Résolution de niveaux du Sokoban

PoulpoGaz, darth-mole

16 mai 2023

Candidat n° 012345

Plan

Le jeu du Sokoban

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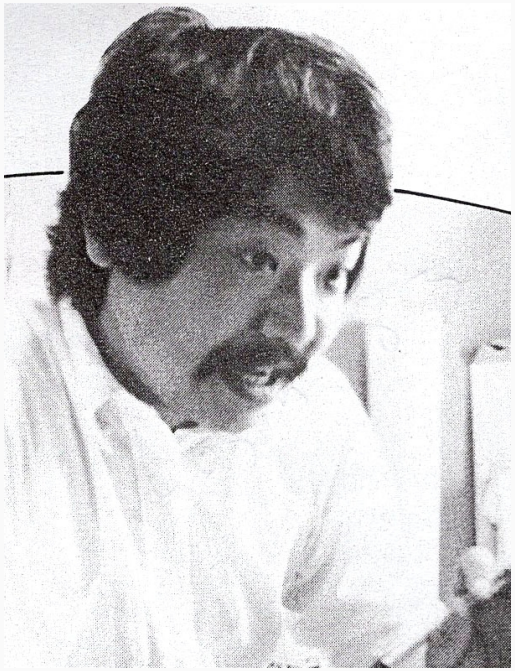
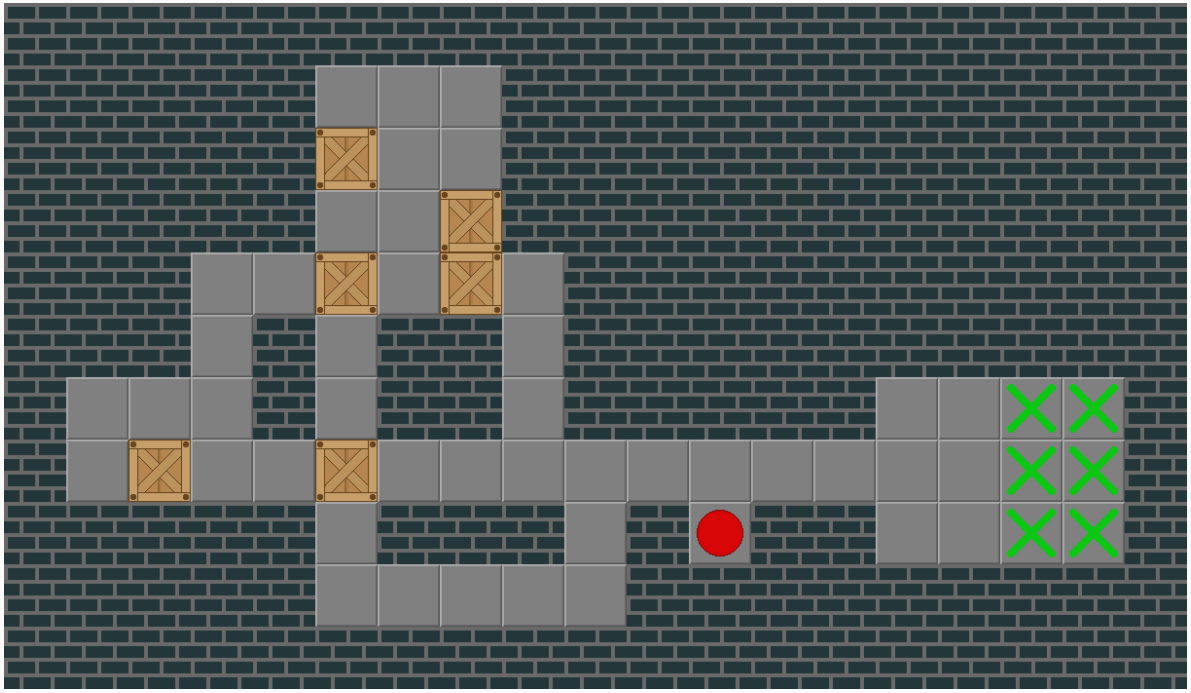
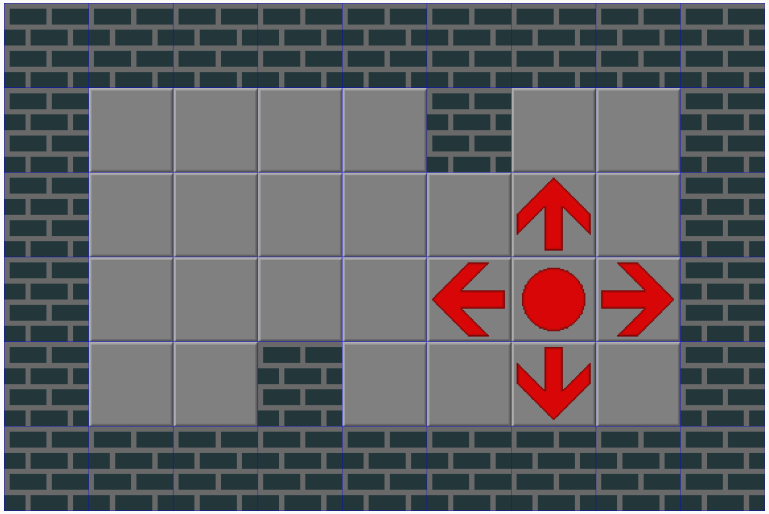


Hiroyuki Imabayashi



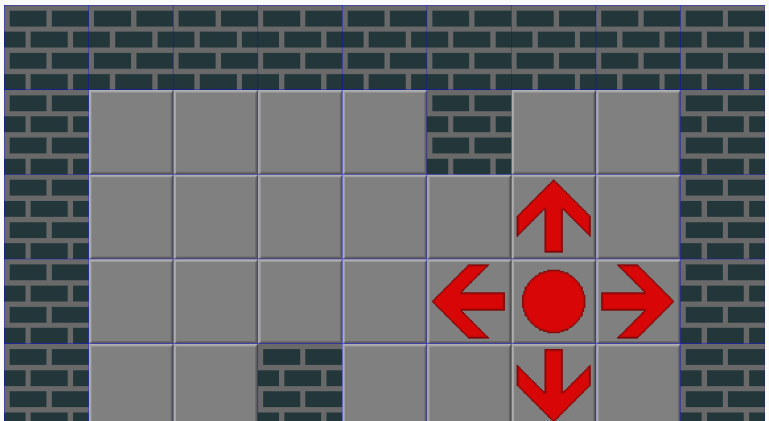
XSokoban

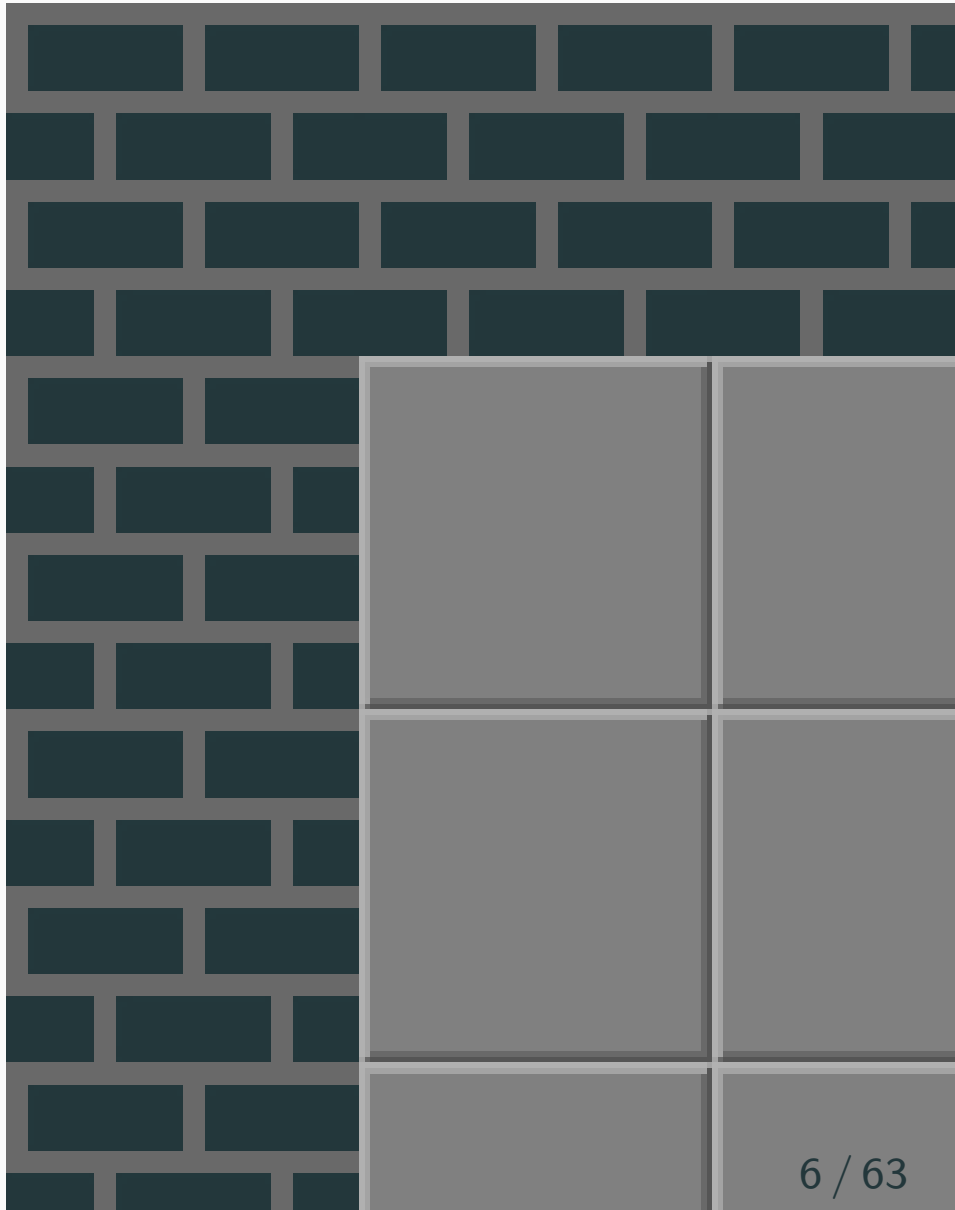
Règles



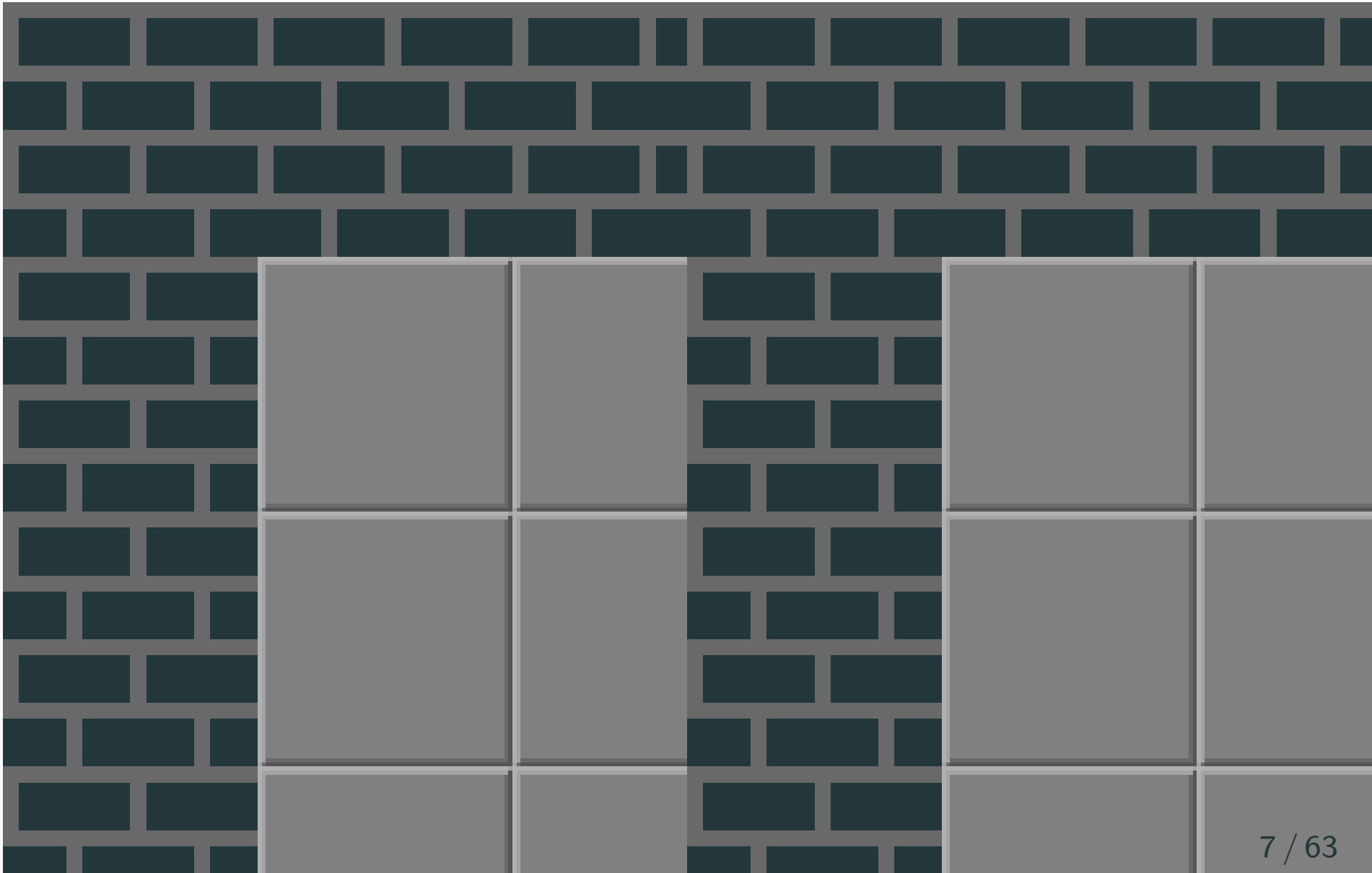
Déplacements autorisés

Règles

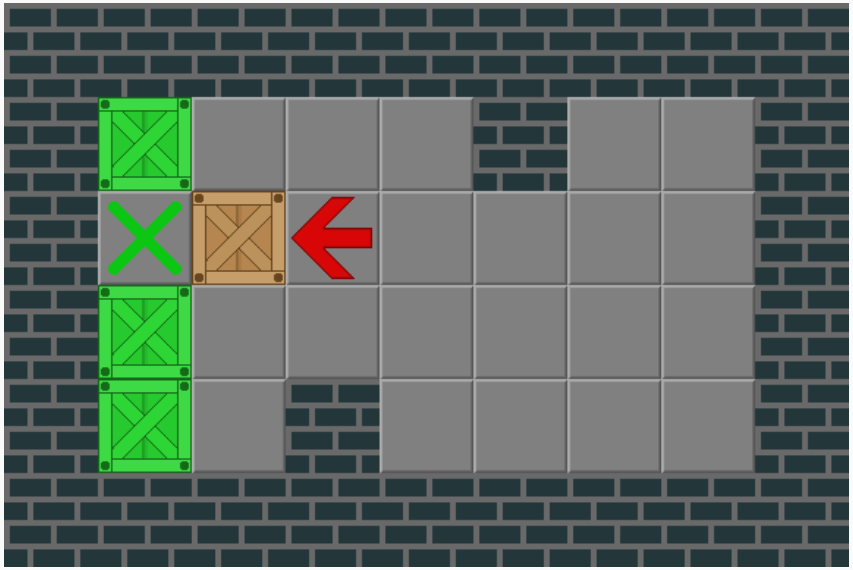


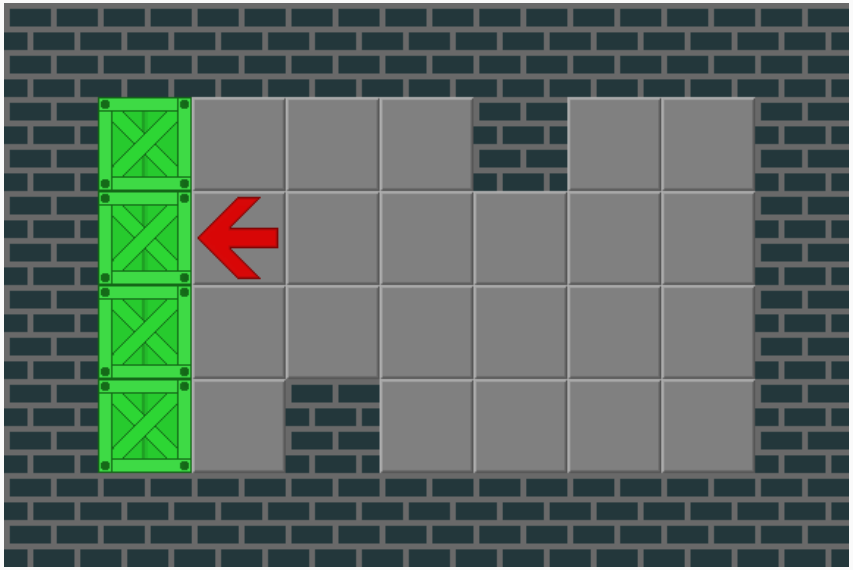


Règles



But du jeu





Lien avec le thème de l'année

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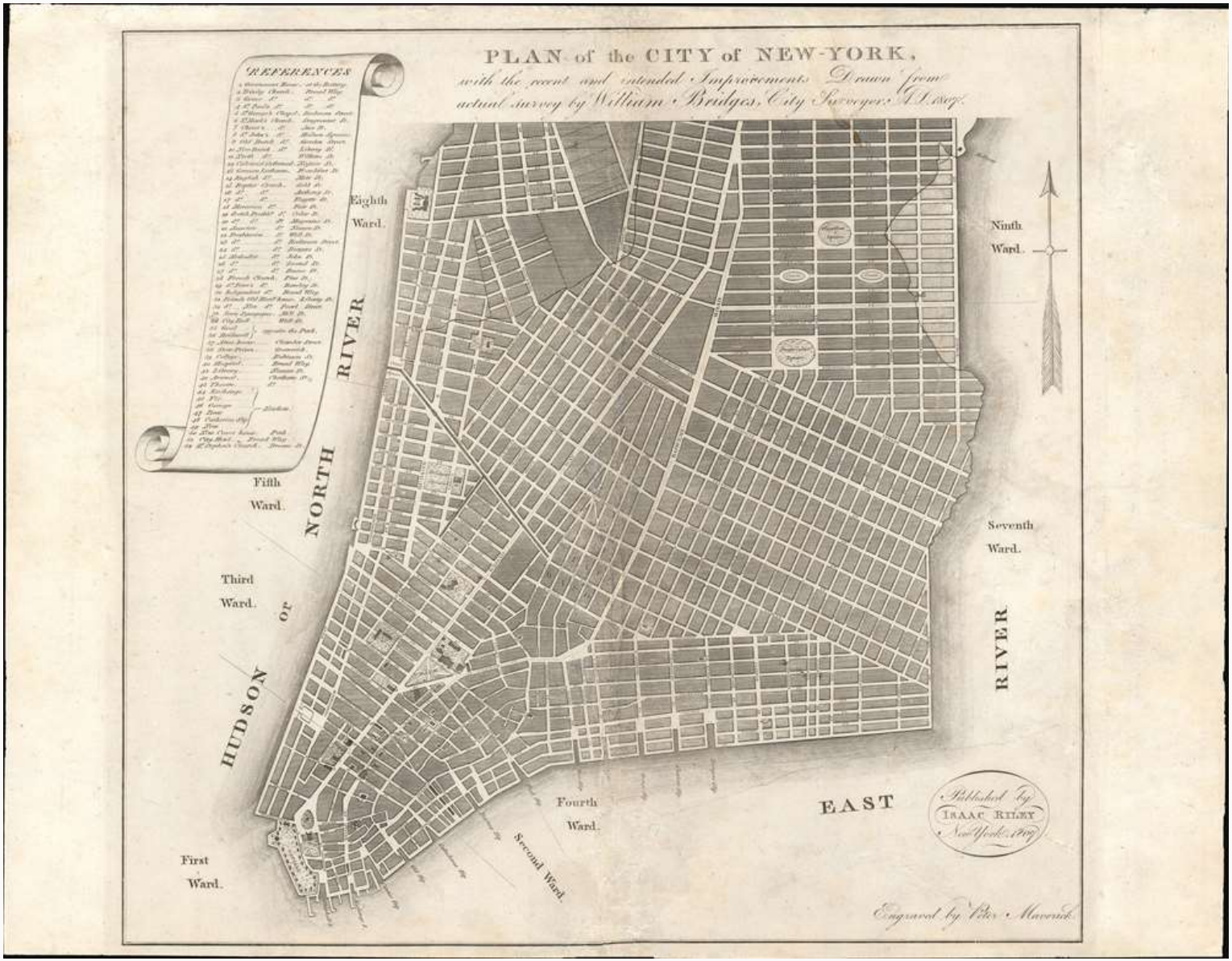
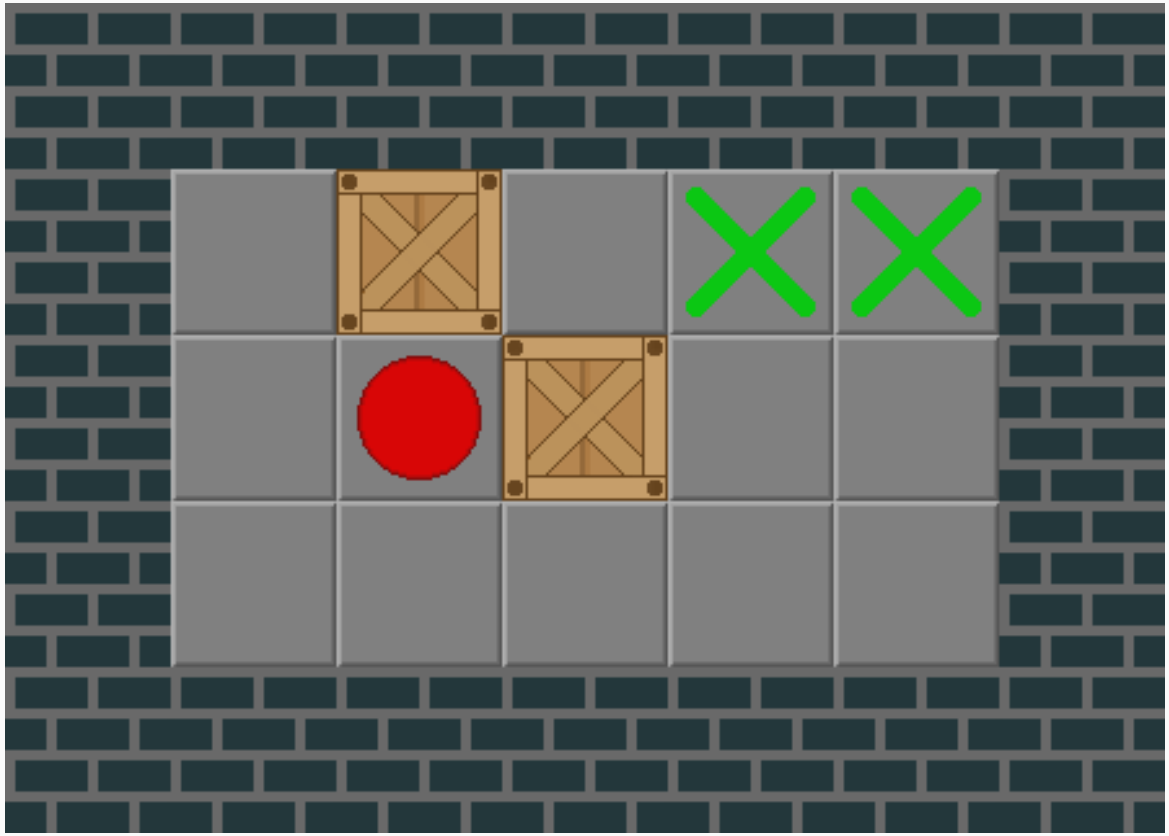
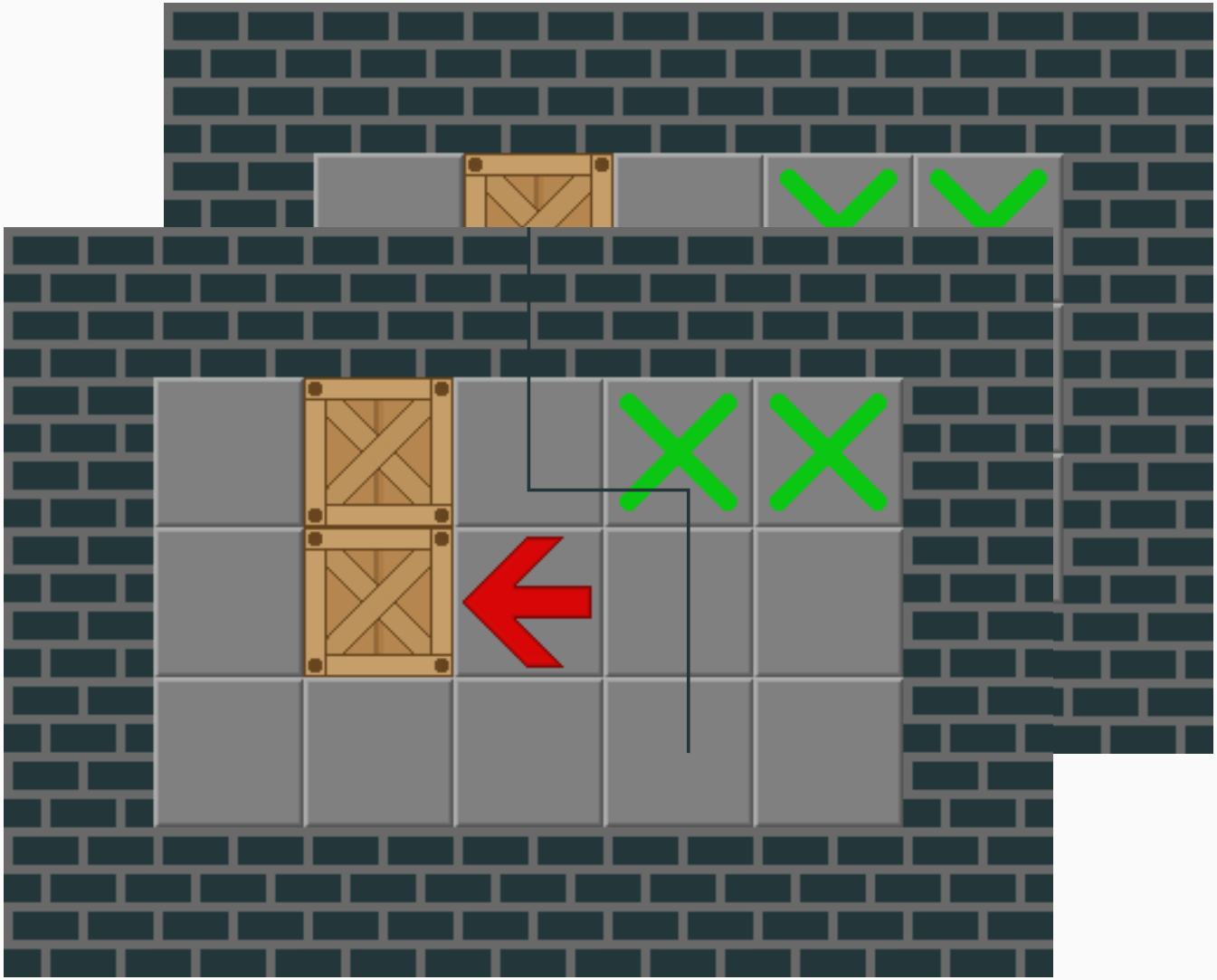


Principe de résolution

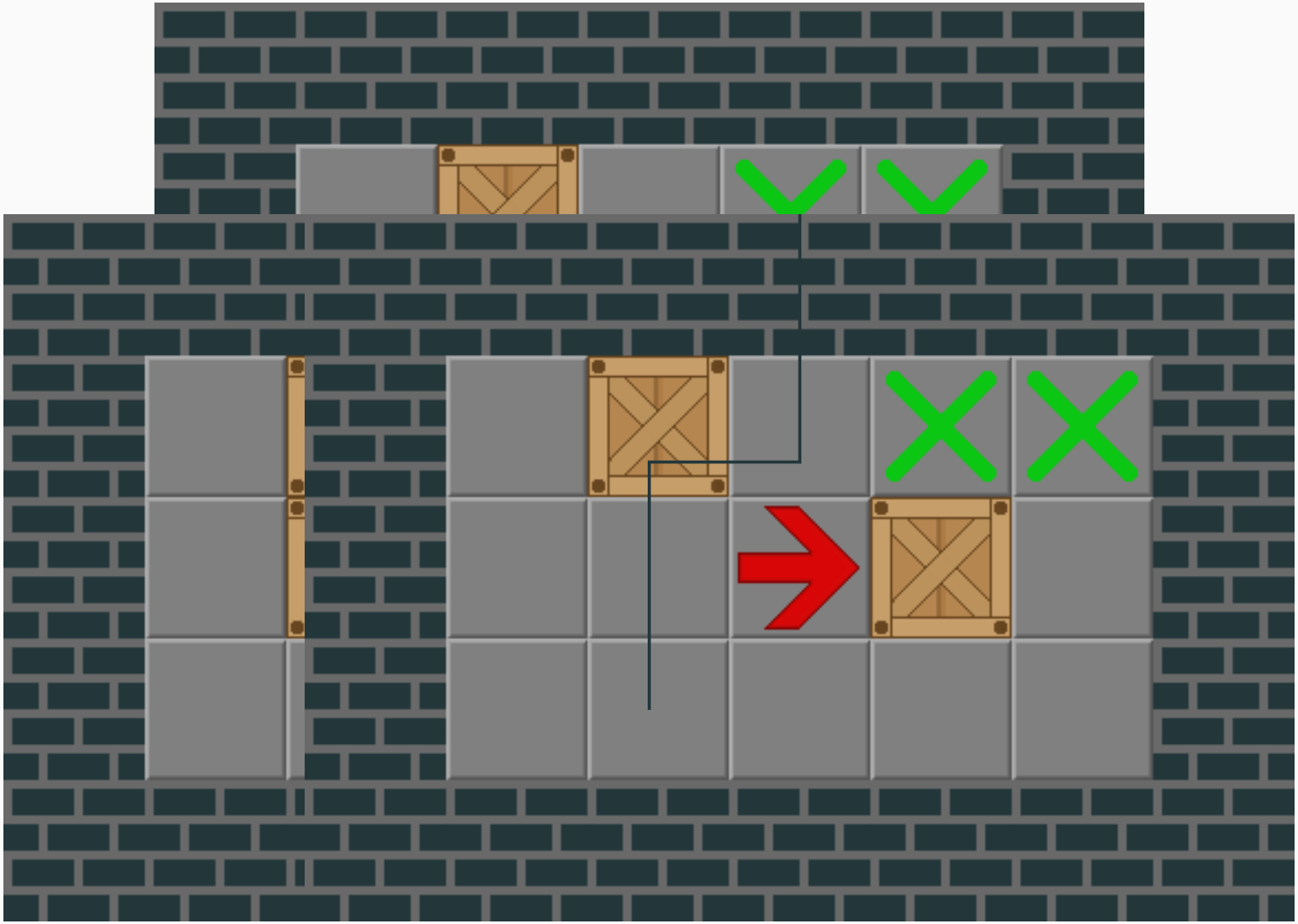
Arbre des états



Arbre des états



Arbre des états



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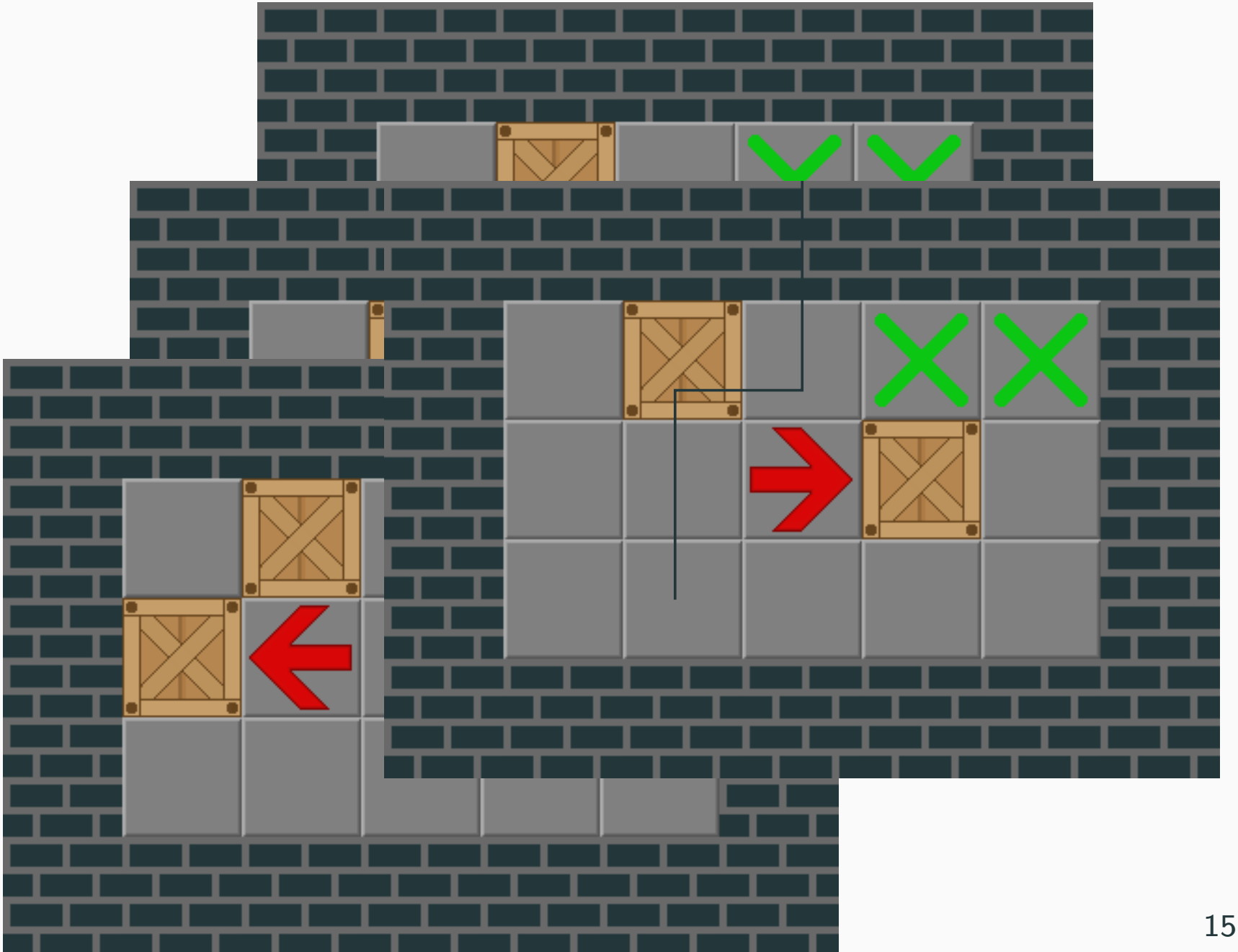
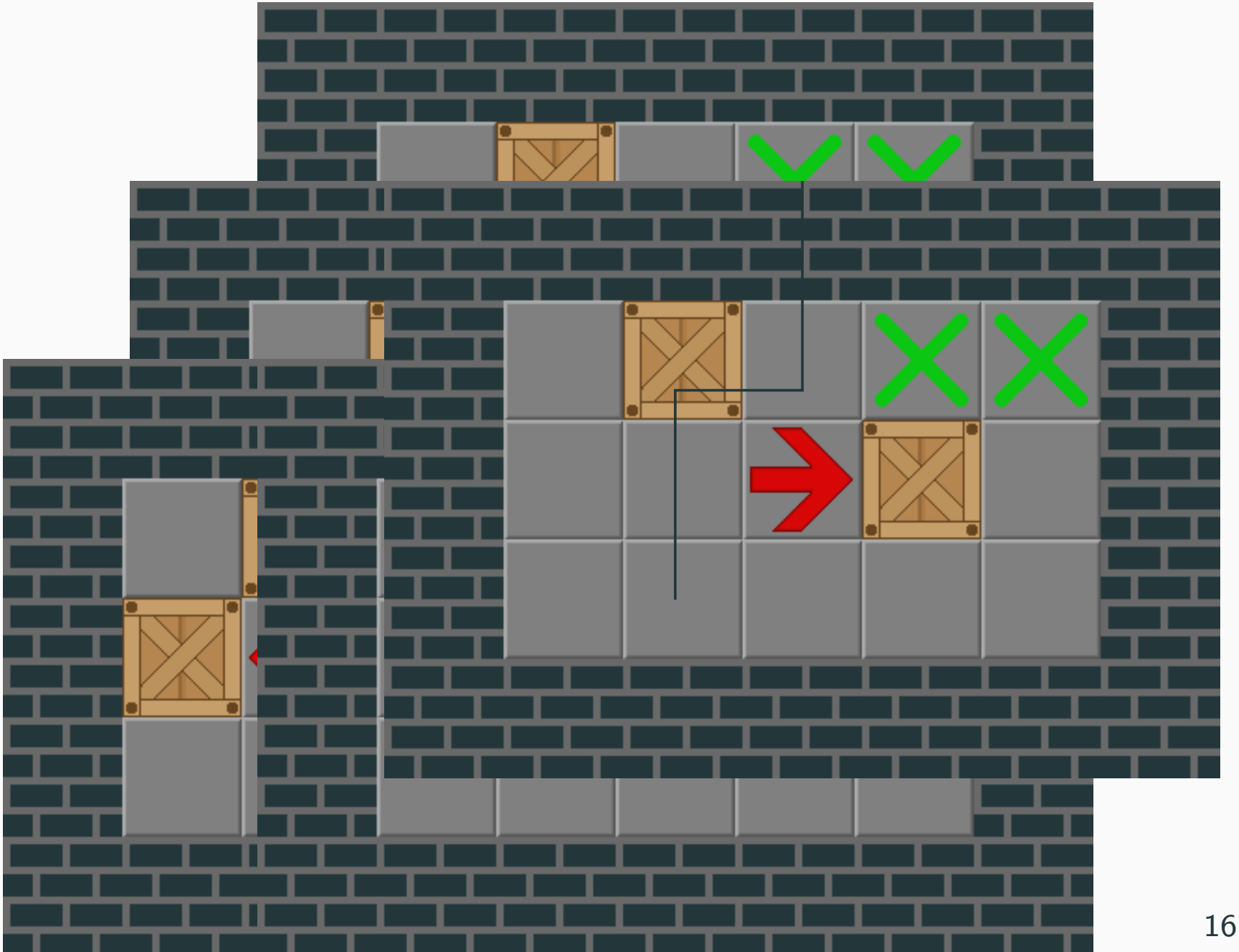
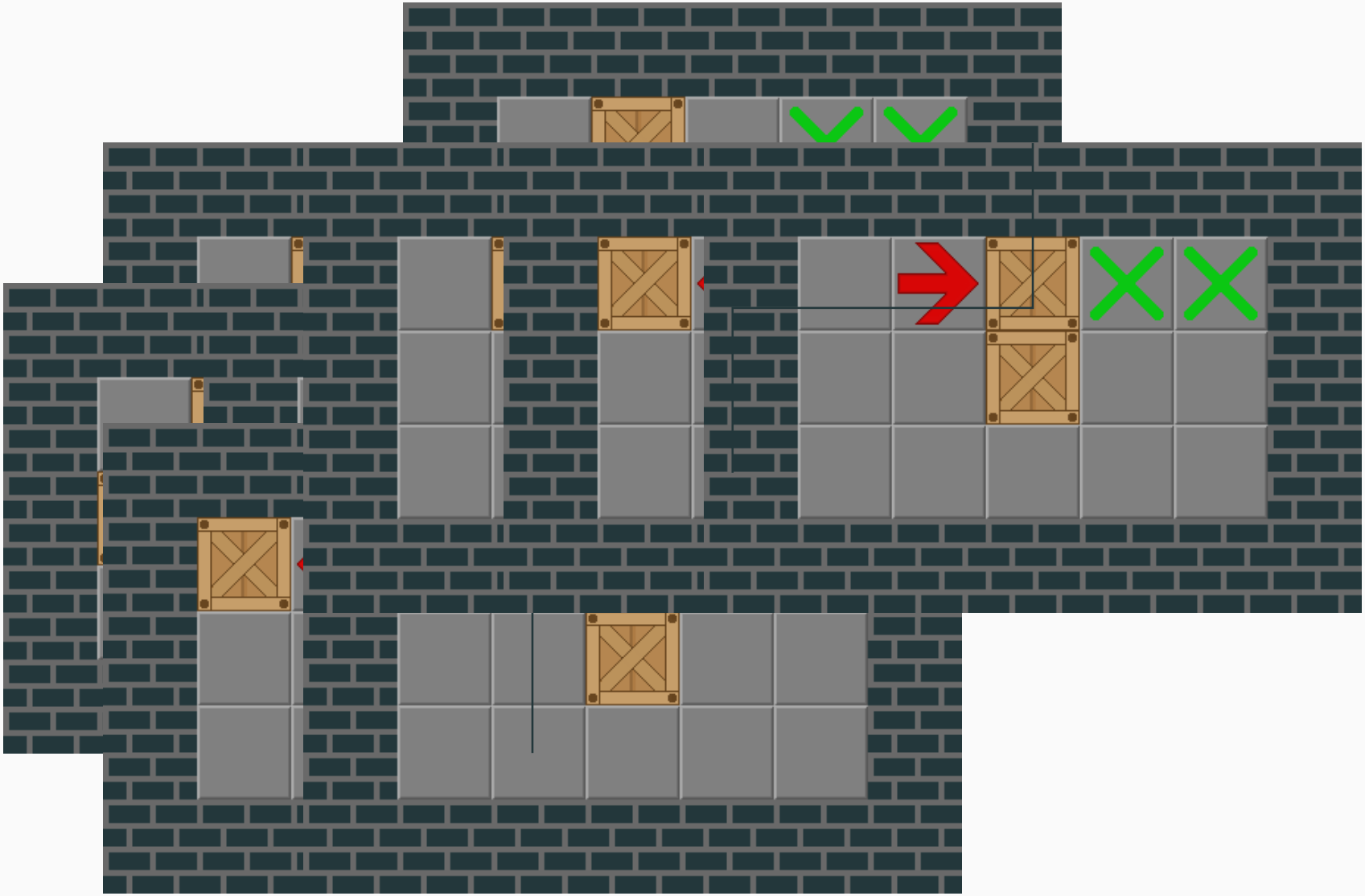


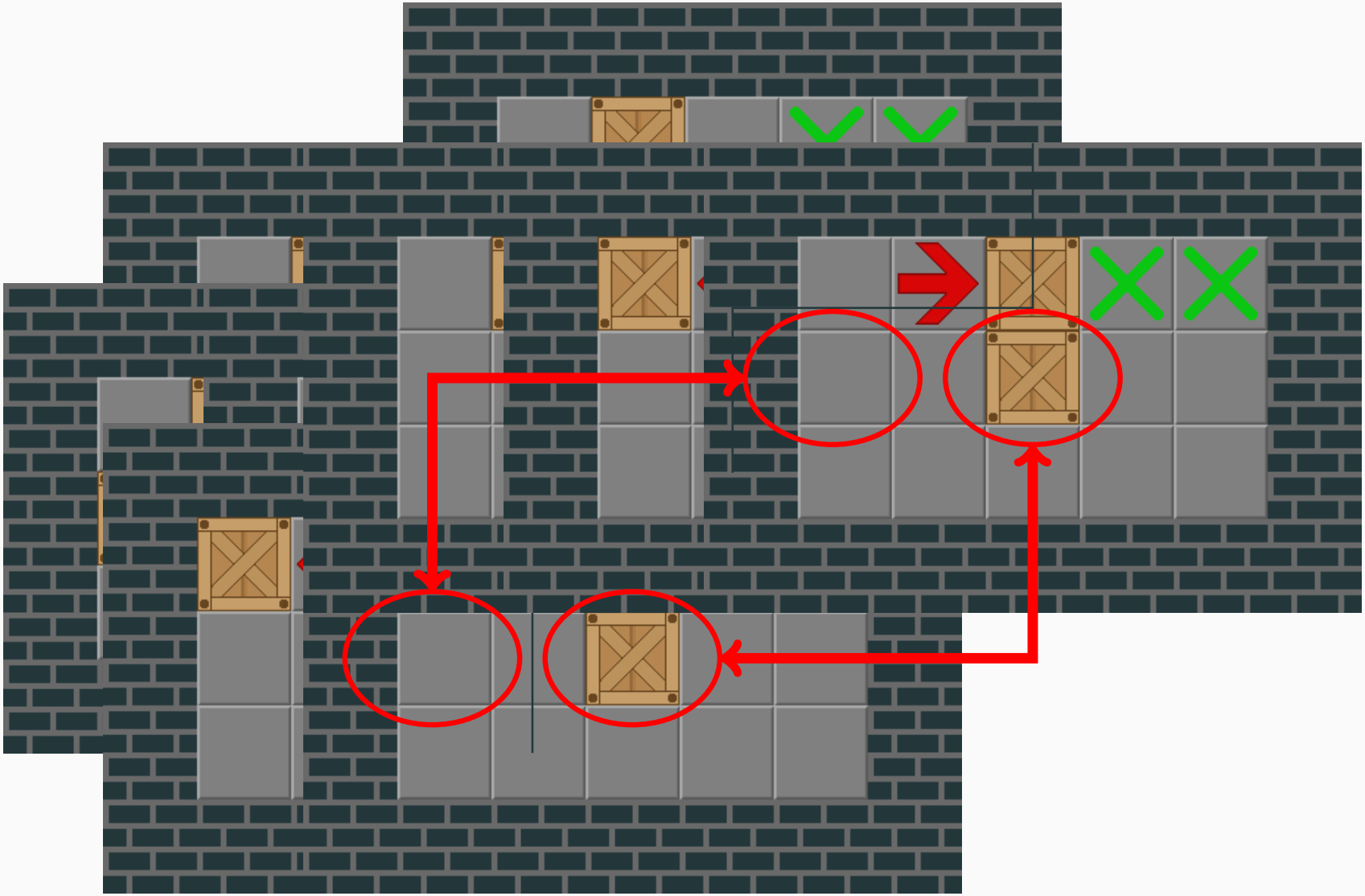
Arbre des états



Exemple développé



Un graphe vu comme un arbre



Hash de Zobrist

Initialisation :

$$T = \begin{array}{c} \begin{array}{cc} \text{caisse} & \text{joueur} \end{array} \\ \begin{pmatrix} 6357 & 5742 \\ -1378 & 42 \\ \vdots & \vdots \\ 93268 & -278 \end{pmatrix} \end{array} \begin{array}{c} \text{case} \\ 0 \\ 1 \\ \vdots \\ wh-1 \end{array}$$

Usage : $(c_1, ..., c_n)$ n caisses et p position du joueur :

$h = \overset{n}{\underset{i=0}{\mathbf{XOR}}} T[c_i][0] \,\mathbf{XOR}\, T[p][1]$

Passer d'une configuration à une autre : $c_i \to c_i', p \to p'$

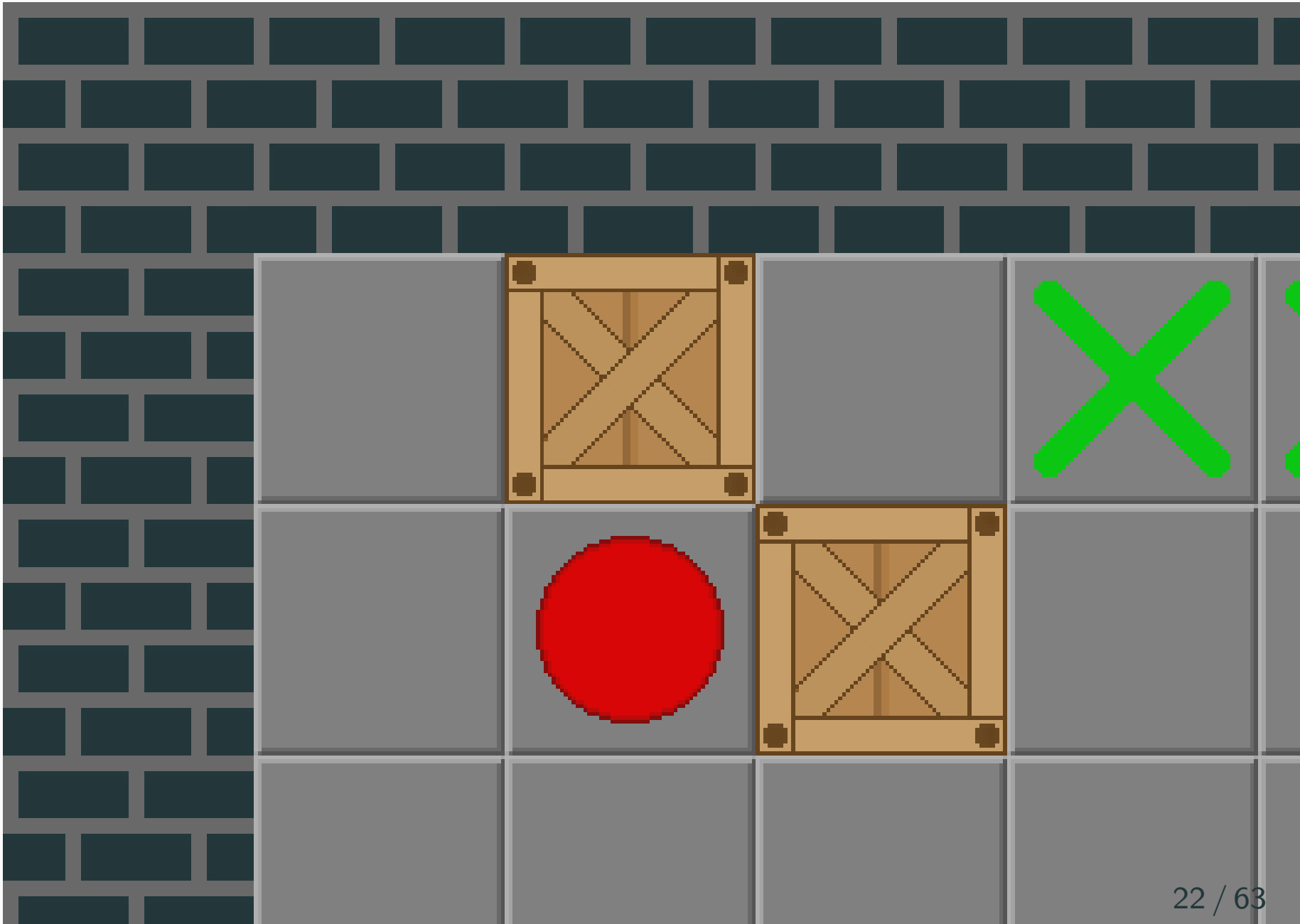
$h = h \,\mathbf{XOR}\, T[c_i][0] \,\mathbf{XOR}\, T[c_i'][0] \,\mathbf{XOR}\, T[p][1] \,\mathbf{XOR}\, T[p'][1]$

Réduction de l'espace de recherche

Réduction de l'espace de recherche

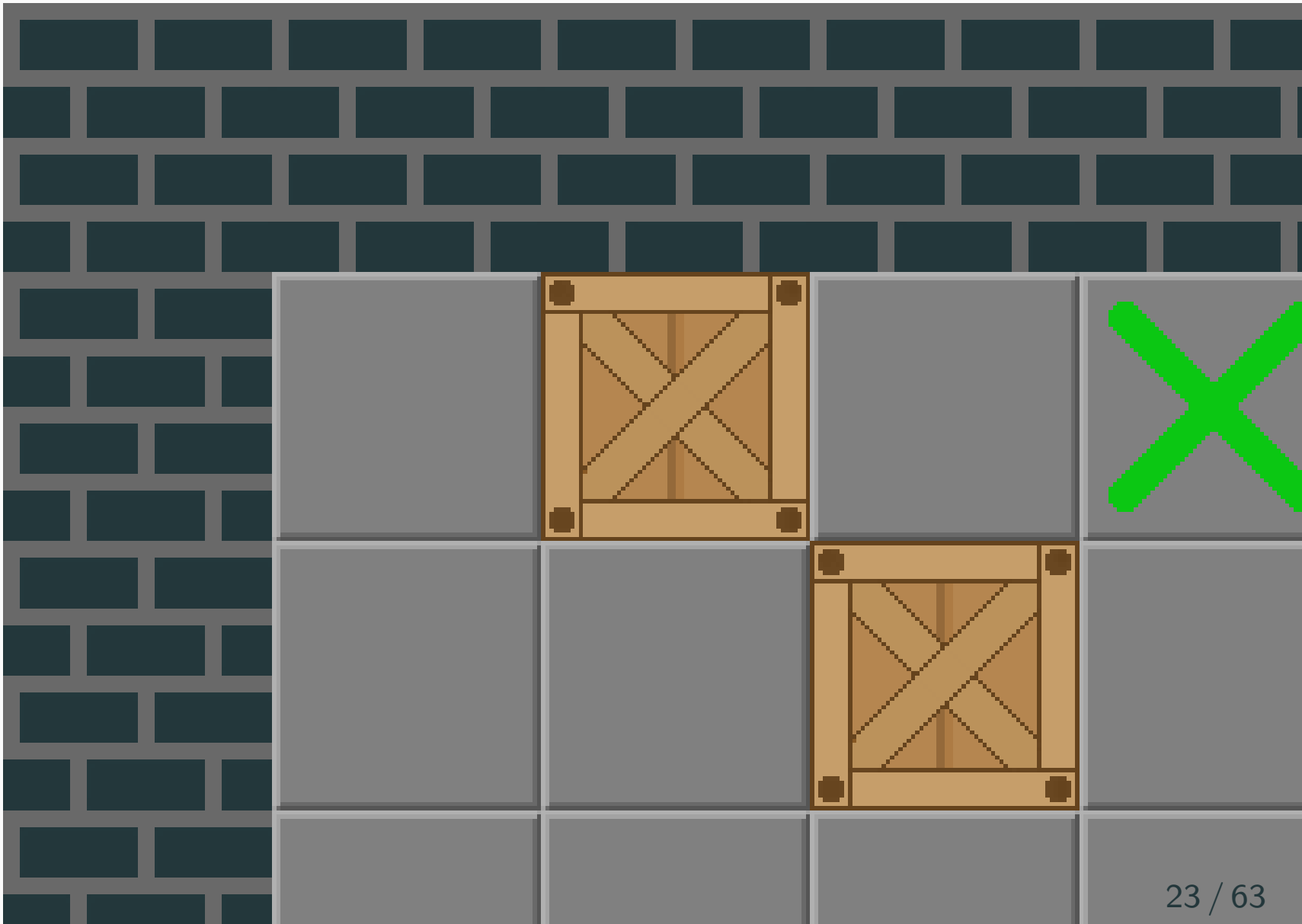
Analyse statique

Détection des positions mortes *(dead positions)*



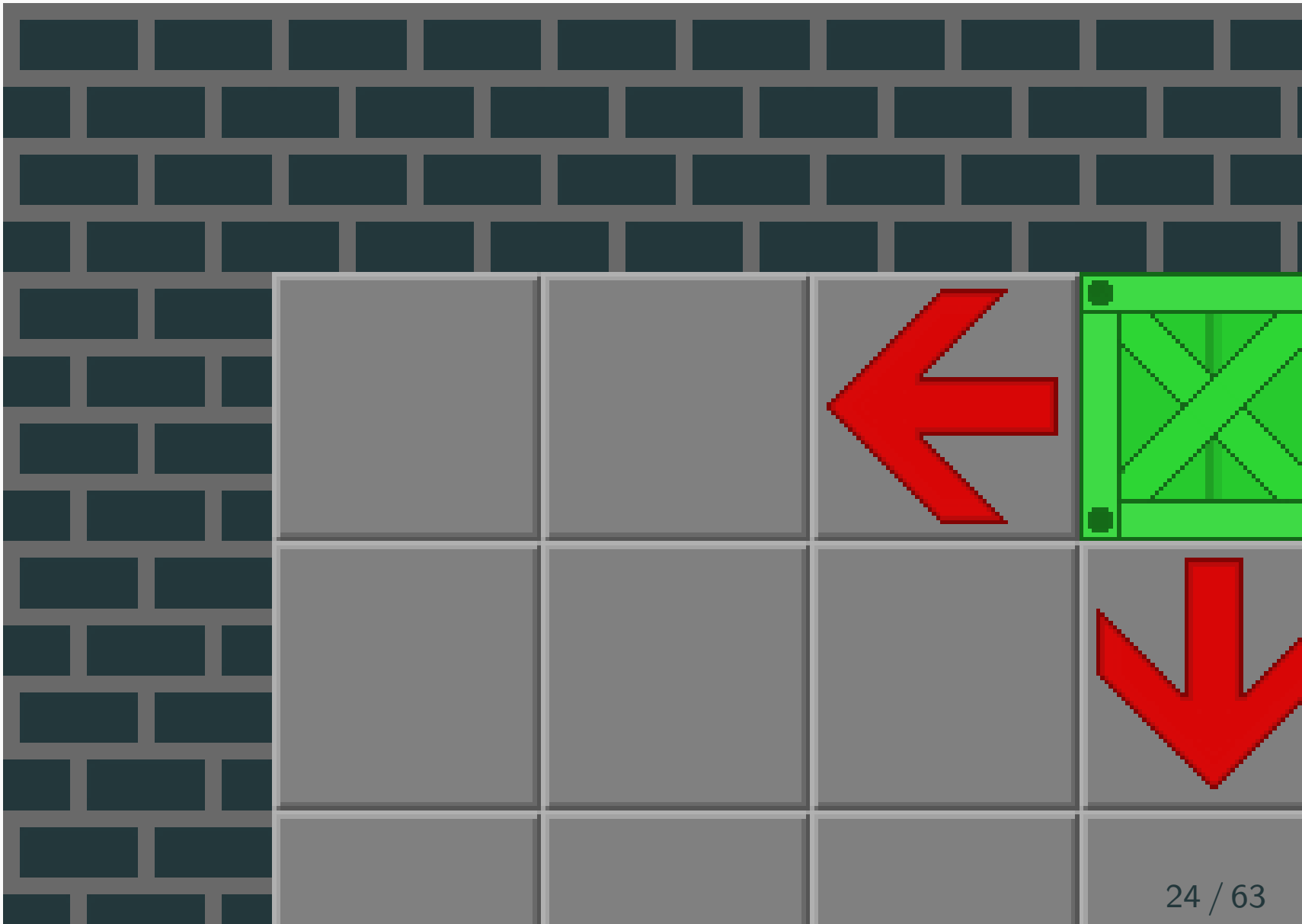
Détection des positions mortes *(dead positions)*

1.



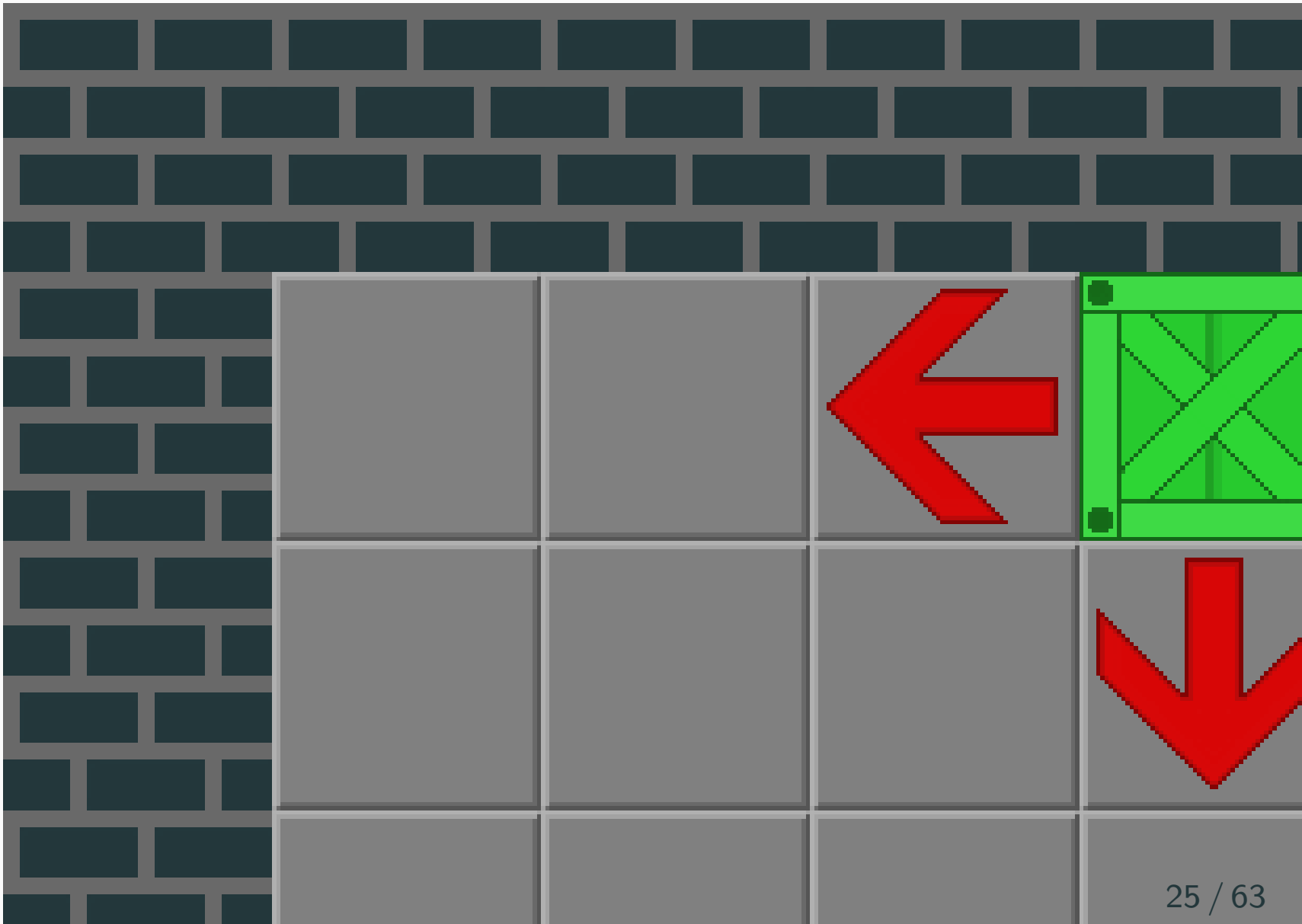
Détection des positions mortes *(dead positions)*

2.

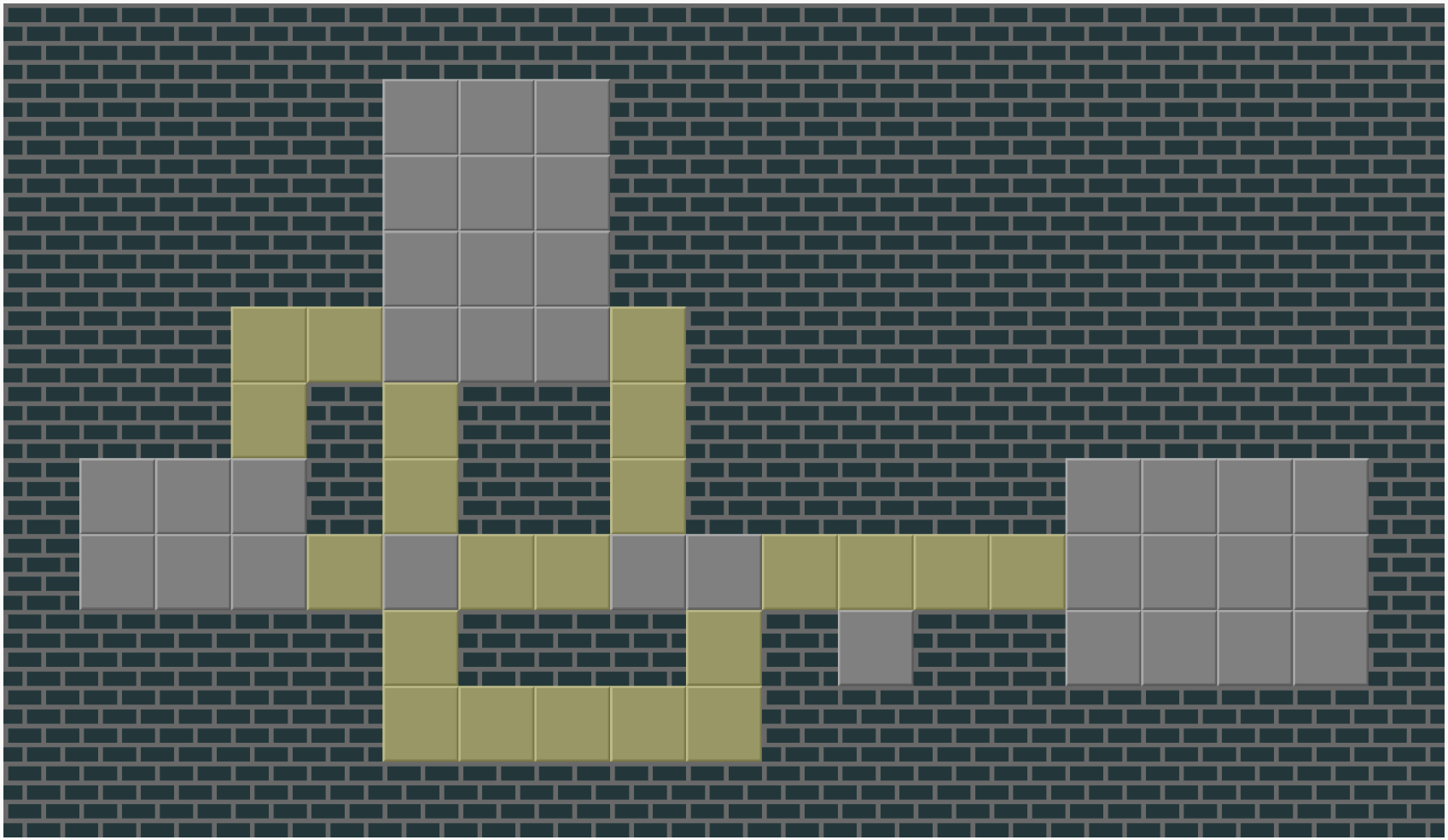


Détection des positions mortes *(dead positions)*

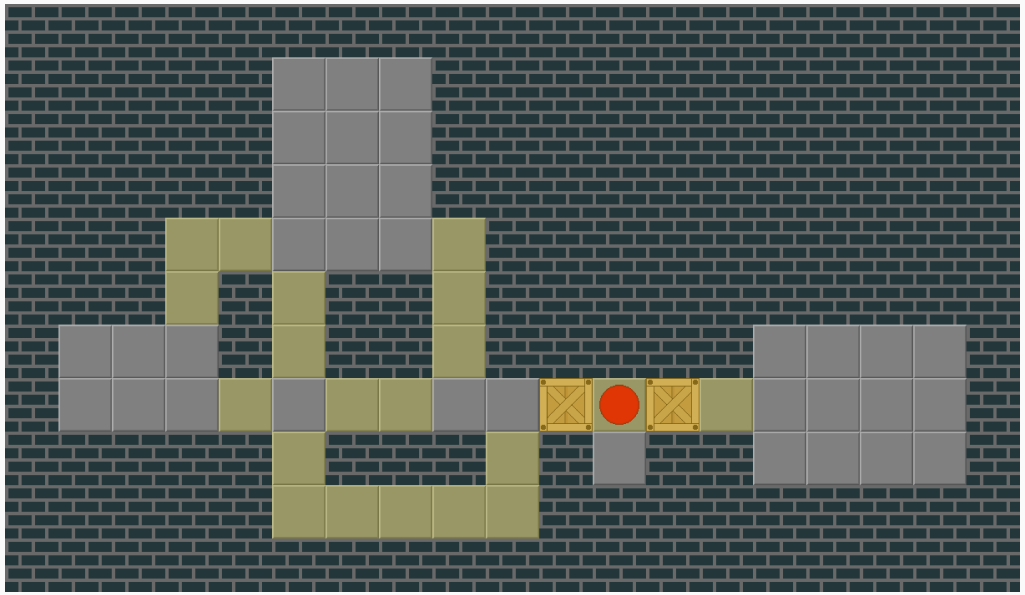
2.

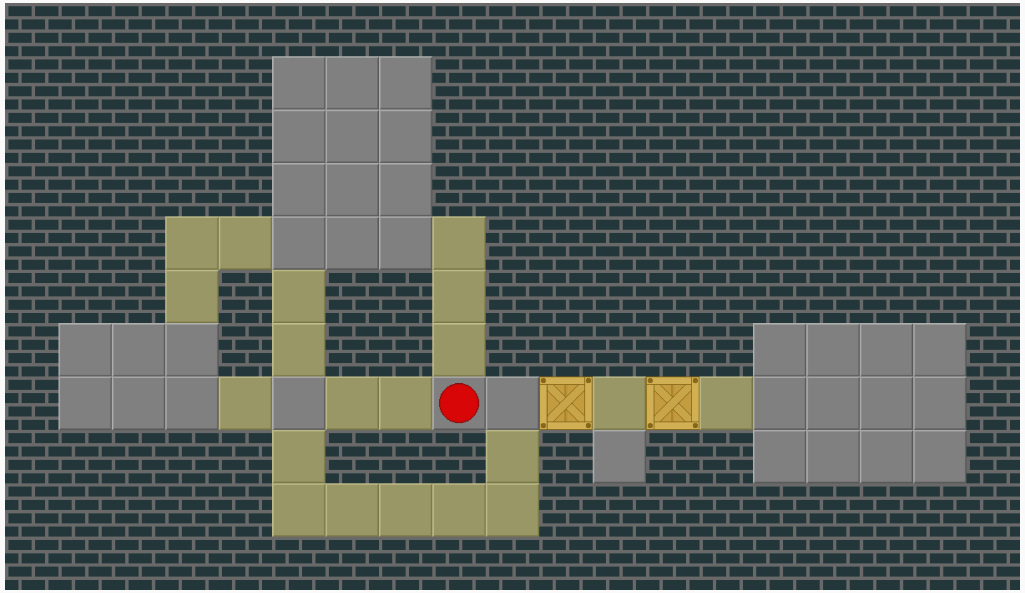


Détection de tunnels

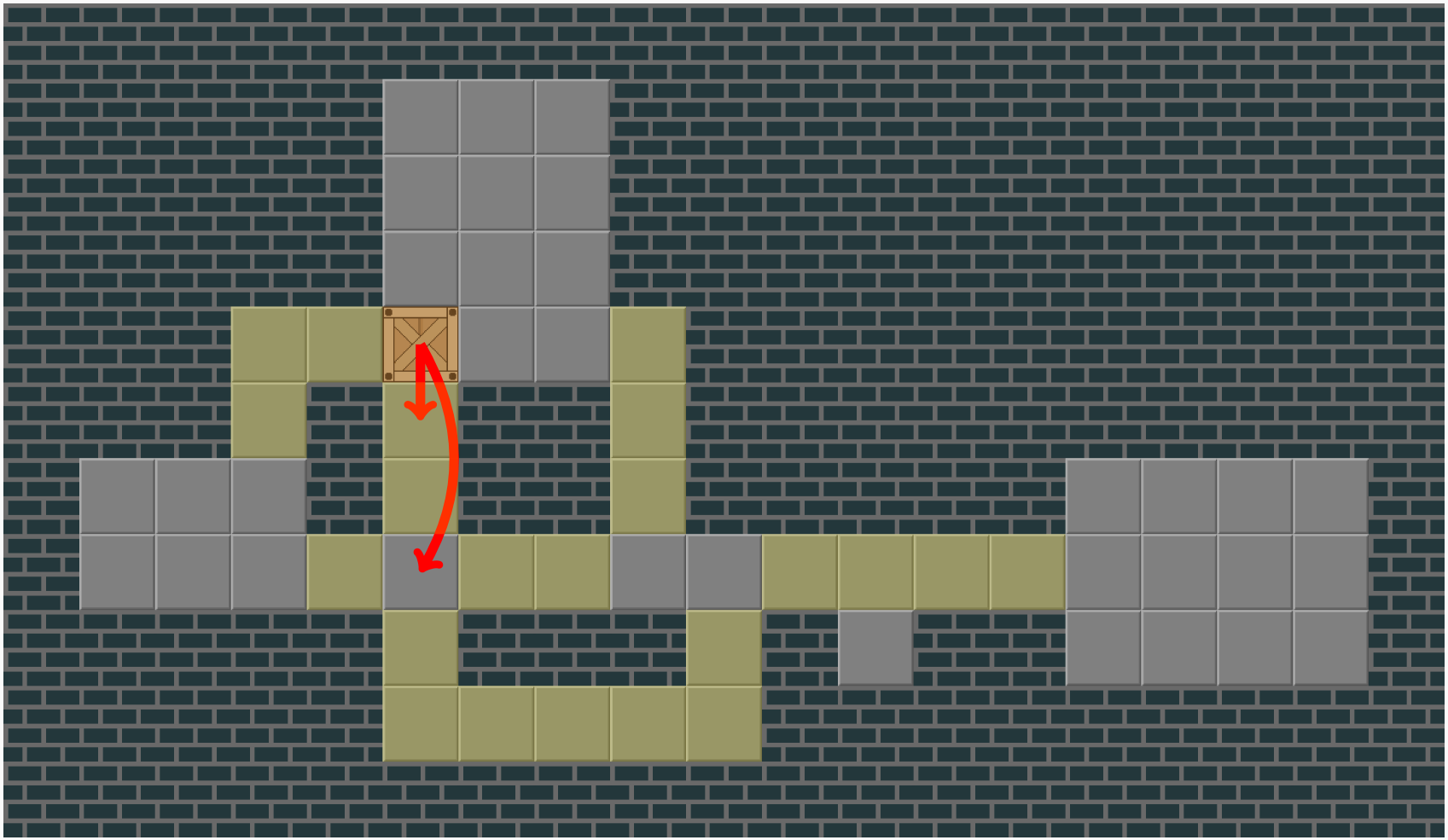


Détection de tunnels

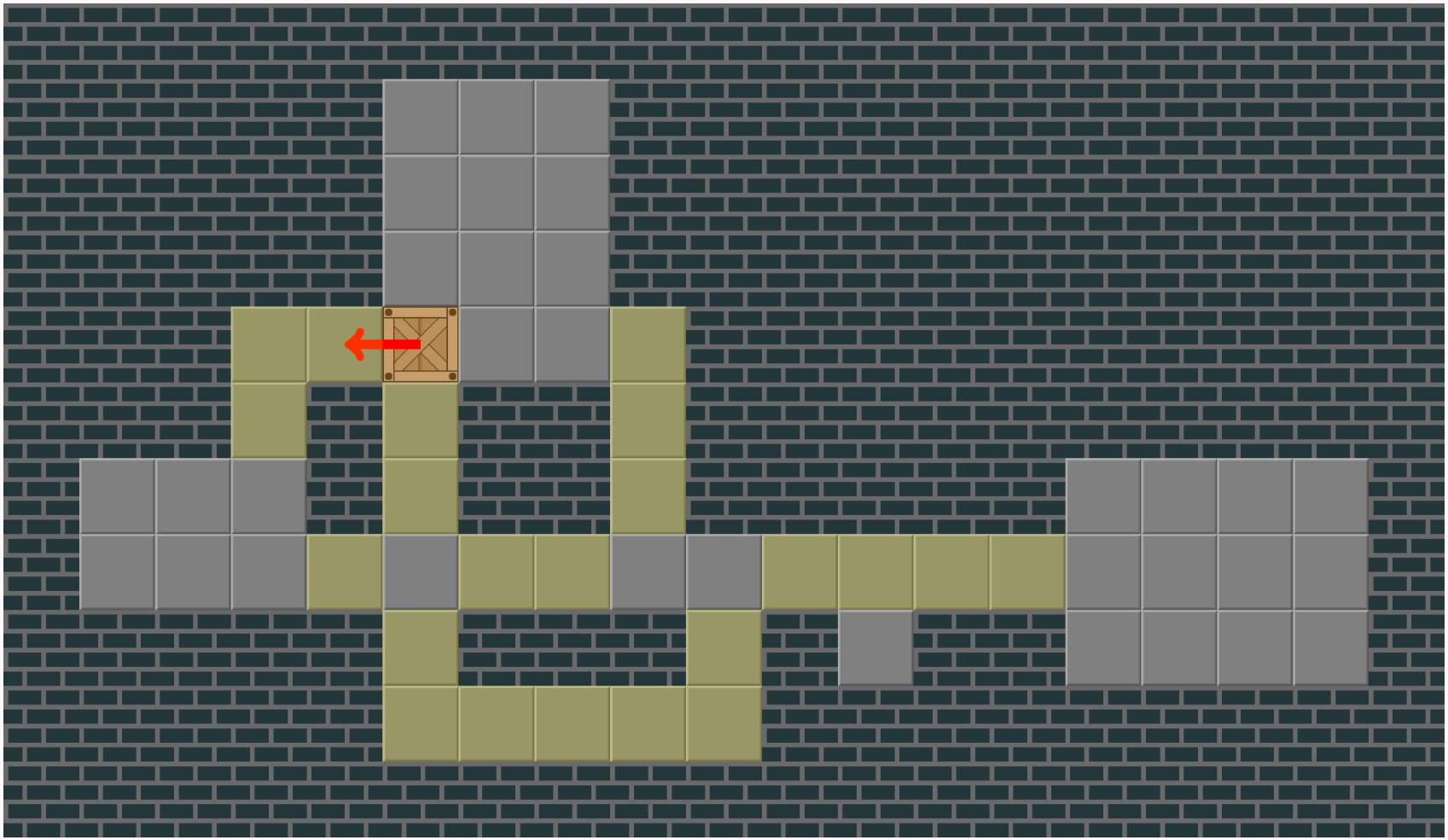




Détection de tunnels



Détection de tunnels



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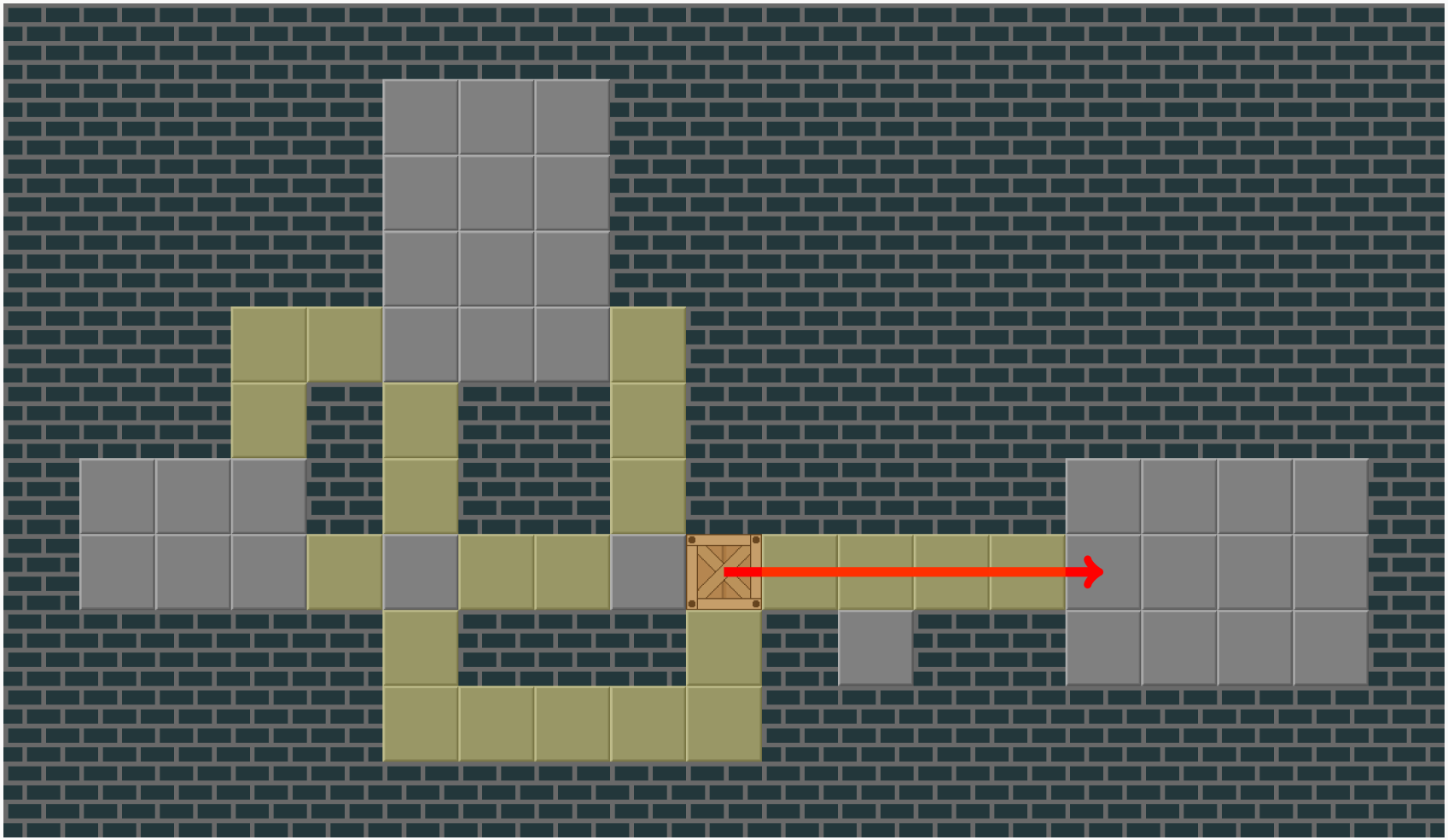
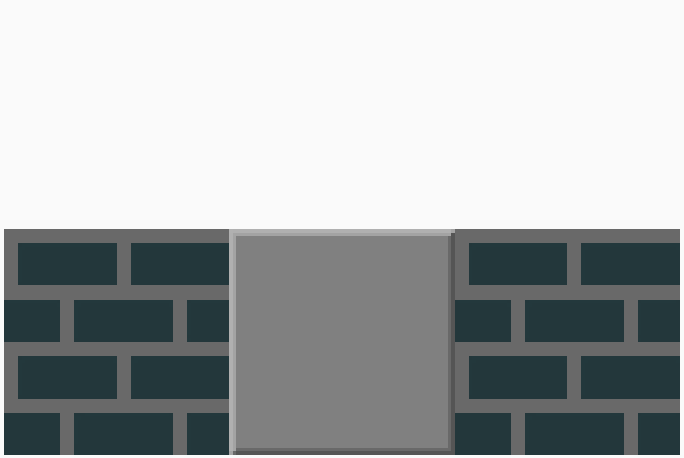
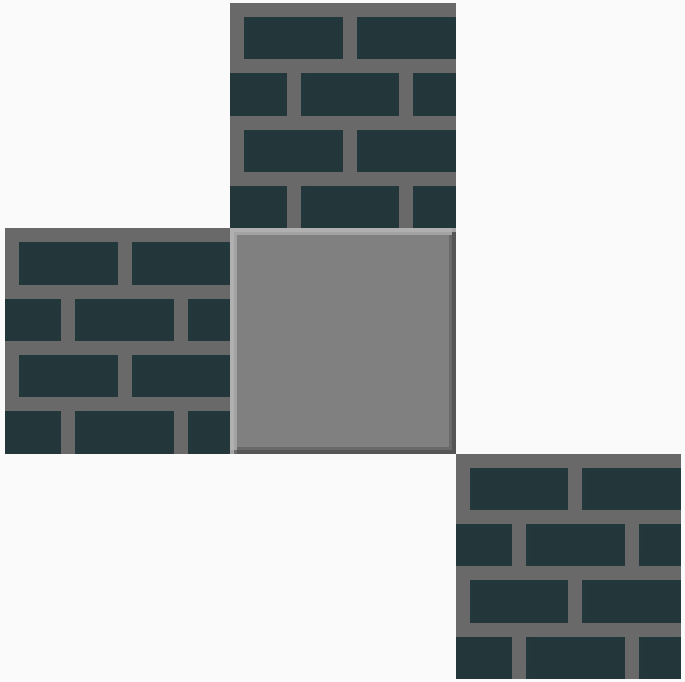
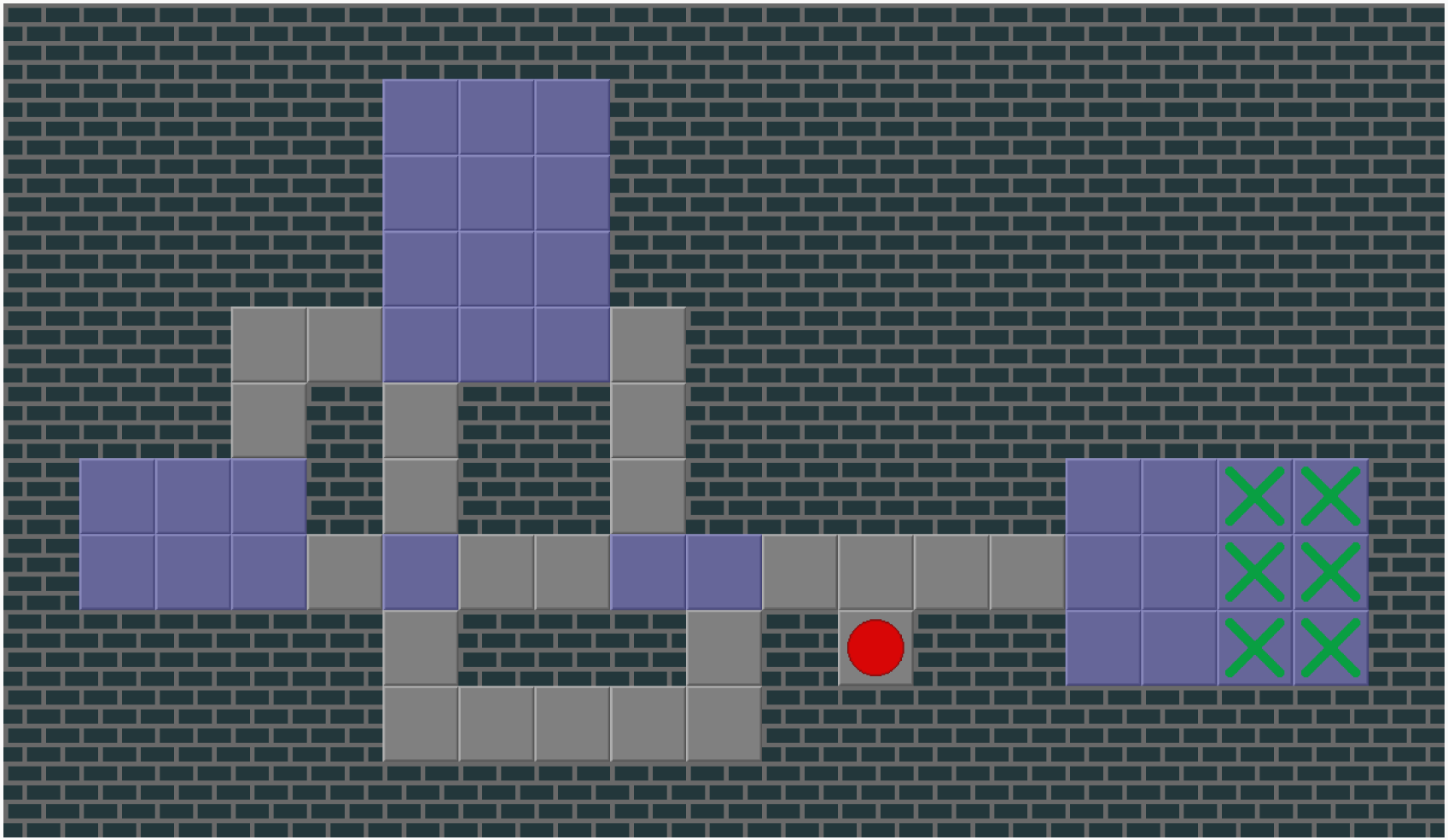


Détection de tunnels

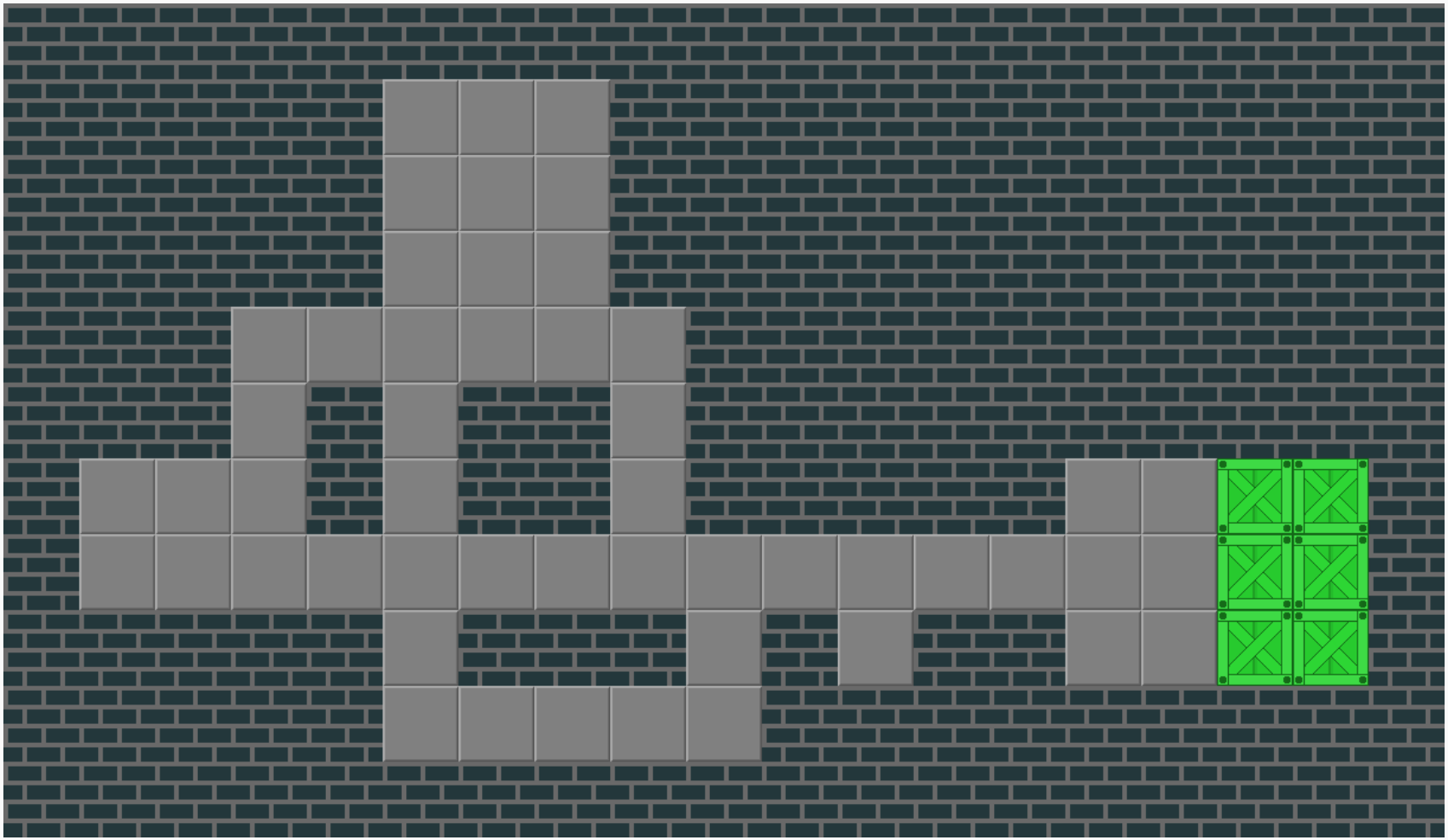




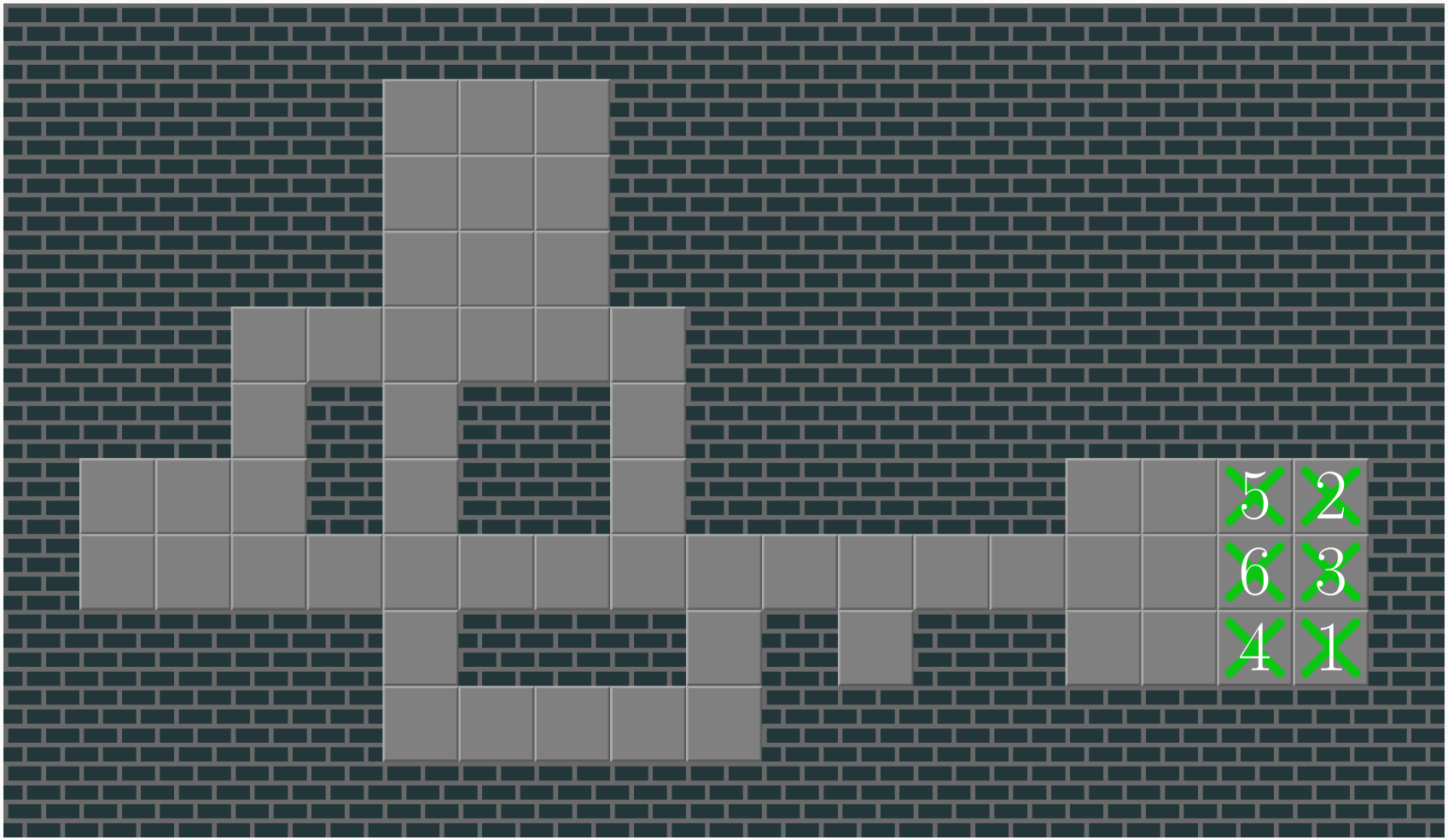
Salles et ordre de rangement *(packing order)*



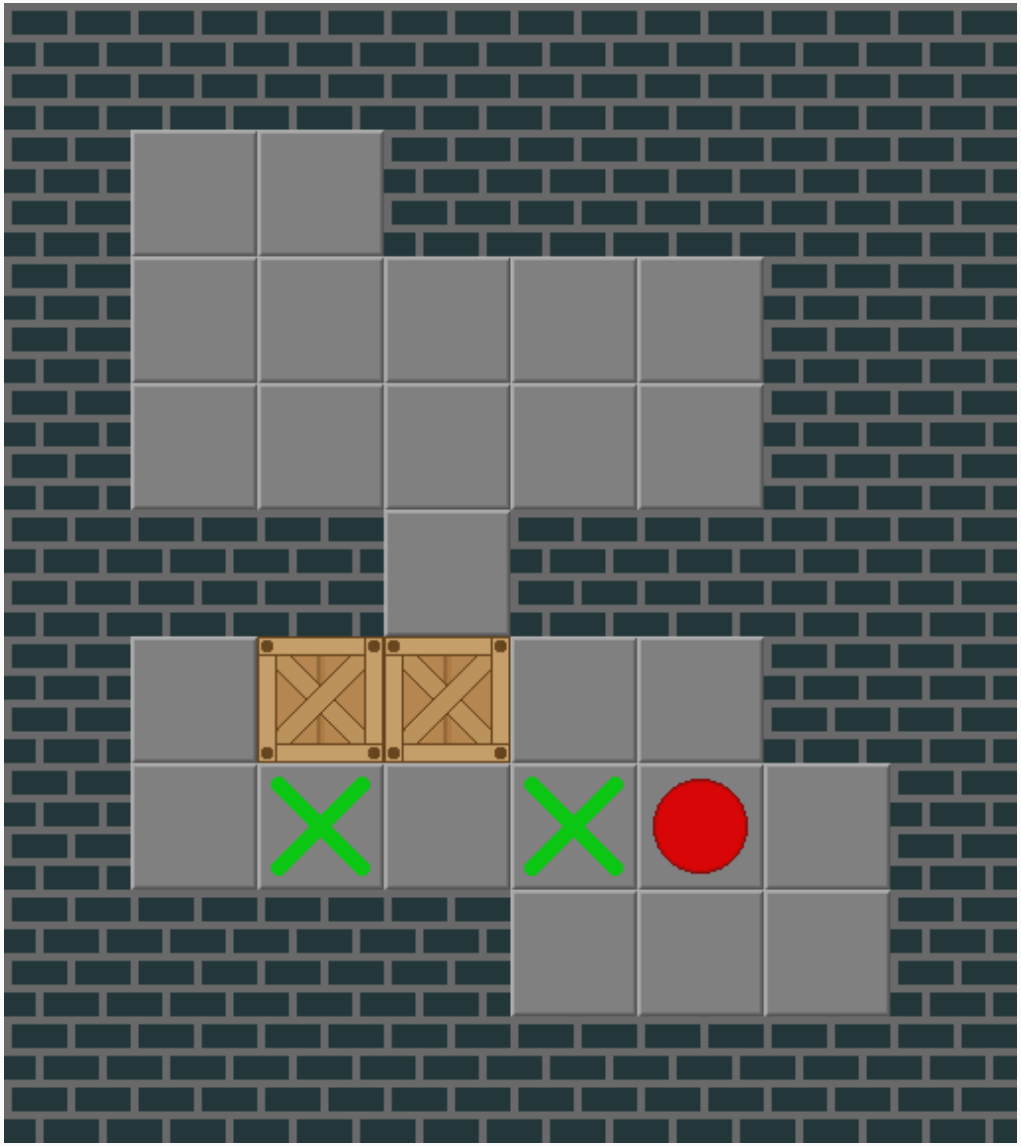
Salles et ordre de rangement *(packing order)*



Salles et ordre de rangement *(packing order)*



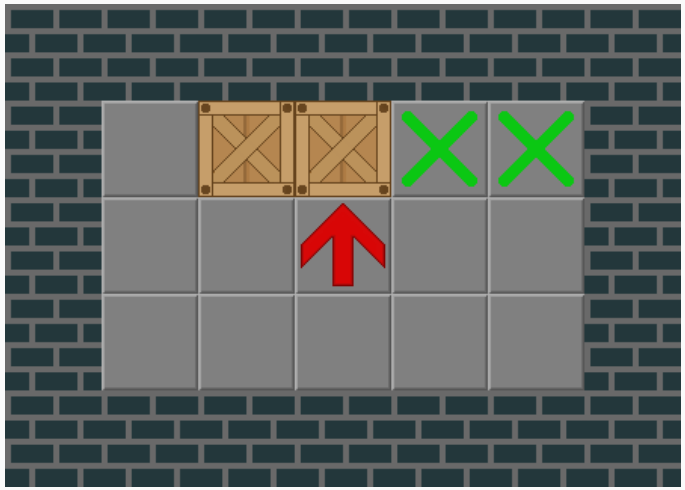
Salles et ordre de rangement *(packing order)*



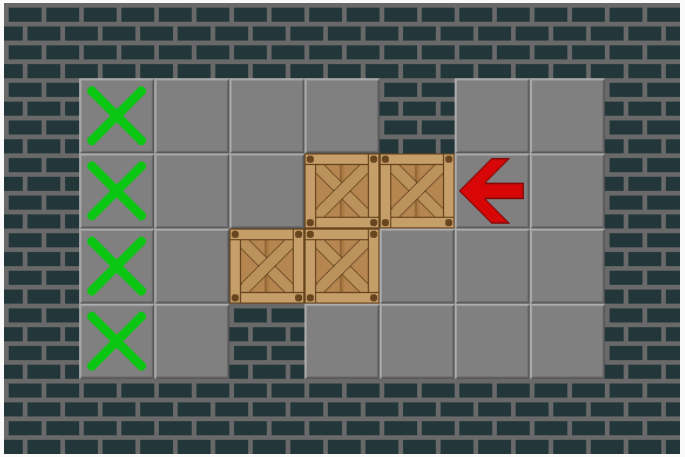
Réduction de l'espace de recherche

Analyse dynamique

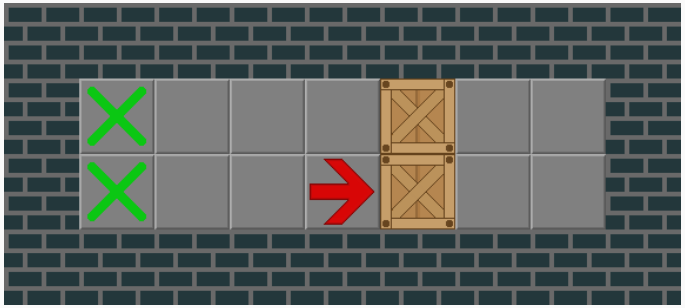
Détection d'impasses *(deadlocks)*



(a) *Freeze deadlock n°1*



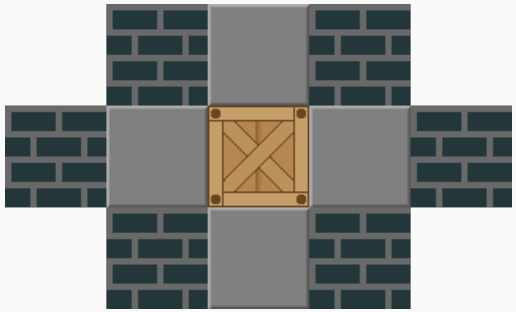
(b) *Freeze deadlock n°2*



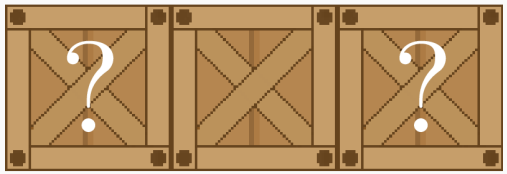
(c) *PI Corral deadlock*

Détection de *freeze deadlocks*

(a) *Règle n°1*

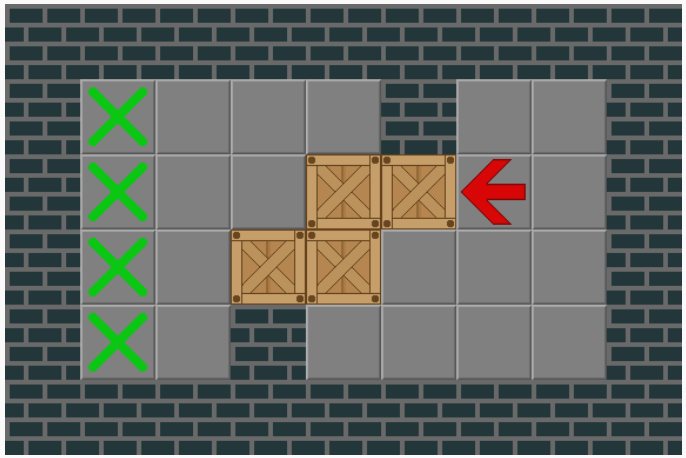


(b) *Règle n°2*

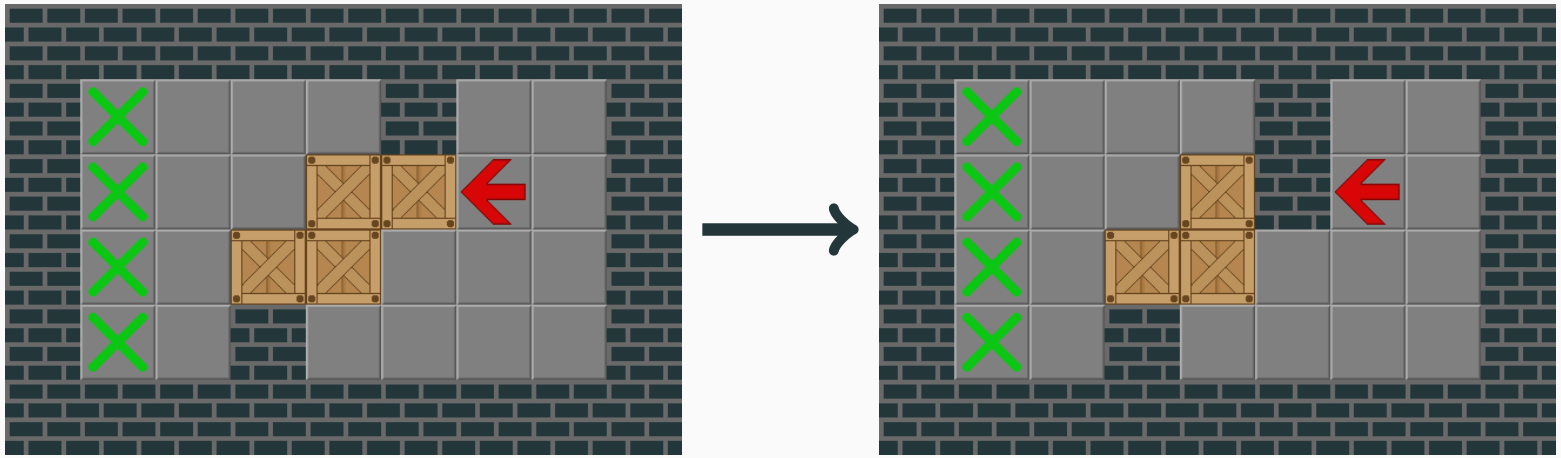


(c) *Règle n°3*

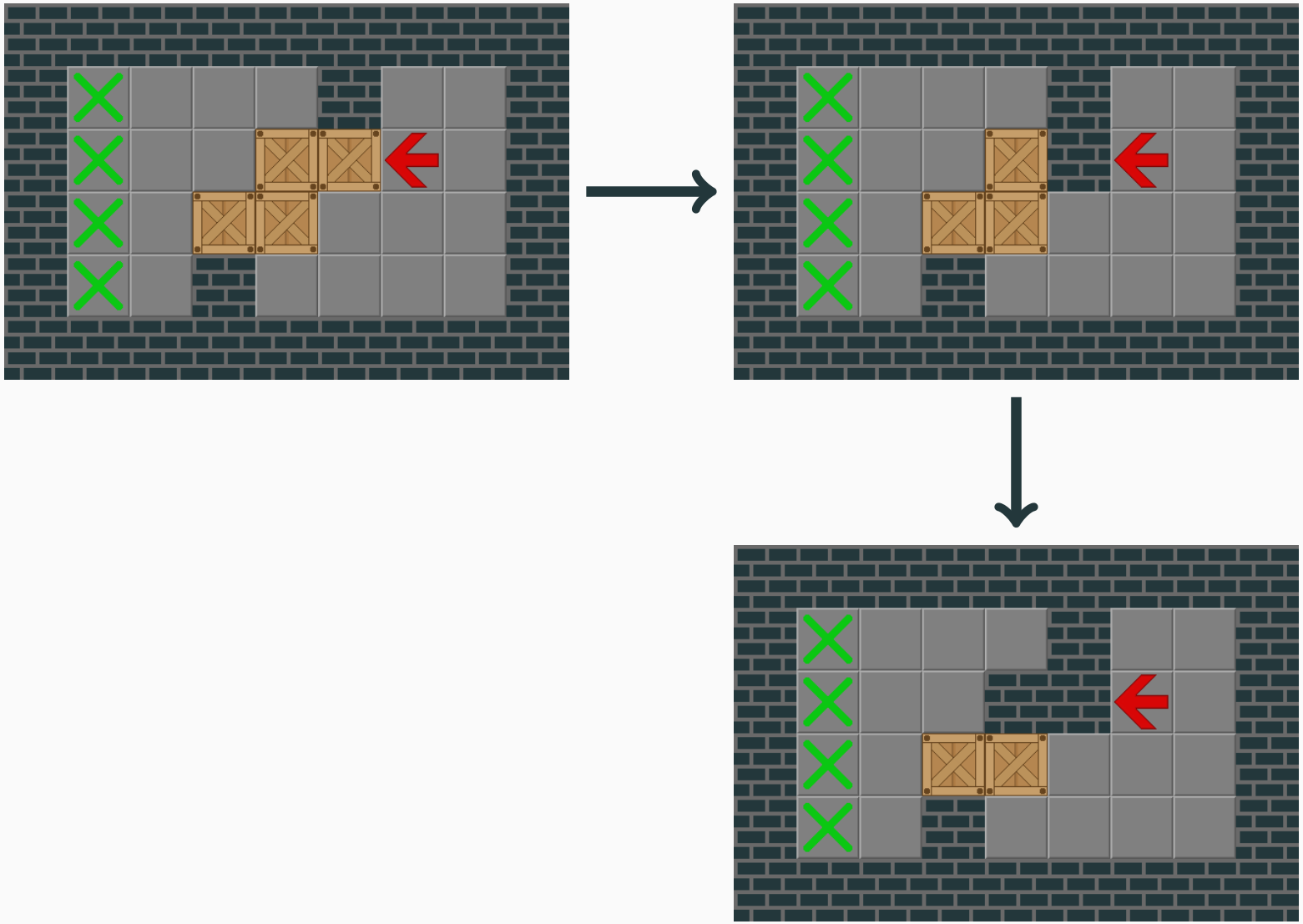
Détection de *freeze deadlocks*



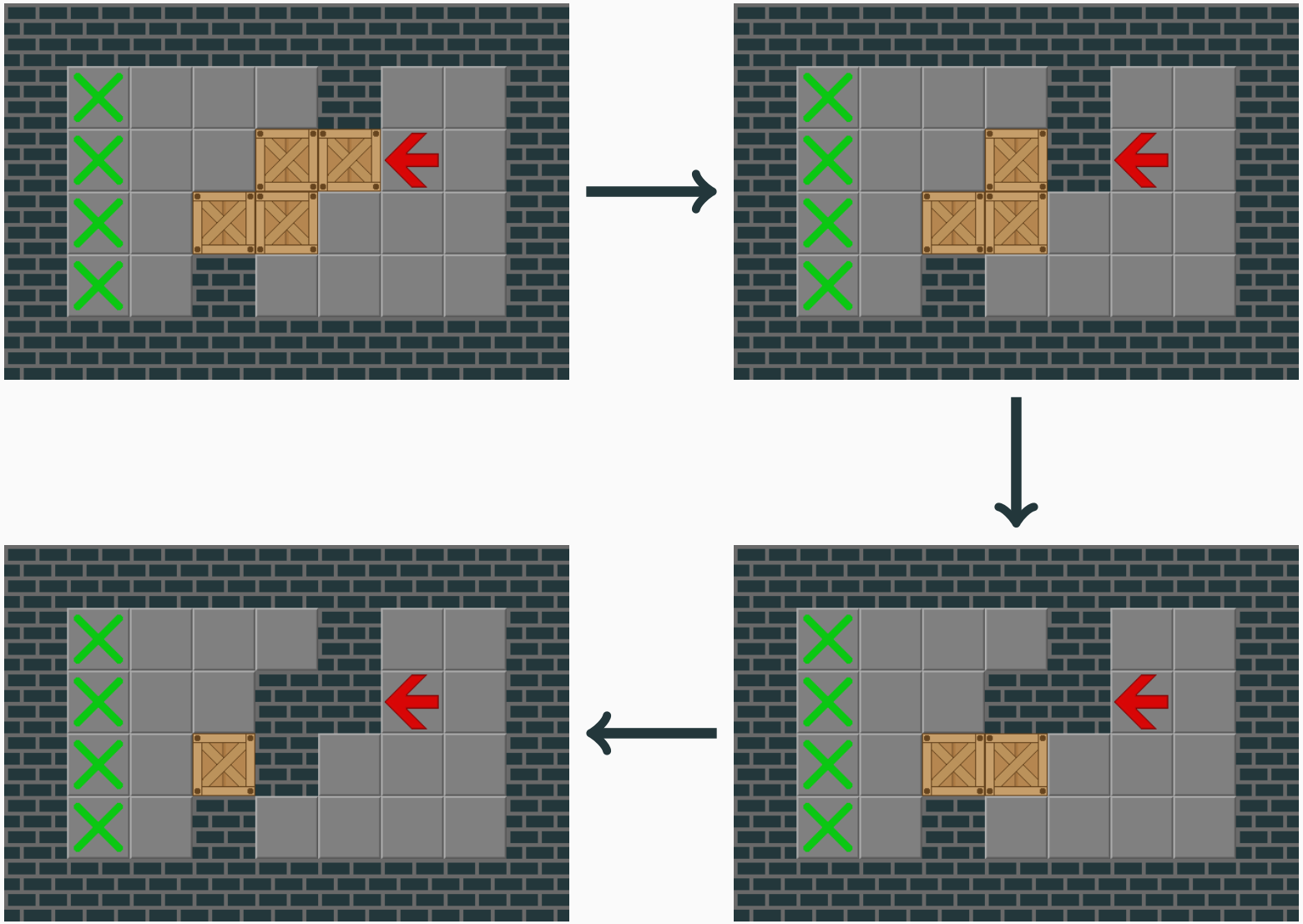
Détection de *freeze deadlocks*



Détection de *freeze deadlocks*

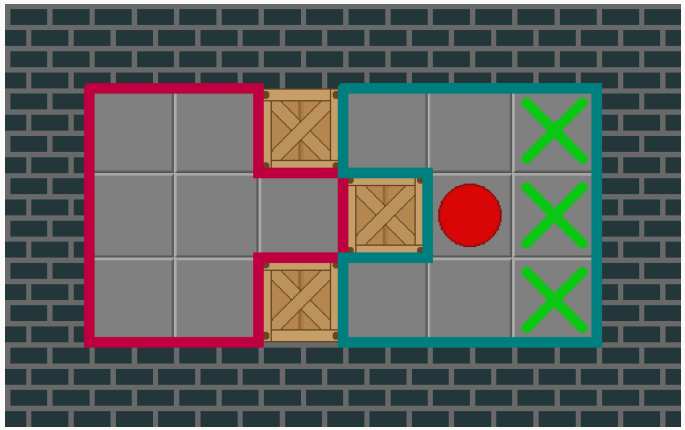


Détection de *freeze deadlocks*

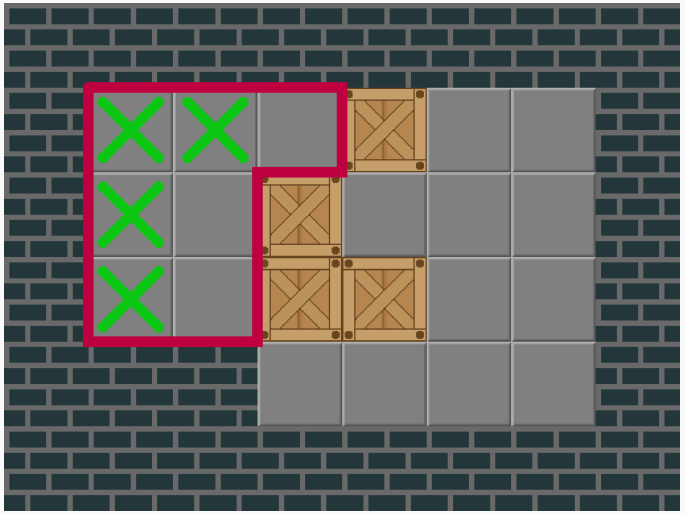


Gelée!

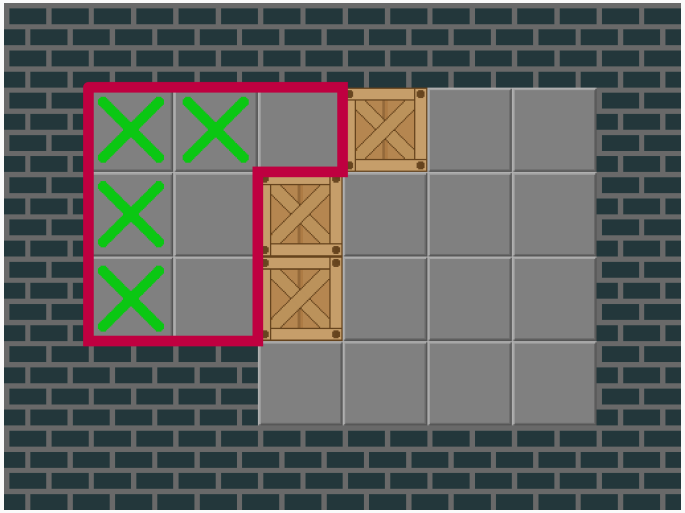
Détection de *PI Corral deadlocks*



(a) *Corral*

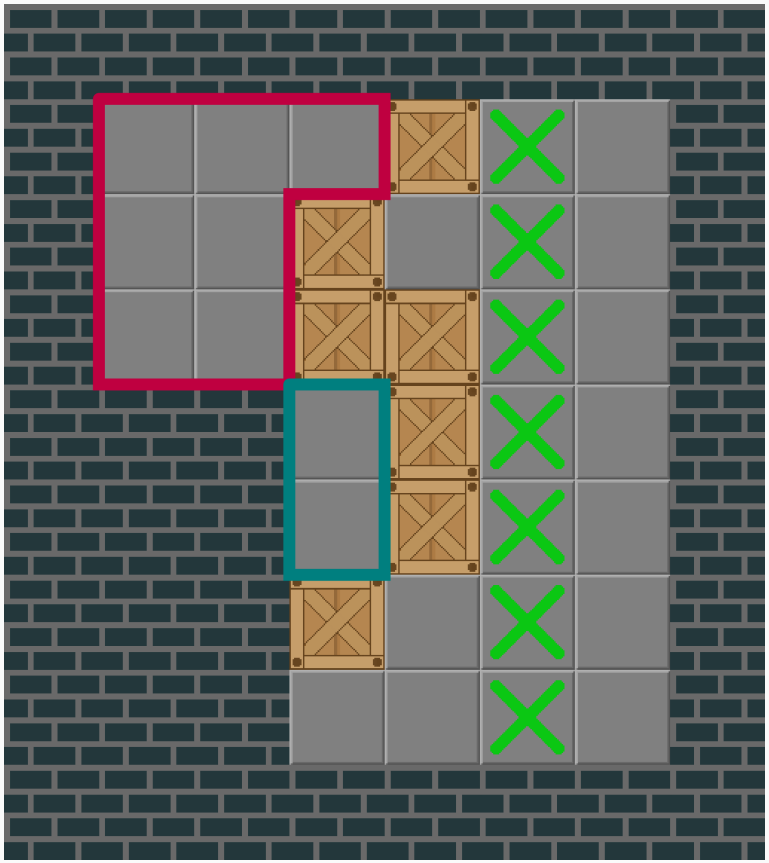


(b) *I Corral*



(c) *PI Corral*

Détection de *PI Corral deadlocks*



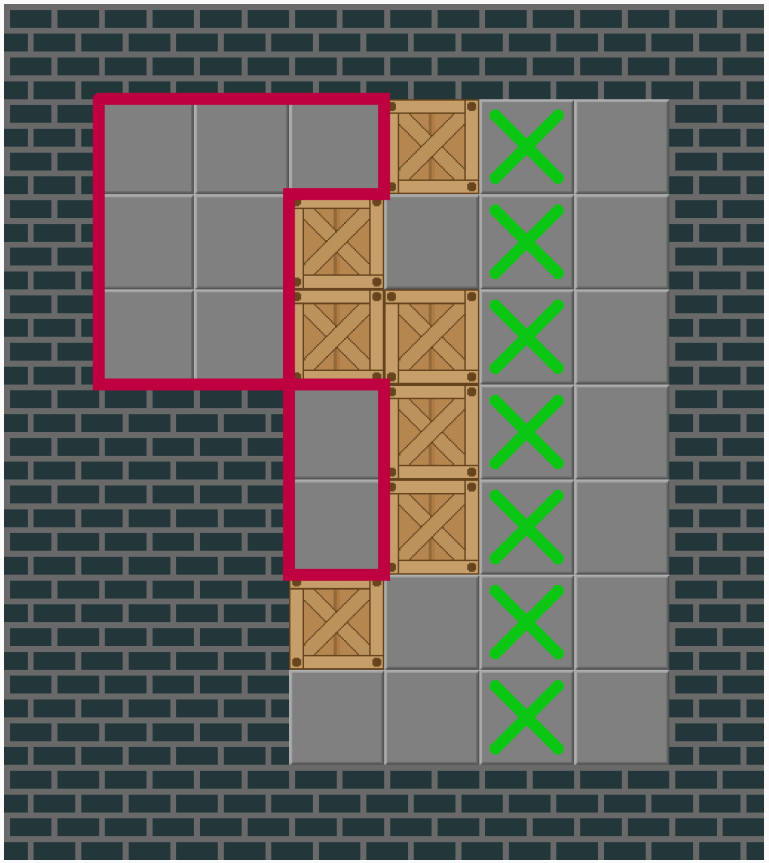
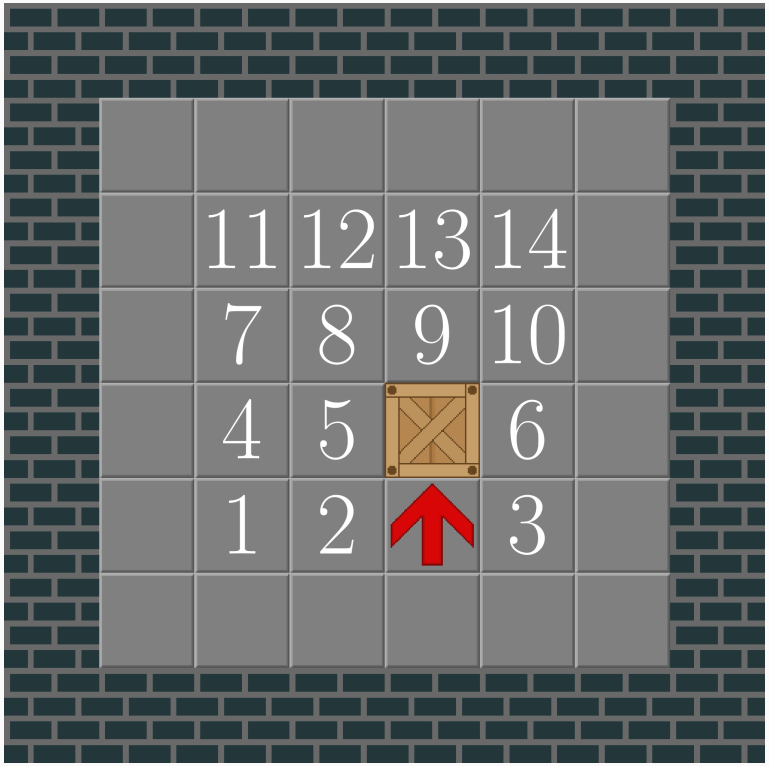


Table de *deadlocks*



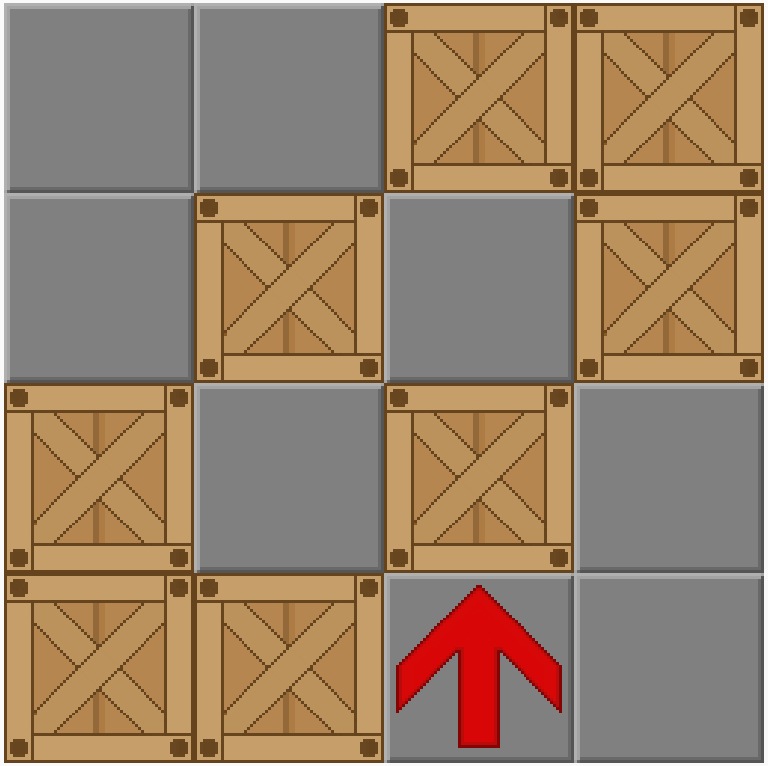
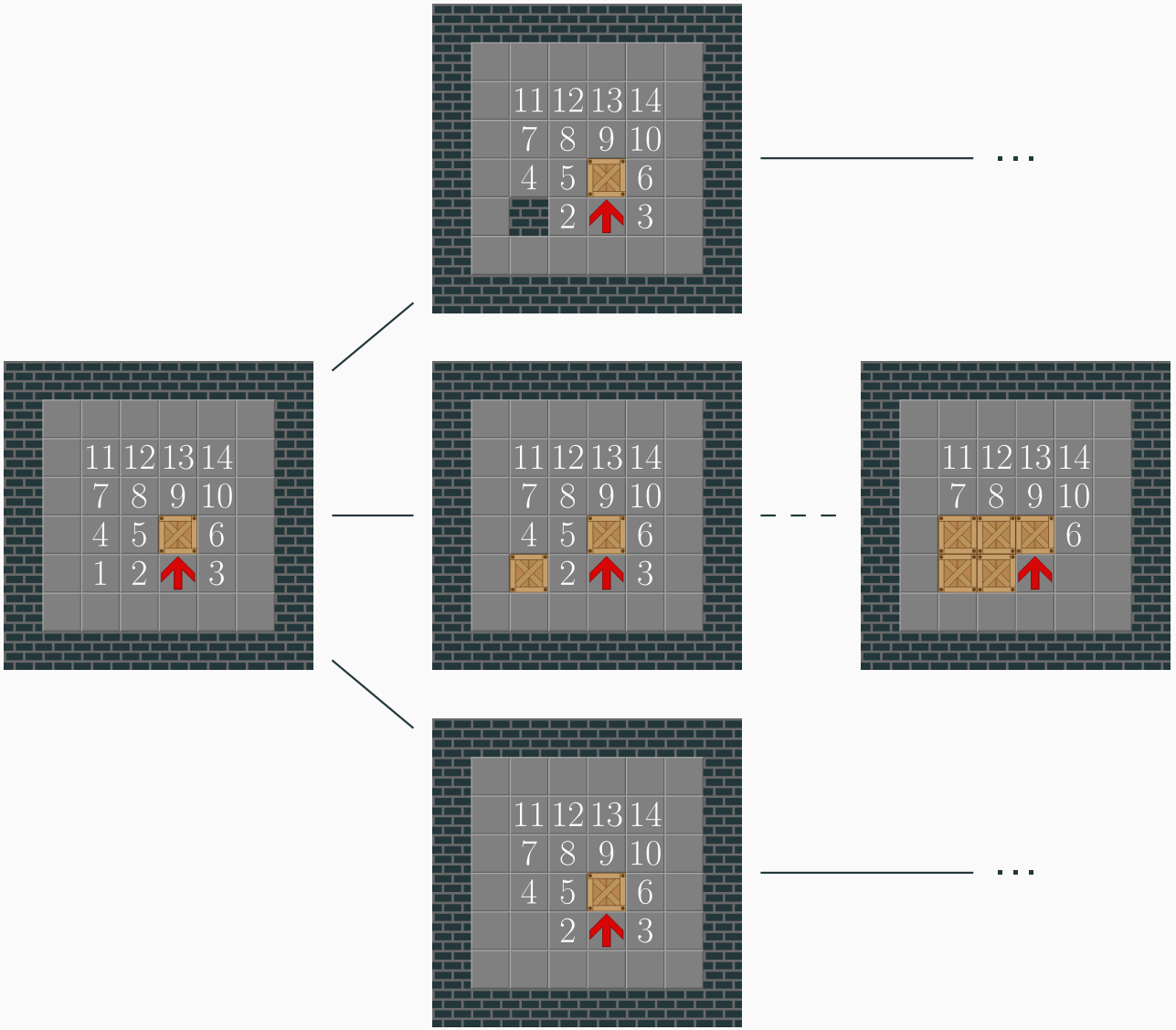


Table de *deadlocks*



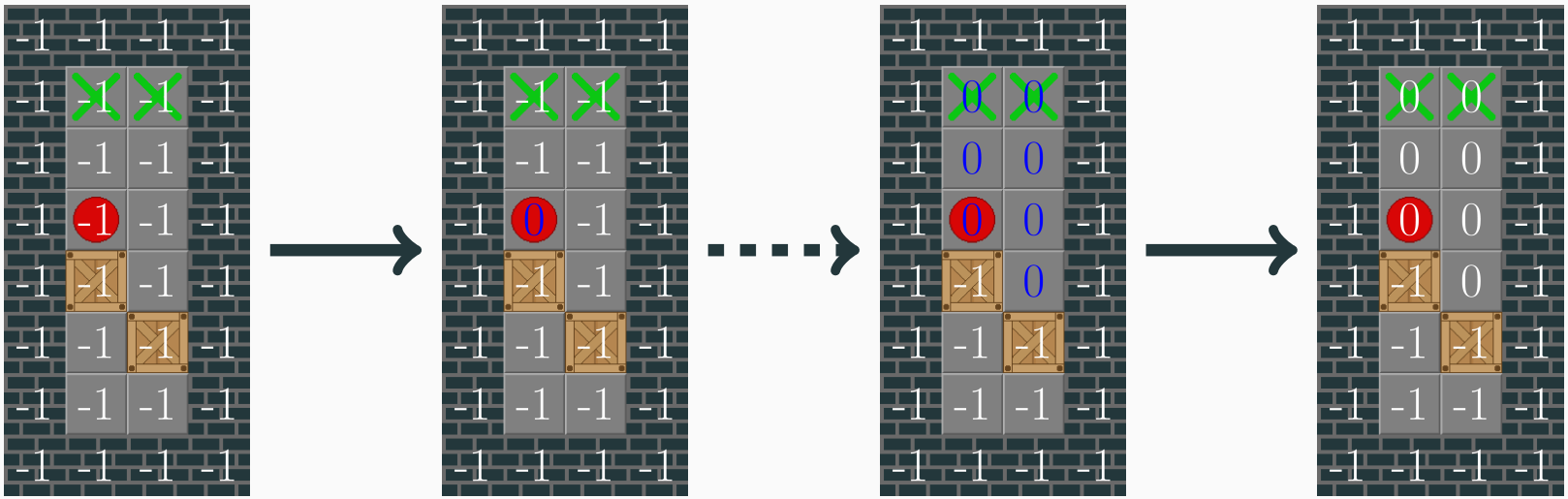
Recherche dirigée par une heuristique

Heuristique simple *(Simple Lower Bound)*

Heuristique gloutonne *(Greedy Lower Bound)*

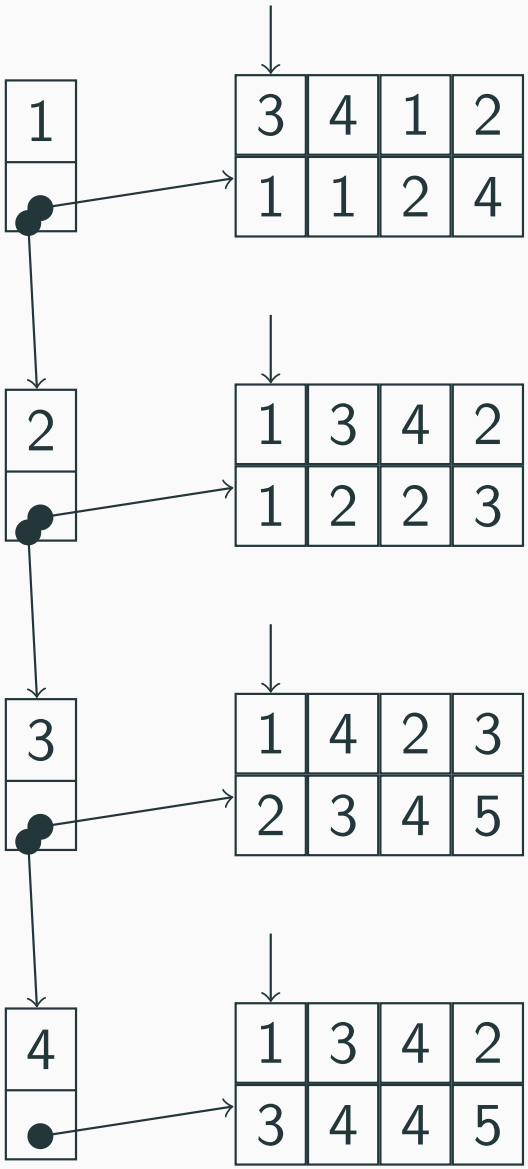
Optimisations

Parcours de graphes : démarquer tous les noeuds en $\mathcal{O}(1)$



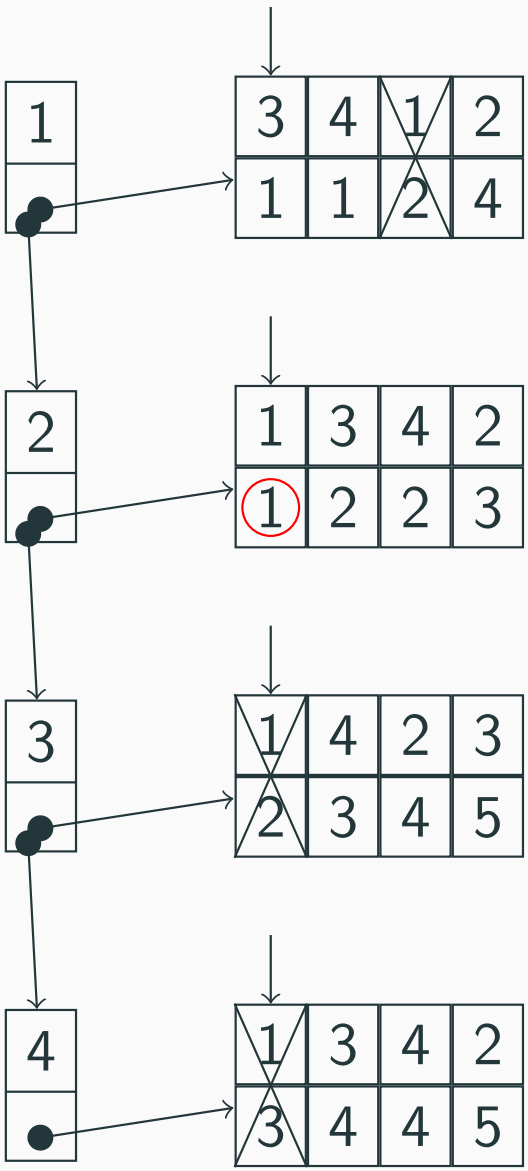
$m = 0$ $m = 0$ $m = 0$ $m = 1$

Greedy Lower Bound en $\mathcal{O}(n^2)$



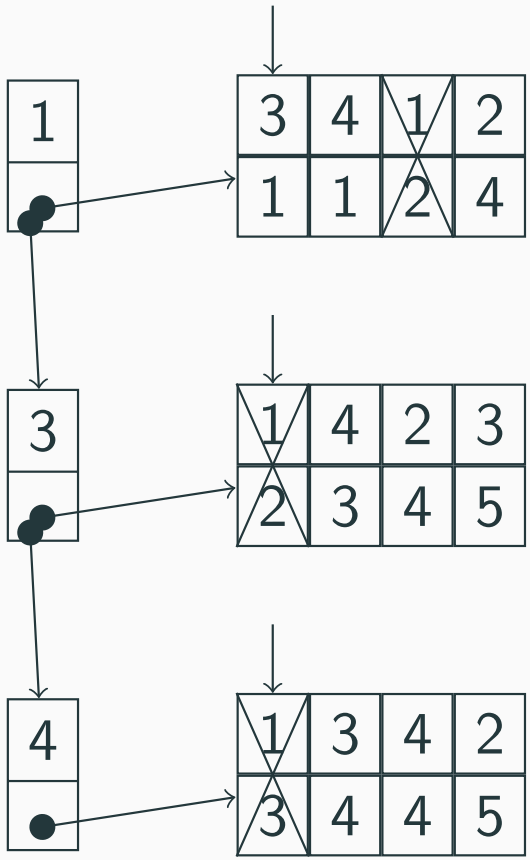
$h =$

Greedy Lower Bound en $\mathcal{O}(n^2)$



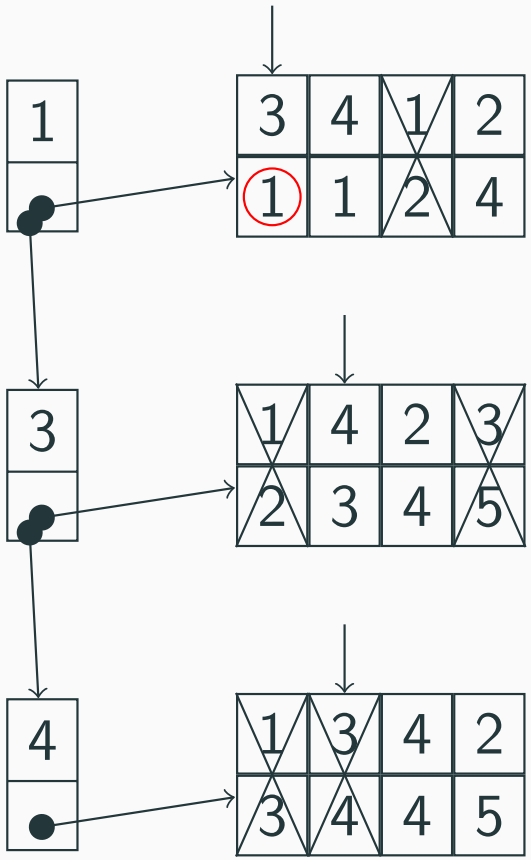
$h = 1+$

Greedy Lower Bound en $\mathcal{O}(n^2)$



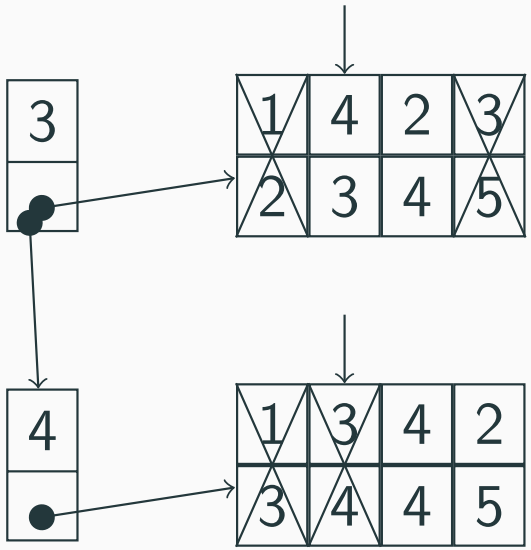
$h = 1+$

Greedy Lower Bound en $\mathcal{O}(n^2)$



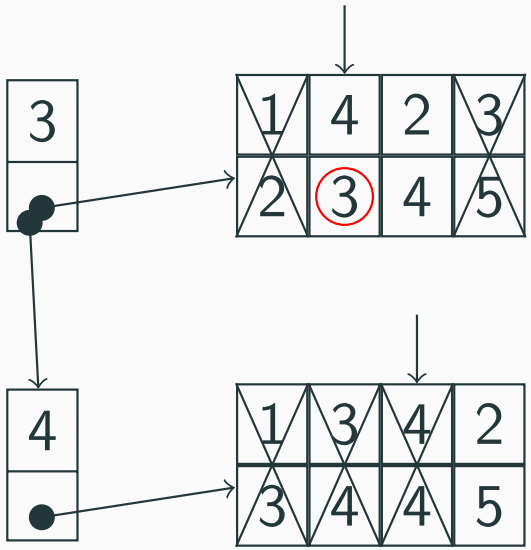
$$h = 1 + 1 +$$

Greedy Lower Bound en $\mathcal{O}(n^2)$



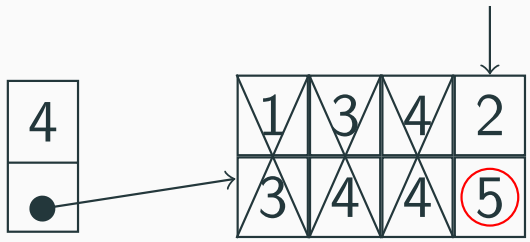
$$h = 1 + 1 +$$

Greedy Lower Bound en $\mathcal{O}(n^2)$



$$h = 1 + 1 + 3 +$$

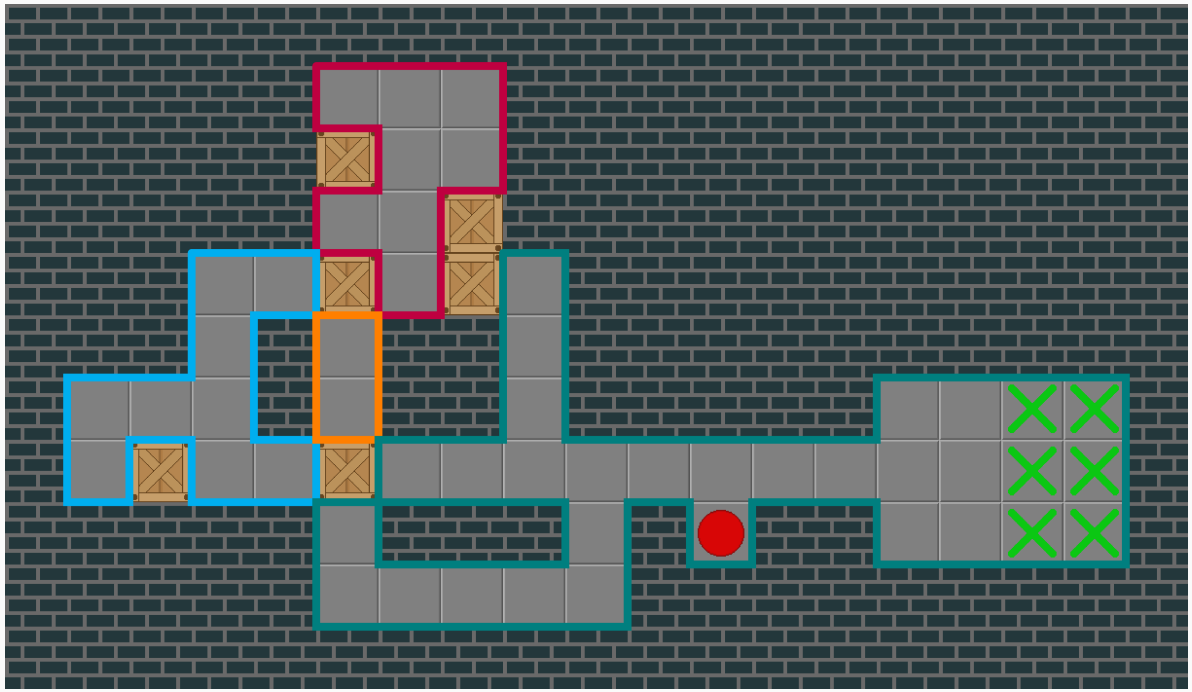
Greedy Lower Bound en $\mathcal{O}(n^2)$



$$h = 1 + 1 + 3 + 5 = 10$$

Calcul des *corrals* en $\mathcal{O}(wh)$

Utilisation de *Union-Find* : partition de $[\![0; wh - 1]\!]$.



Calcul des *corrals* en $\mathcal{O}(wh)$

```
1:  procedure CORRAL(x, y)
2:      if not solid(x,y) then
3:          createSingleton(x, y)
4:      else
5:          if solid(x-1, y) and solid(x,y-1) then
6:              createSingleton(x, y)
7:          else if not solid(x-1, y) and solid(x,y-1) then
8:              addToCorral(x-1,y, x,y)
9:          else if solid(x-1, y) and not solid(x,y-1) then
10:             addToCorral(x,y-1, x,y)
11:         else
12:             addToCorral(x-1,y, x,y)
13:             union(x,y-1, x,y)
14:         end if
15:     end if
```

Résultats

Annexe

Tableau des compléxités