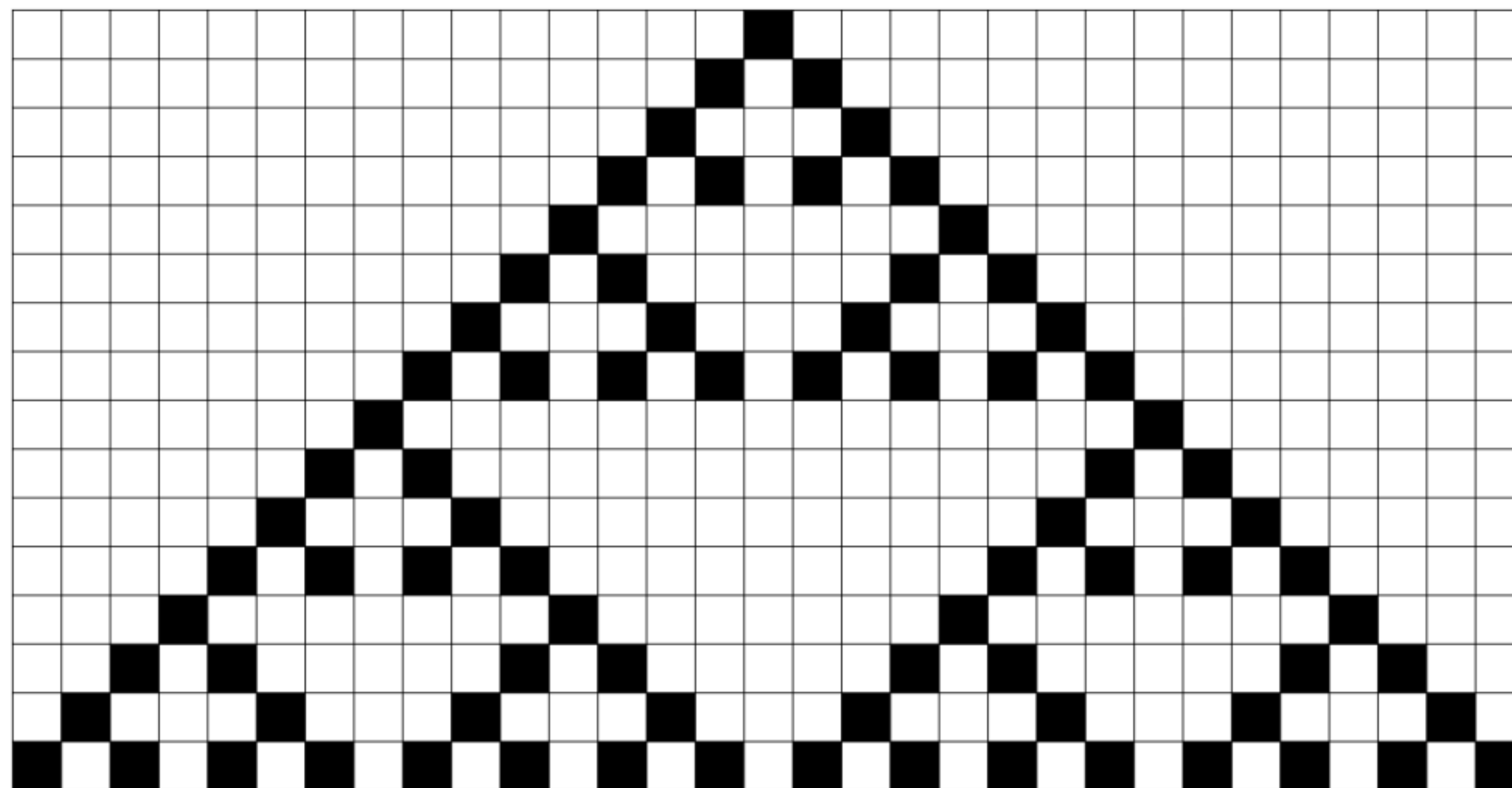
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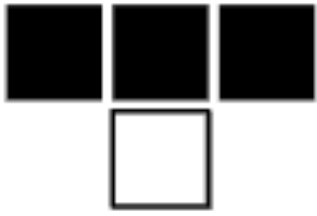
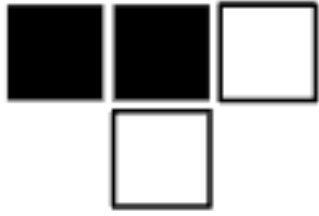
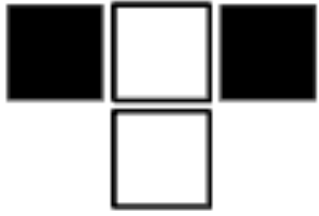
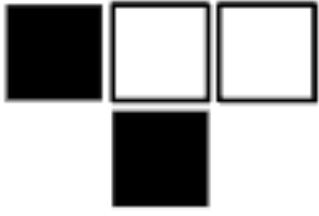
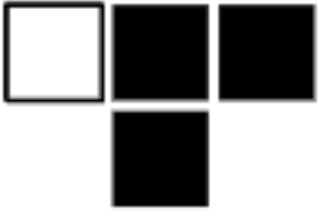
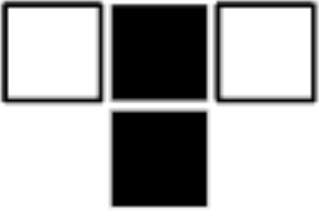
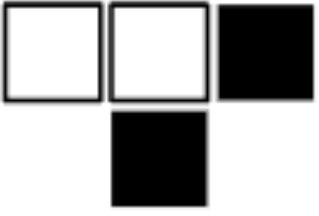
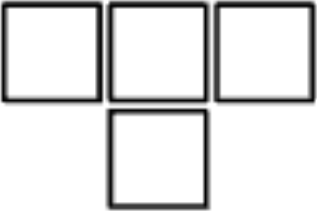


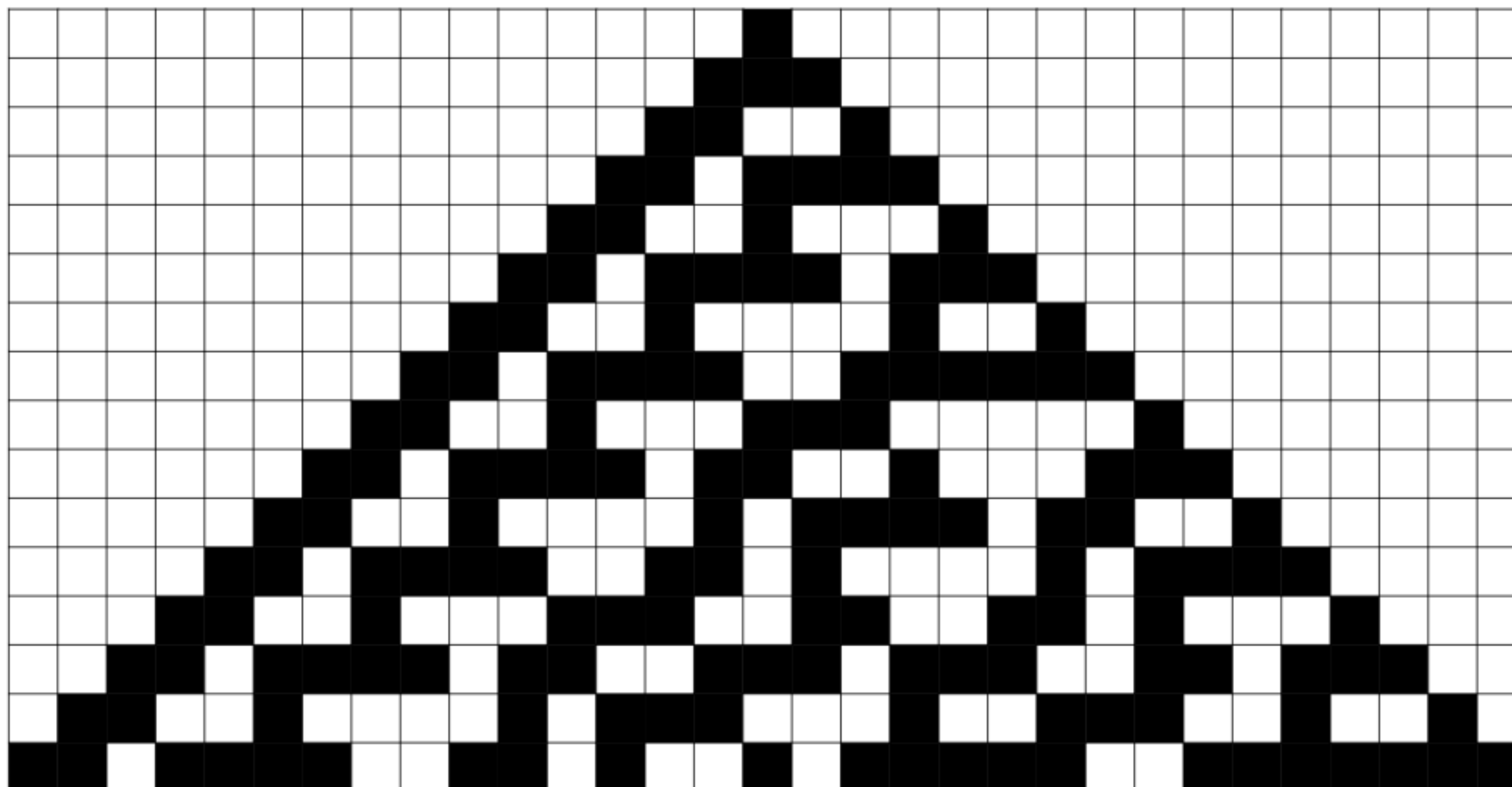
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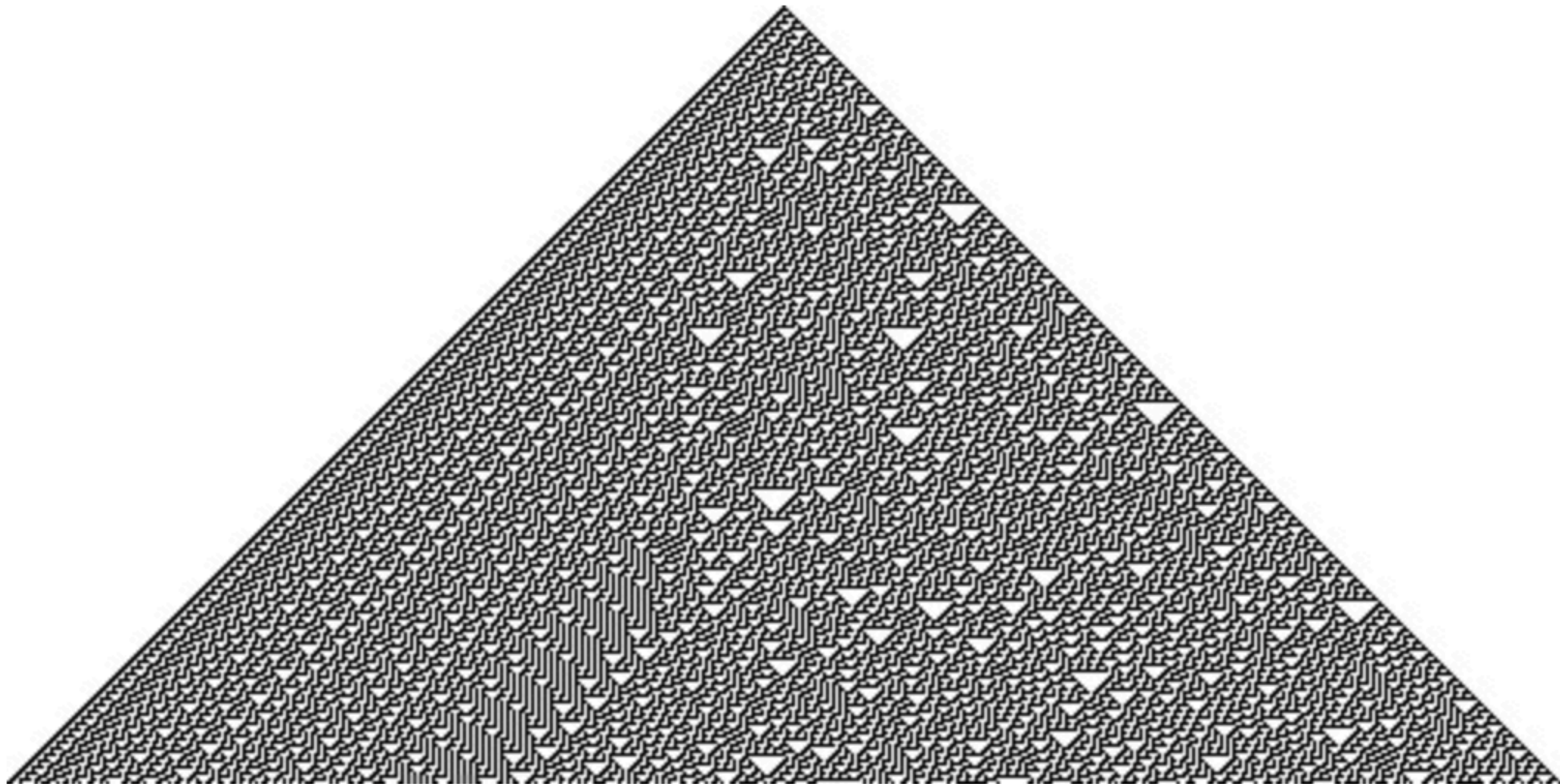
							
0	1	0	1	1	0	1	0



rule 30

							
0	0	0	1	1	1	1	0





Classes

- Iniciando com estado aleatório
- Classe 1 - Homogêneo
- Classe 2 - Estável simples
- Classe 3 - Padrão irregular
- Classe 4 - Estrutura complexa

Jogo da vida

- John Conway 1970
- Menos de 2 vizinhos - morre
- 2 ou 3 vizinhos - vive
- Mais de 3 vizinhos - morre
- 3 vizinhos - vive
- Turing completo
- Golly

Modelo SIR

- Modelo minimalista para reproduzir a dinâmica de propagação de uma doença
 - Cada autômato é um indivíduo da população em um dos estados:
 - 0 - Susceptível
 - 1 - Infectada
 - 2 - Recuperada
 - Indivíduo infectado contamina susceptíveis vizinhos com probabilidade p_c
 - Indivíduo infectado tem probabilidade p_R de se recuperar