Simplifying Memory Management by Sharing Immutable Succinct Memory Images of Isomorphic Data Objects

Paul Tarau

Department of Computer Science and Engineering
University of North Texas

ISMM'11 Wild And Crazy Ideas, June 4, 2011, 3:30pm-4:30pm

What can 2012 succinctly encode? [1,0,1,1,1,0,1,1,1,1]

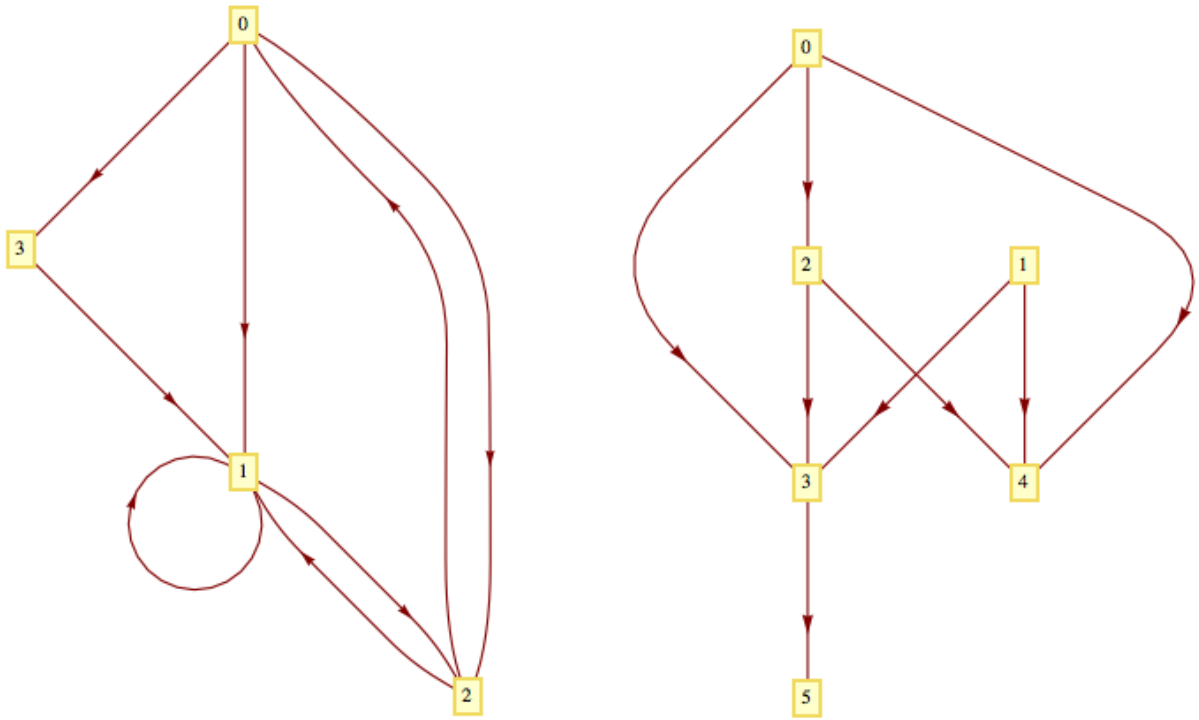

Figure: 2012: *as a digraph* and *as a DAG*

What else can 2012 succinctly encode?

a set: [2,3,4,6,7,8,9,10]

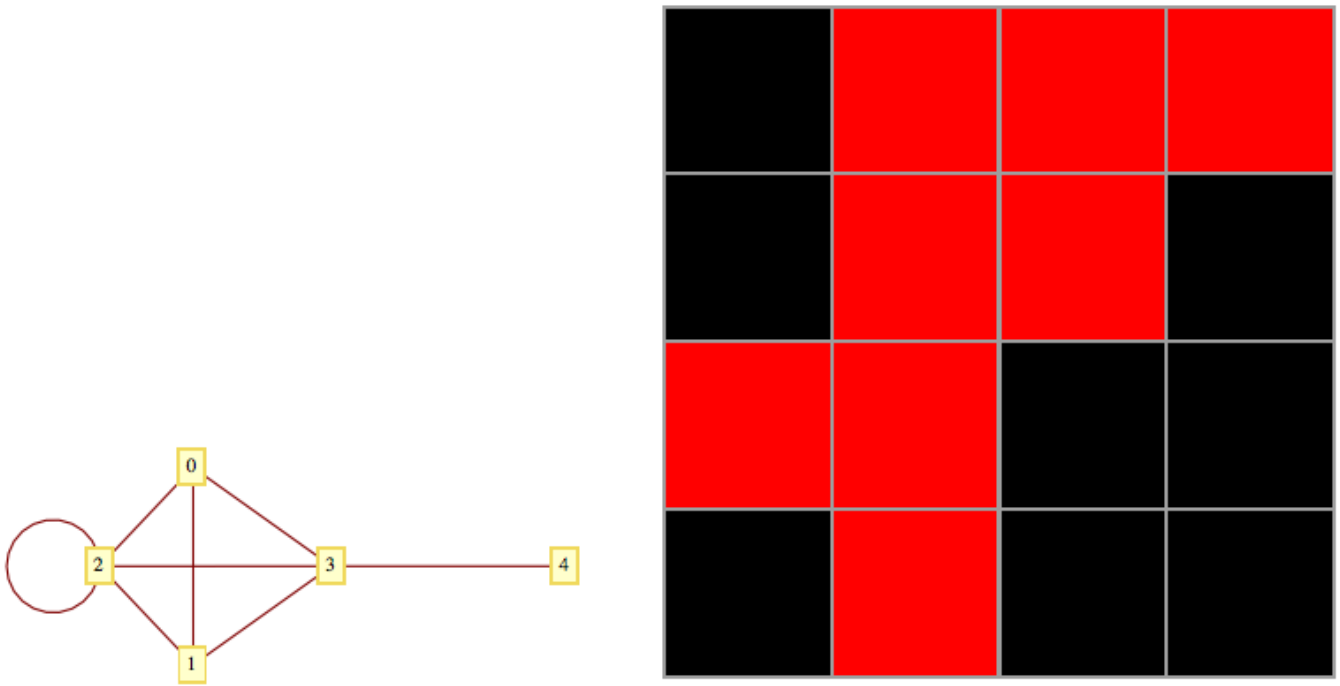

Figure: 2012: *as a graph* and *as a binary relation*

What else can 2012 succinctly encode?

a hypergraph: [[0,1],[2],[0,2],[0,1,2],[3],[0,3],[1,3],[0,1,3]]

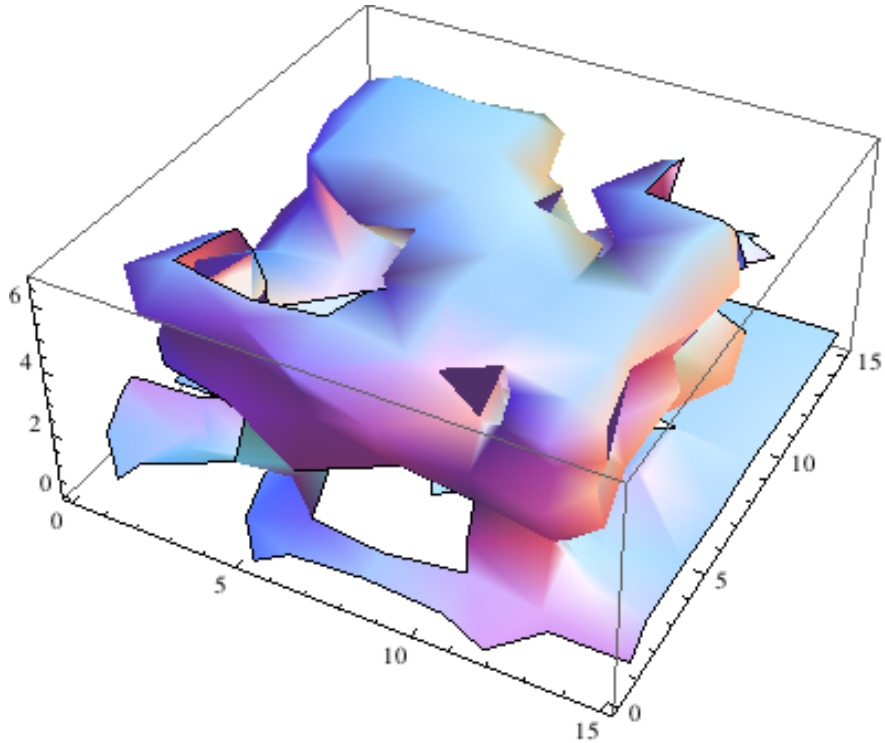

Figure: 2012: *as a sound track* and *as a shape*

What else can 2012 succinctly encode?

DNA: [Adenine,Thymine,Cytosine,Thymine,Thymine,Cytosine]

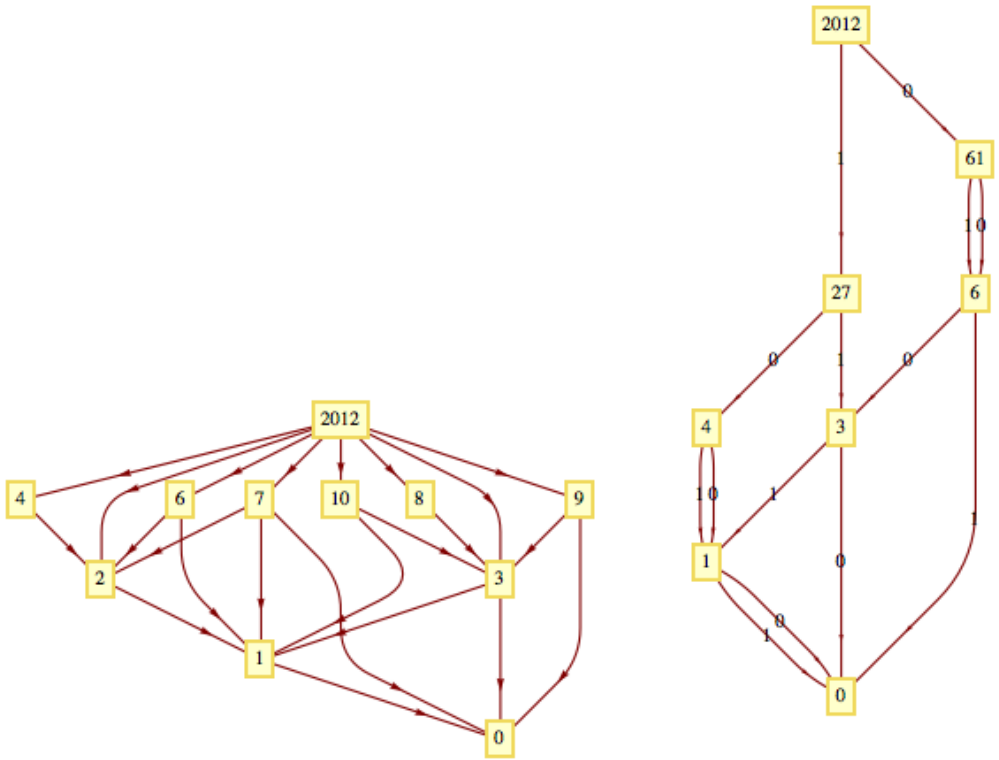

Figure: 2012: *as DAGs representing a rose tree* and *a binary tree*

The Idea Itself

- from Gödel's theorems: unique *natural numbers* are associated to *formulas* and *proofs*
- from combinatorics: ranking/unranking *bijections* between trees, graphs etc. and natural numbers
- succinct representations - a lot of things fit in a few bits - as shown in the previous slides

$\Rightarrow$

- share a *unique succinct memory image* independently of what it represents externally
- this assumes that the image is *immutable* and the clients know what it *means* to them - for instance by keeping track of types
- note that objects fitting in a word are (obviously) just copied
- larger objects point to their smaller parts in the monotonically growing store of immutable objects

Building such isomorphisms in a principled way

How to build these isomorphisms? 150 pages of literate Haskell at:

- http://logic.csci.unt.edu/tarau/research/2010/ISO.pdf
- http://logic.csci.unt.edu/tarau/research/2010/ISO.hs
- a few of them of them, this time in Java at:

  http://logic.csci.unt.edu/tarau/teaching/GraphTheory/jISO

Just in case - various tree types can also be used for *arbitrary size arithmetic computations*, see PPDP'10 paper - draft at:

http://logic.csci.unt.edu/tarau/research/2010/tarau_ppdp2010_draft.pdf