

Punch Out Model Synthesis

A Stochastic Algorithm for Constraint Based Tiling Generation

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Punch Out Model Synthesis (*POMS*) A Constraint Based Tiling Generation (*CBTG*) algorithm:

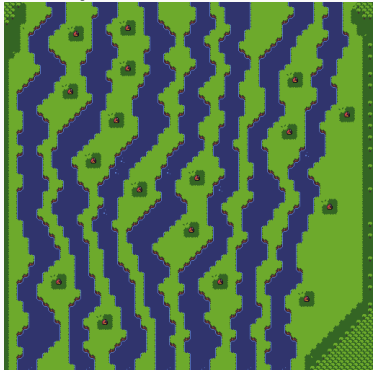
- Works on large grids
- Minimal setup requirements
- Resilience to contradiction

Introduction

Definitions

- *Grid* composed of *cells*
- Each *cell* can hold *D* *tiles*
- Pairwise tile *constraints* in each dimension
($\pm X, \pm Y, \pm Z$)

Example



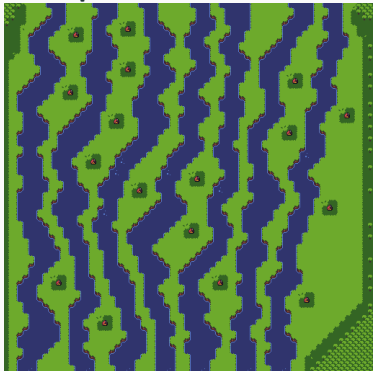
Introduction

Constraint Based Tiling Generation (CBTG) Problem

Find a valid grid realization

A *realization* is a single *tile* placement at each *cell* respecting *constraints*.

Example

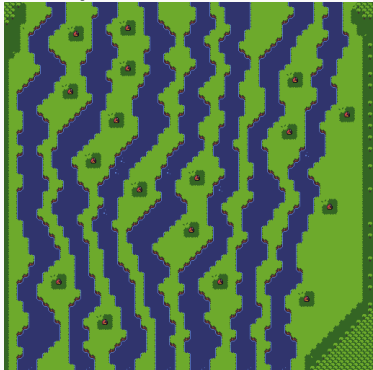


Introduction

Definitions

A region is *Arc Consistent* if all *tiles* in every *cell* within the region have at least one valid neighbor in each direction

Example

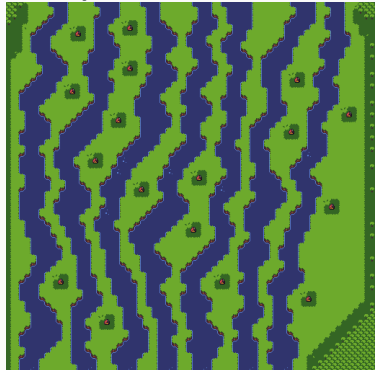


Introduction

Definitions

The basis for a *Constraint Propagation* algorithm can be made by removing tiles without a valid neighbor

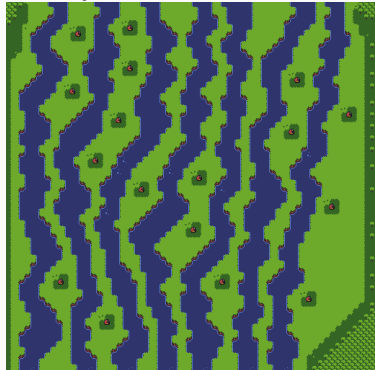
Example



Definitions

- *Block Level Solver*:
completely maintains *Arc Consistency*
- *Grid Level Solver*:
only keep minimal
information for the entire
grid but work on *block*
sub-regions

Example



Related Work

	<i>WFC</i>	<i>BMS</i>	<i>MMS</i>	<i>POMS</i>
Solver Type	Block	Block	Grid	Grid
Contradiction Resilience	No	Yes	Yes	Yes
Block Step Consistent	n/a	n/a	Yes	No
Indeterminate Initial State	Yes	Yes	No	Yes
Ergodic	Yes	Yes	No	Yes

WFC: Wave Function Collapse (Gumin)

BMS: Breakout Model Synthesis (Hoetzlein)

MMS: Modify in Blocks Model Synthesis (Merrell)

Tile Arc Consistent Correlation Length (TACCL) (Hoetzlein)

How much influence does a tile choice have over long distances?

TACCL as a heuristic to estimate correlation length

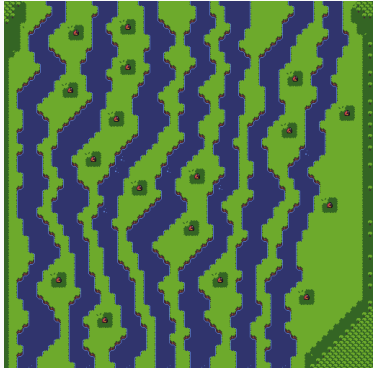
Tile Arc Consistent Correlation Length (TACCL)

TACCL

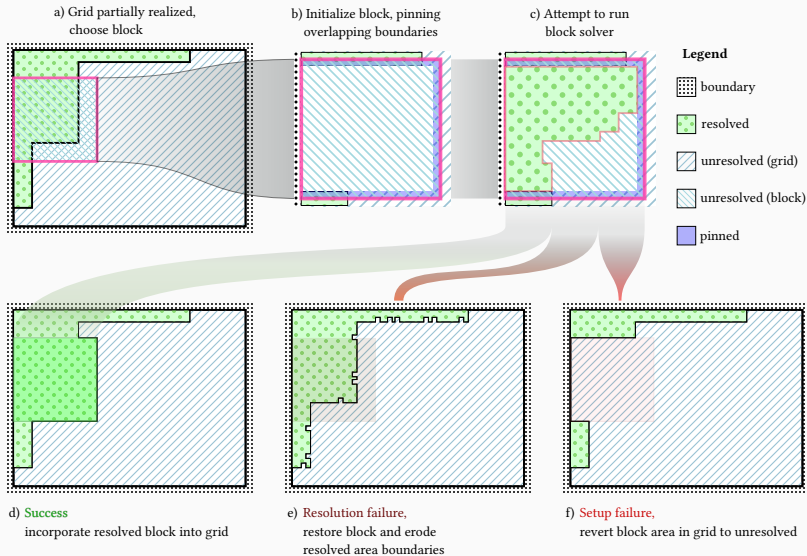
Take block in isolation

- Set block to indeterminate state
- Fix a tile at the center
- Propagate constraints
- Take minimum bounding box of altered cells
- Repeat for all tiles

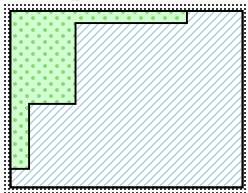
Example



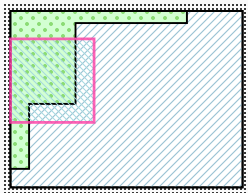
Algorithm: Overview



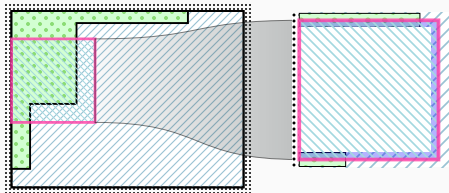
Grid partially realized



Choose block

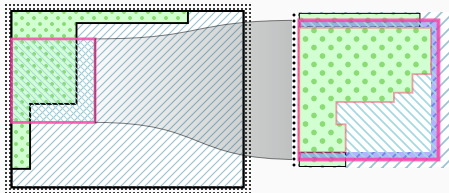


Algorithm



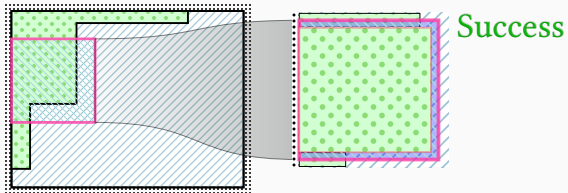
Initialize block
Pin boundaries
Revert interior
(Apply any restrictions)

Algorithm

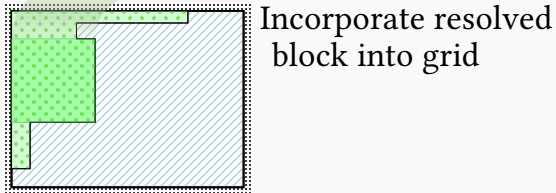
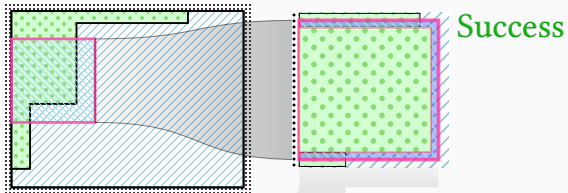


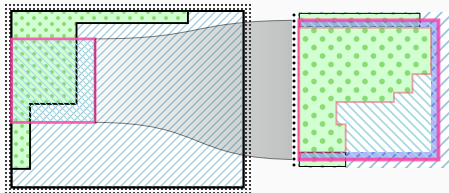
Attempt to solve

Algorithm



Algorithm

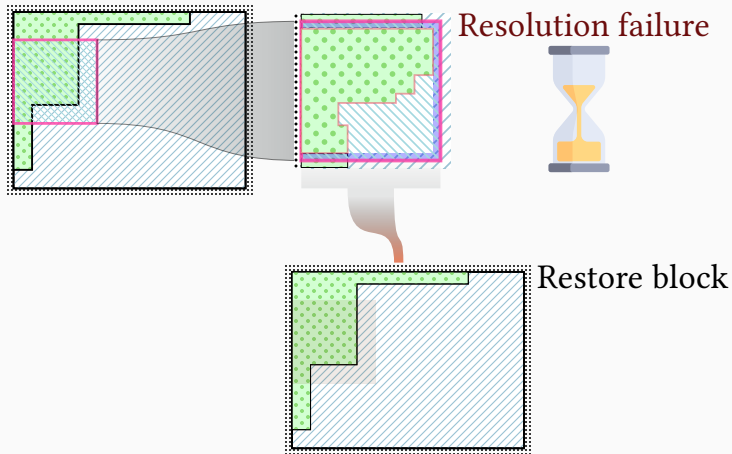




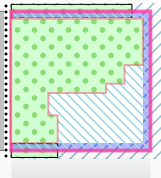
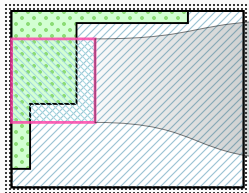
Resolution failure



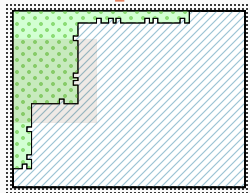
Algorithm



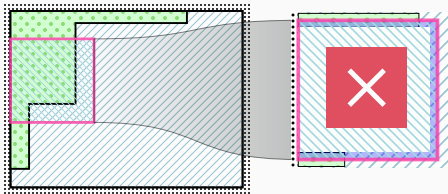
Algorithm



Resolution failure



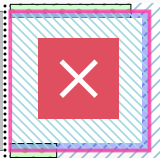
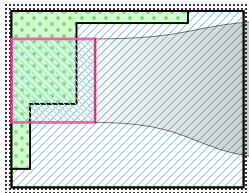
Restore block
Erode boundary



Setup failure

Failed initial
Arc Consistency

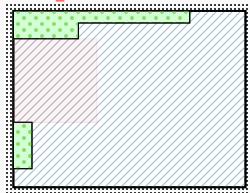
Algorithm



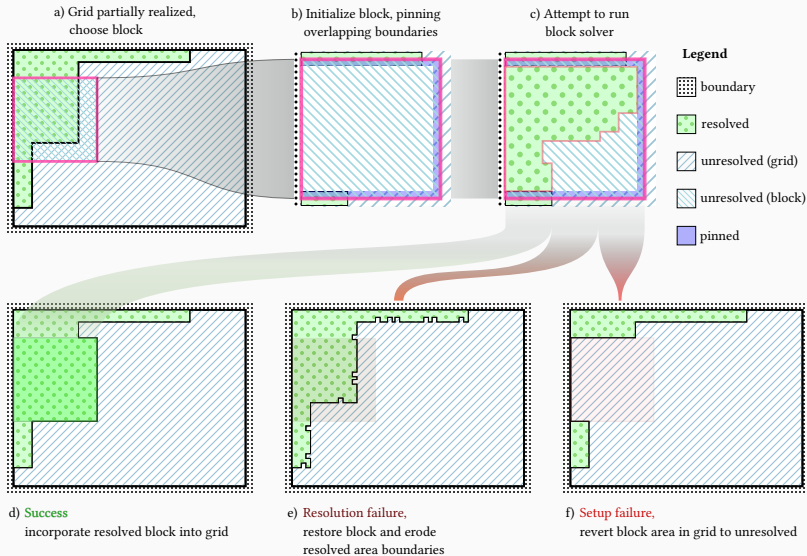
Setup failure

Failed initial
Arc Consistency

Revert area



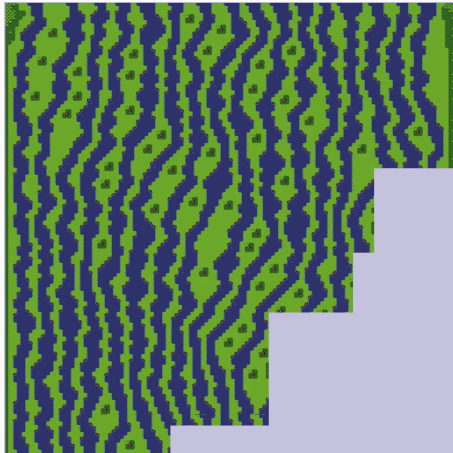
Algorithm



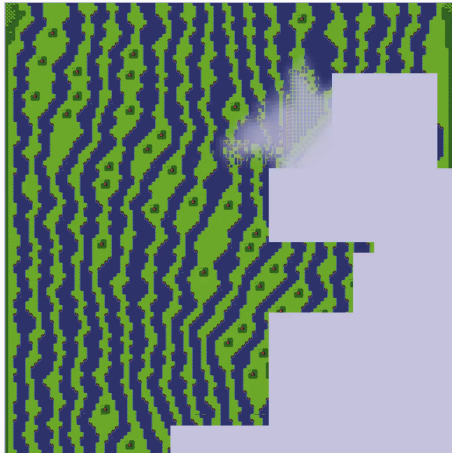
Pill Mortal Tile Set

ThKaspar's *Forest Micro* Tile Set

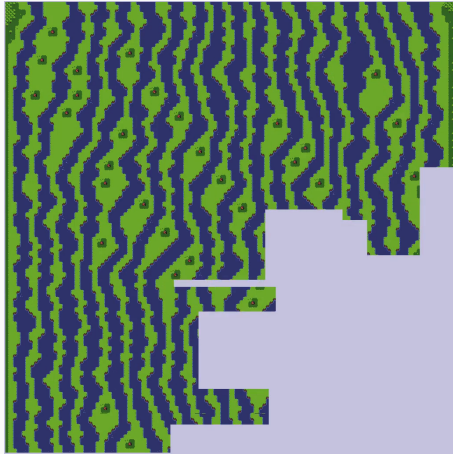
Revert Block



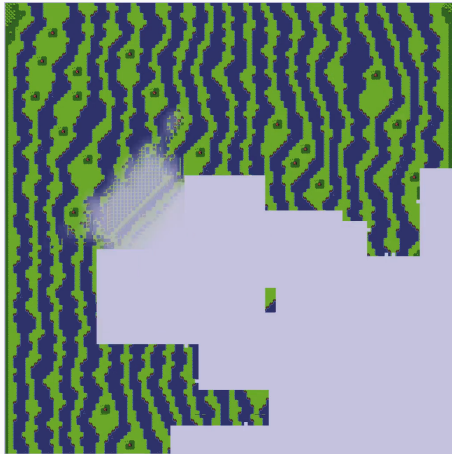
Revert Block



Erode Boundary



Erode Boundary



Results

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Conclusion

<https://github.com/zzyzek/PunchOutModelSynthesis>