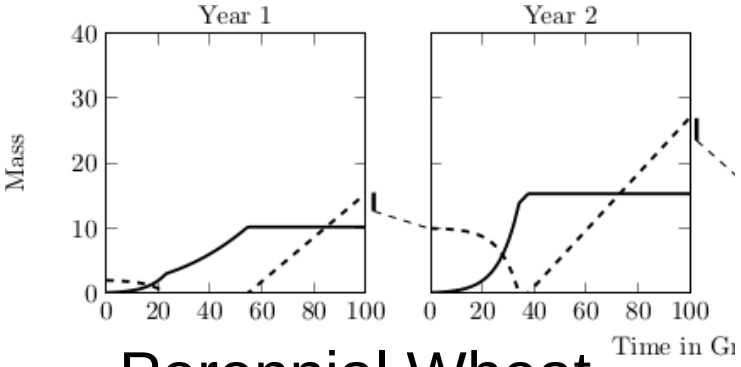
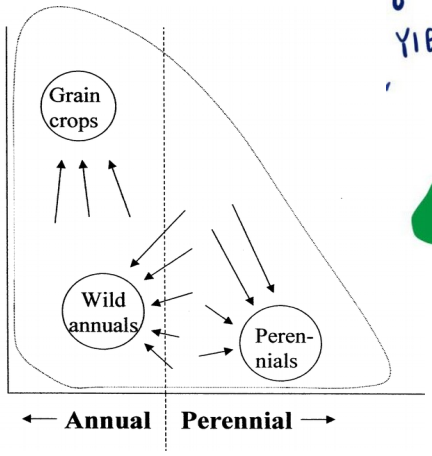
Hydrology at the largest and longest scales

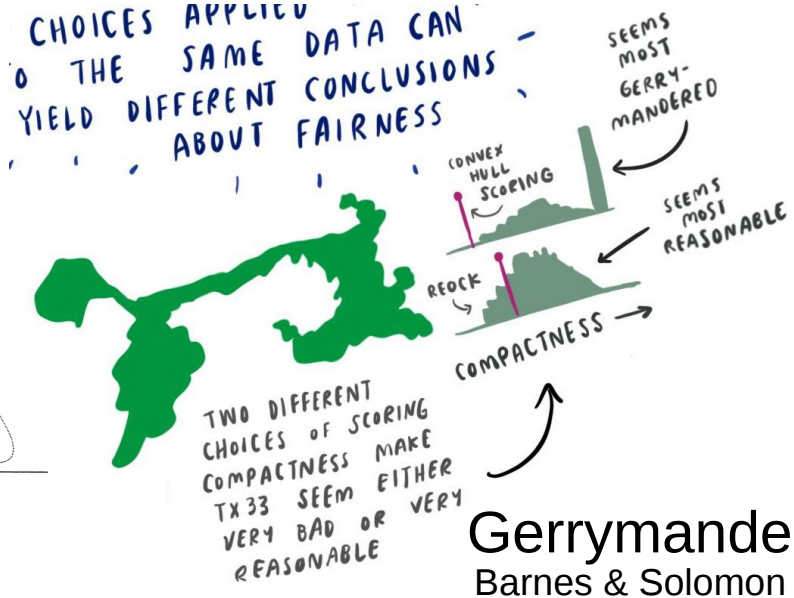
Richard Barnes



Perennial Wheat

Barnes et al (2019 – In prep)

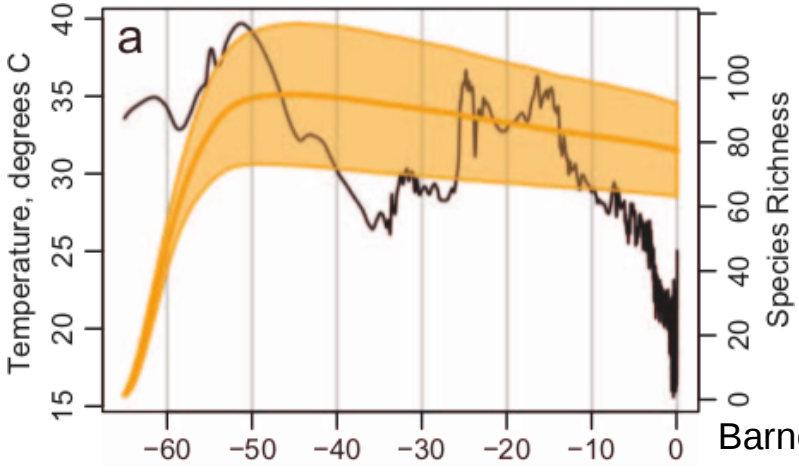




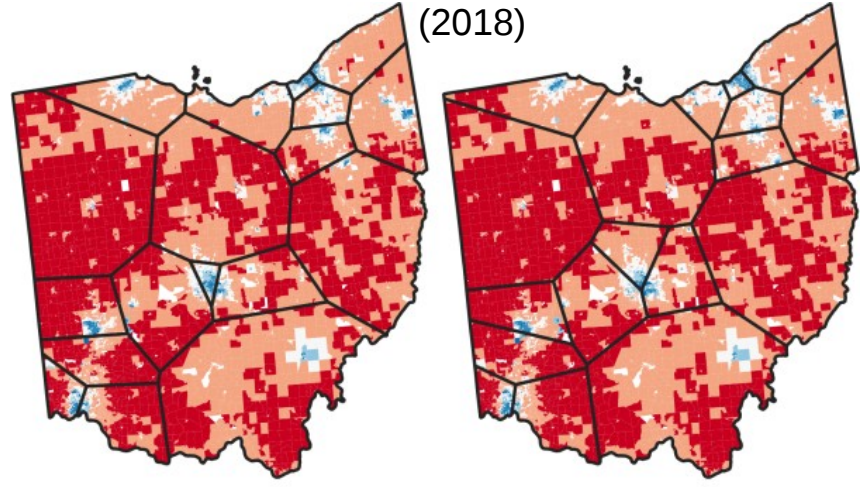
Gerrymandering

Barnes & Solomon (2018)

EcoEvoGeo: Salamanders



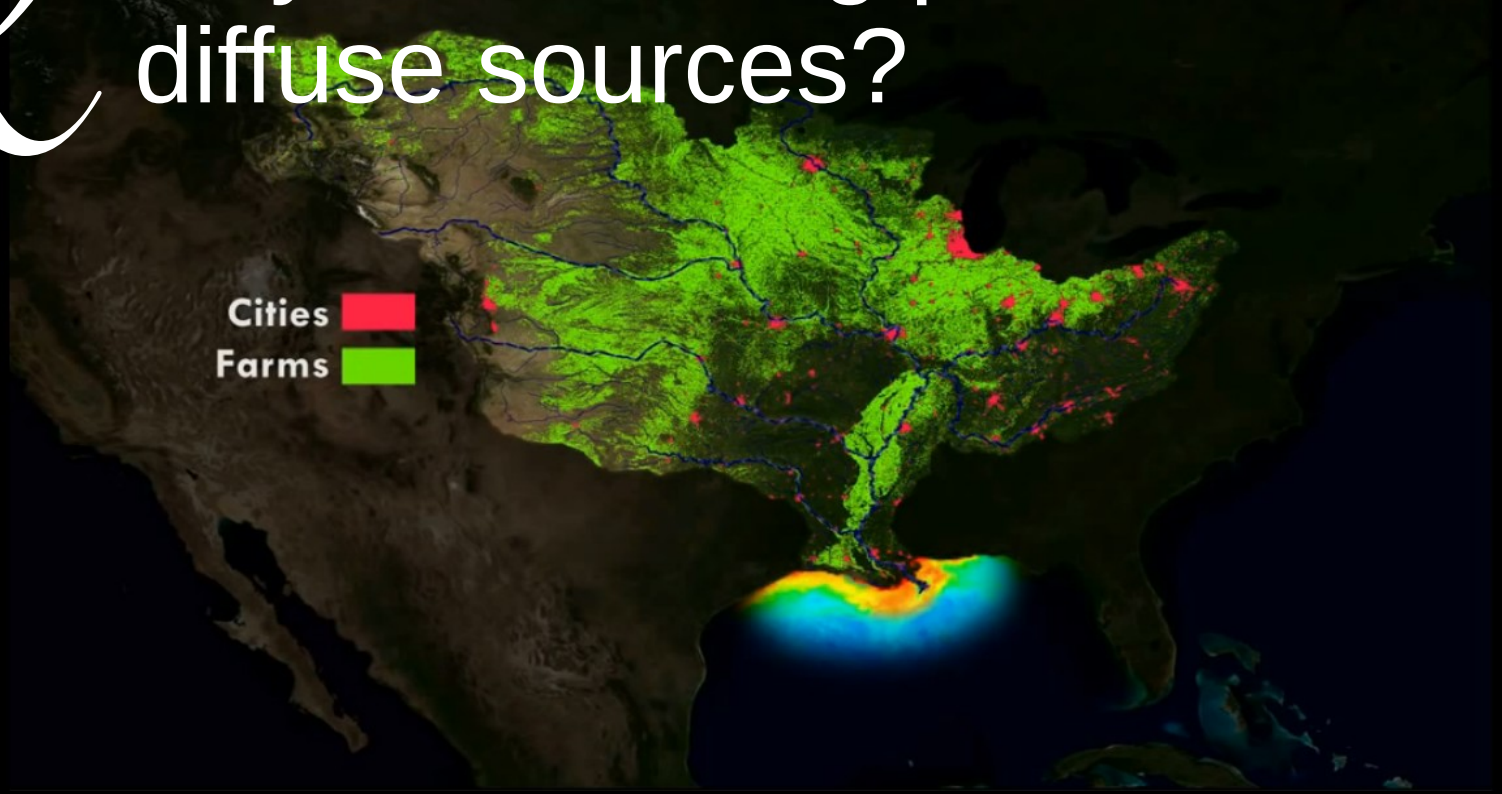
Barnes & Clark (2017)



(a) 13 Republicans 5 Democrats

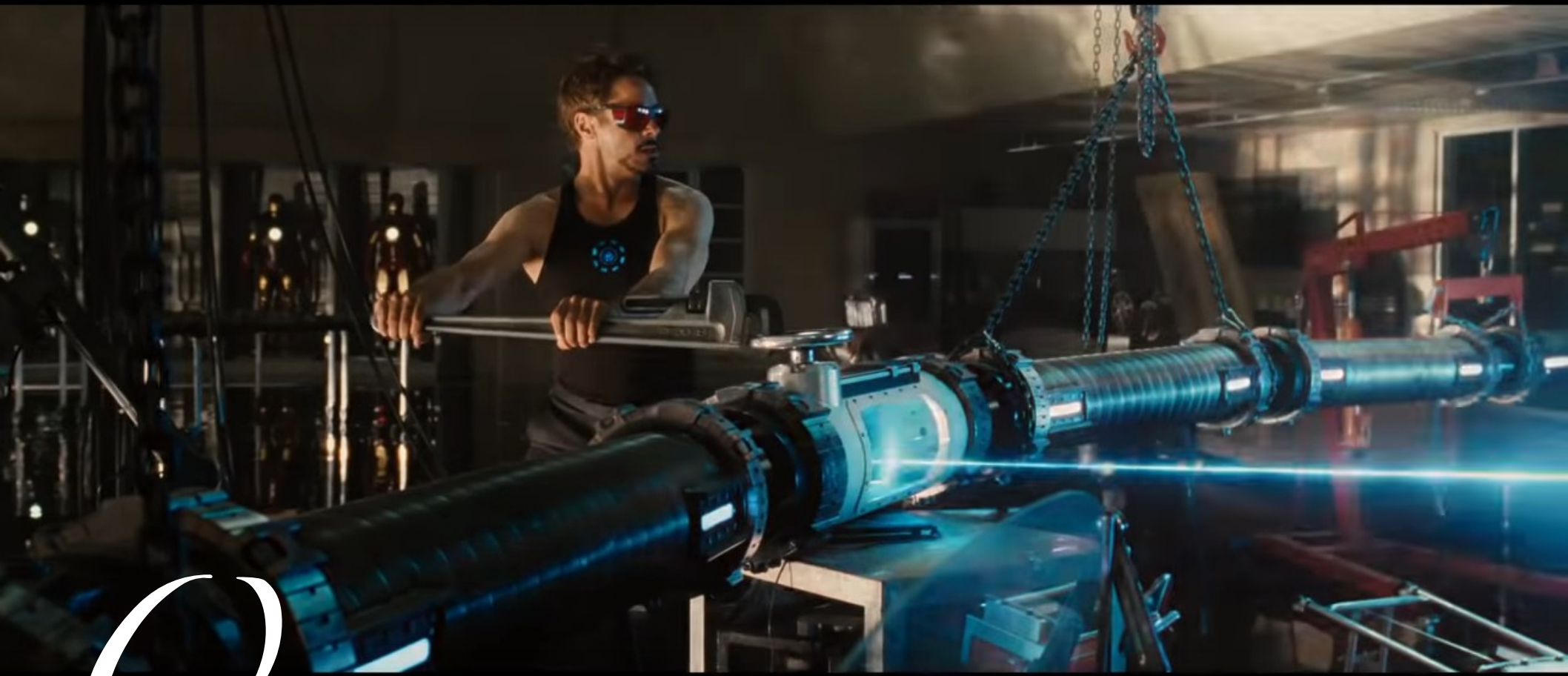
(b) 10 Republicans 8 Democrats

What is the most cost-effective way of reducing pollution from diffuse sources?



Nature Conservancy

Q
How do landscapes evolve?
Barnes

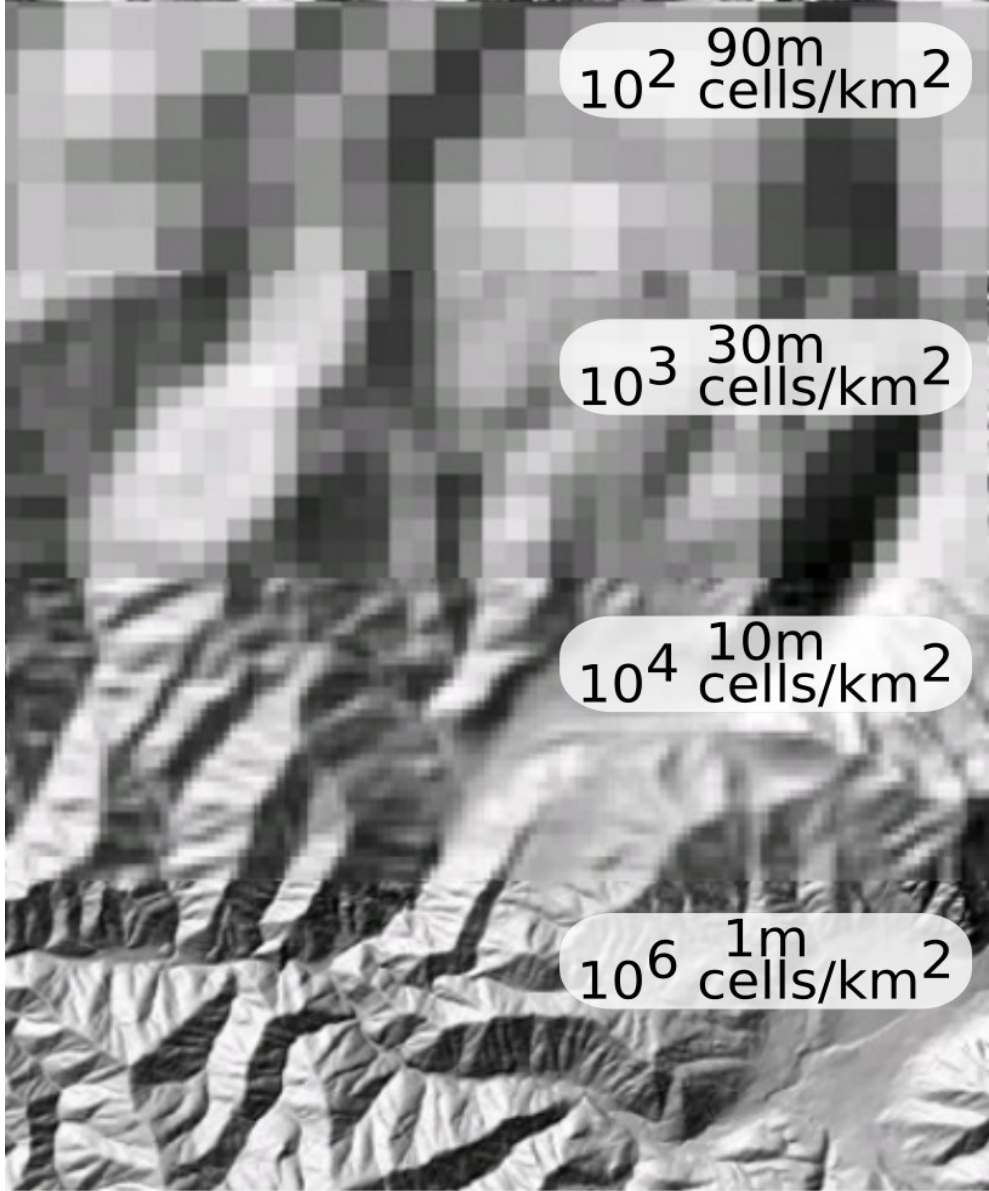


Q Is this a good way to cut metal?

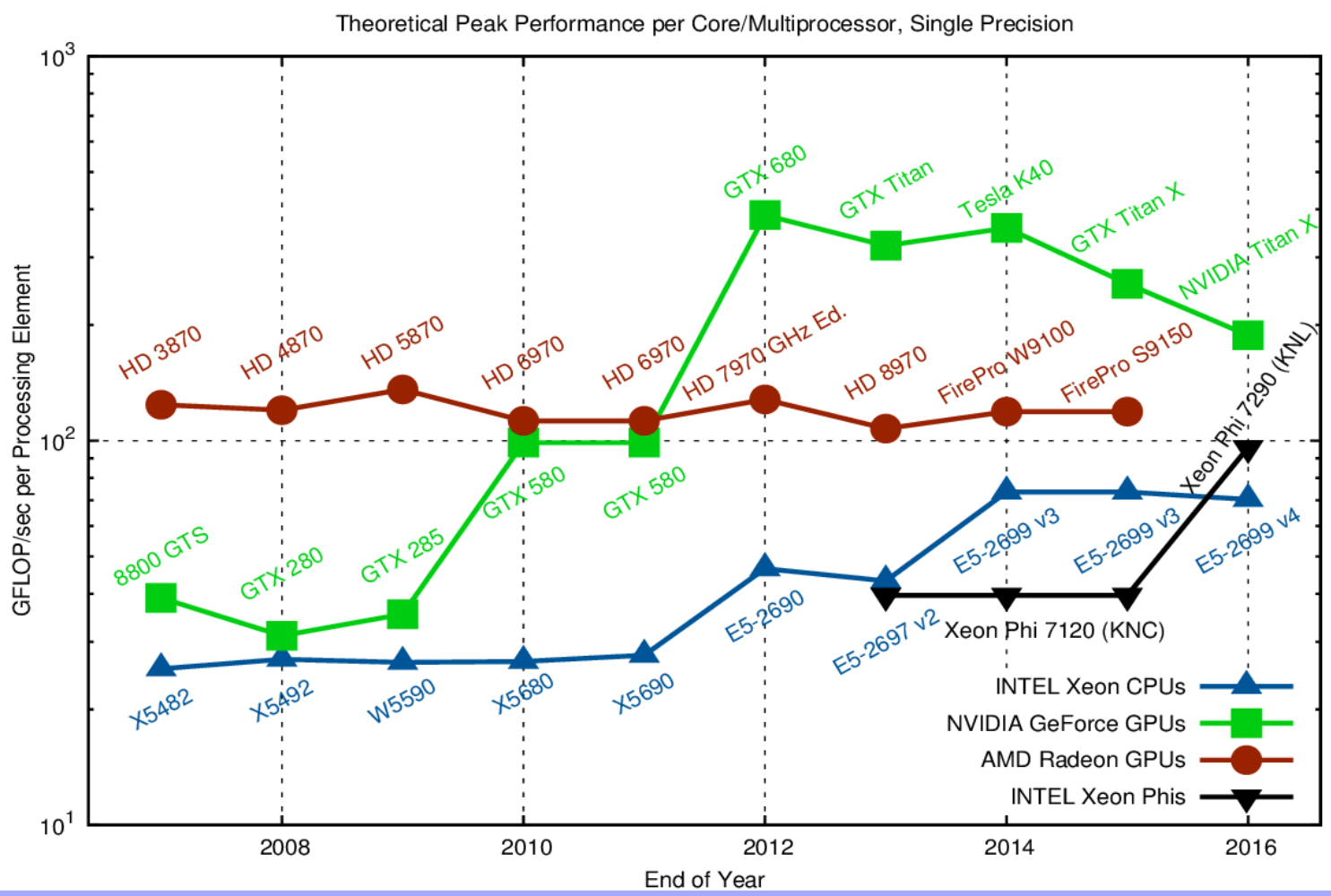
Q

Why is this

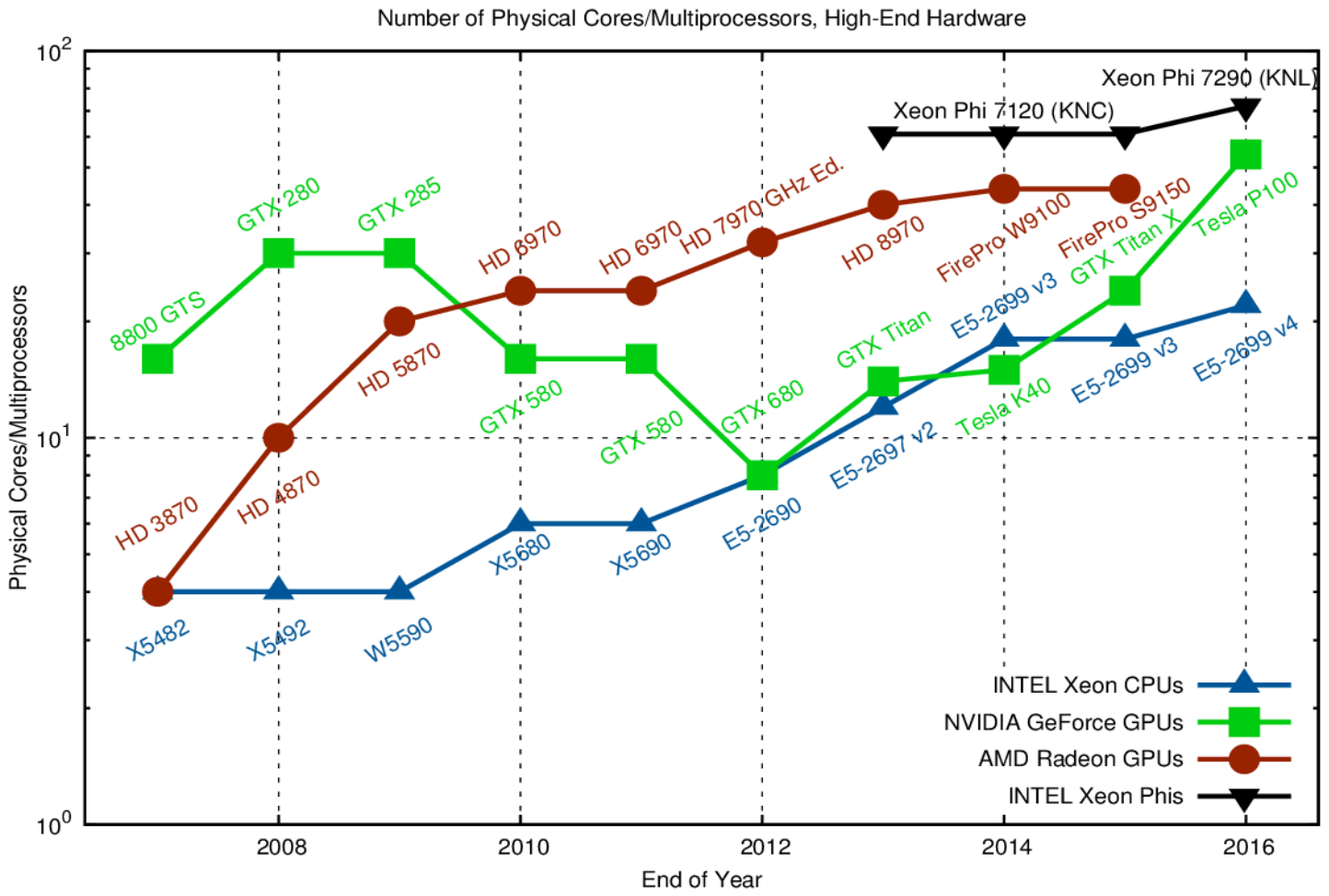
Challenging?



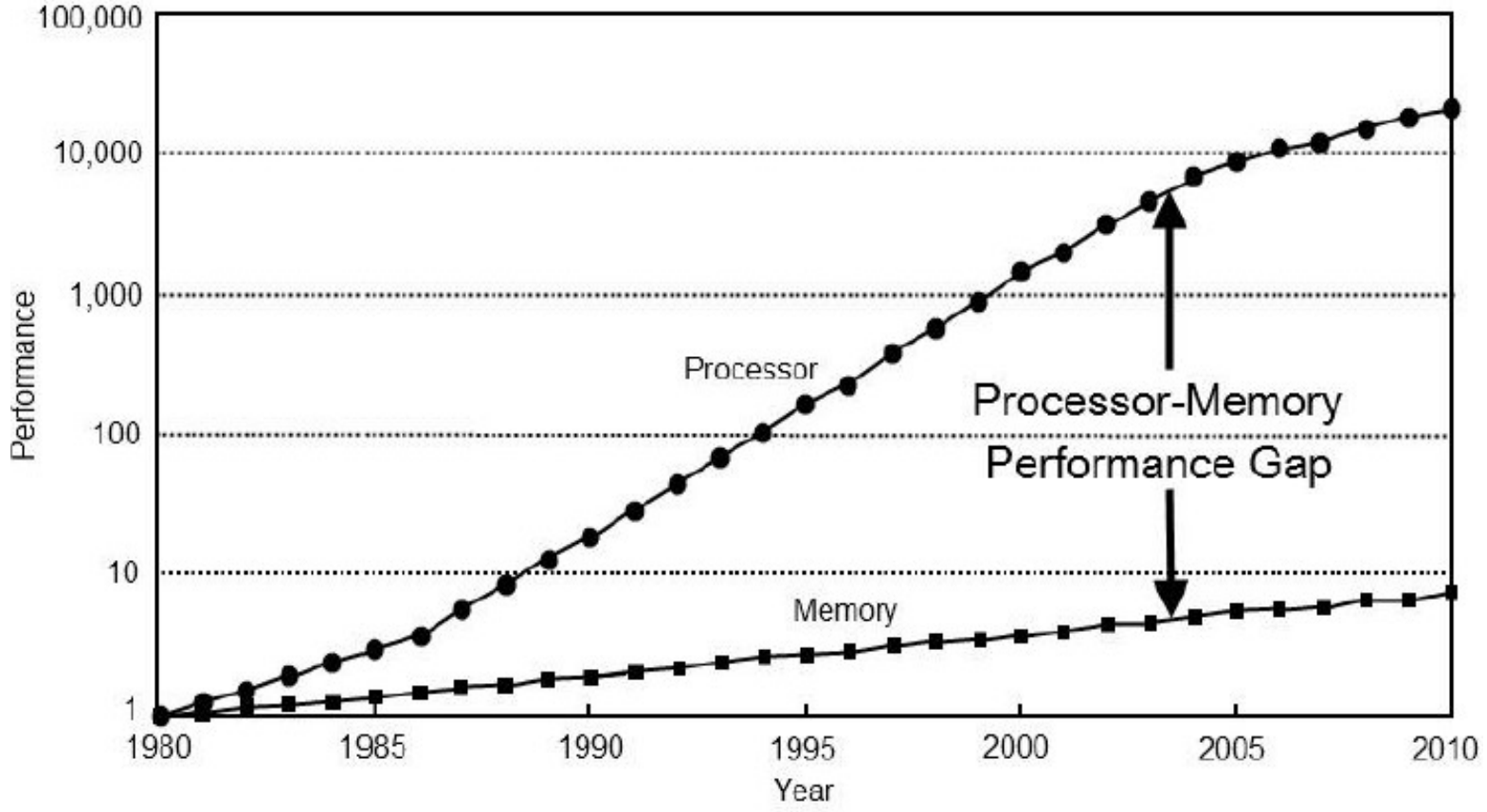
“Big” Data



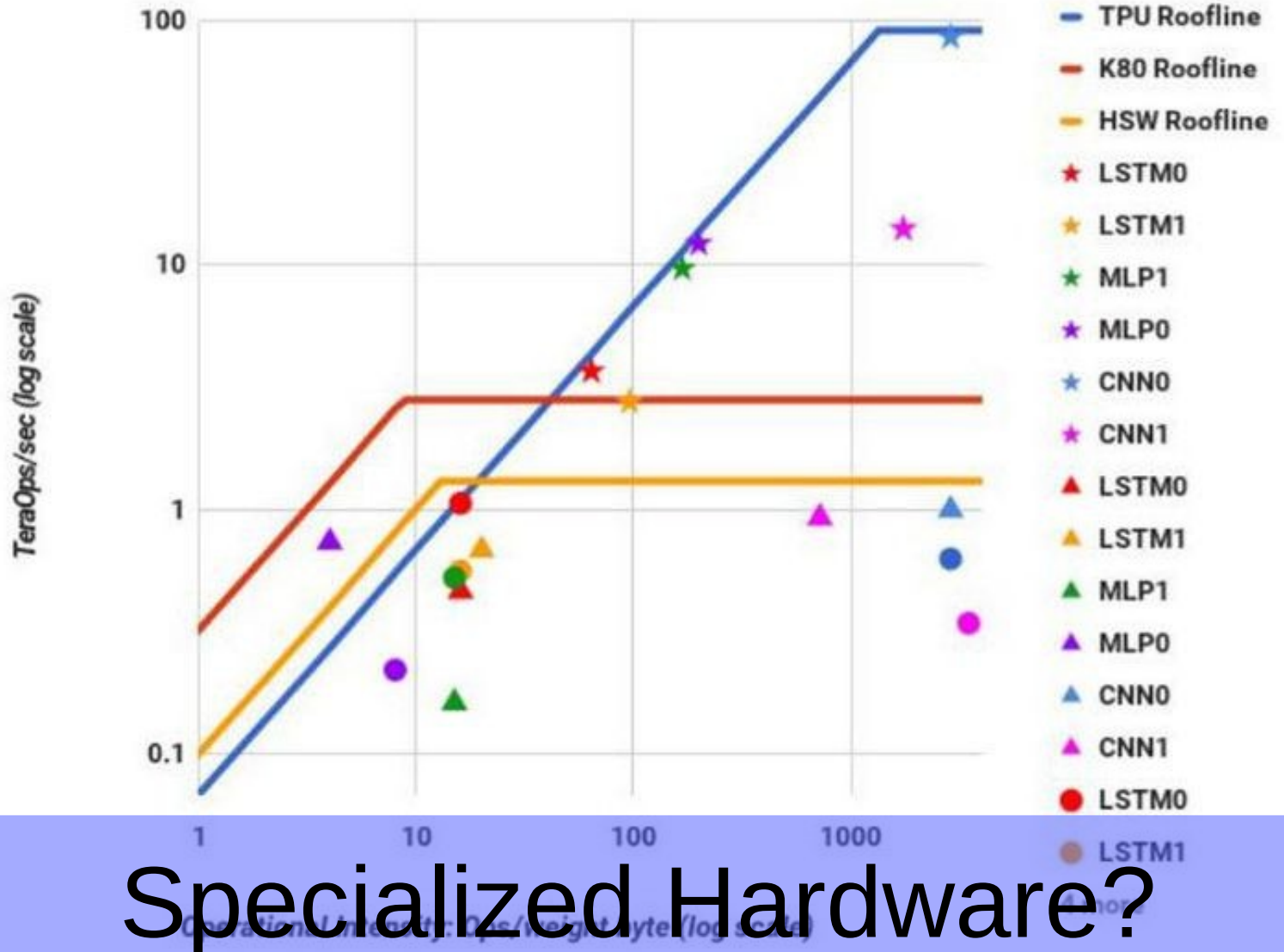
Flops per Core



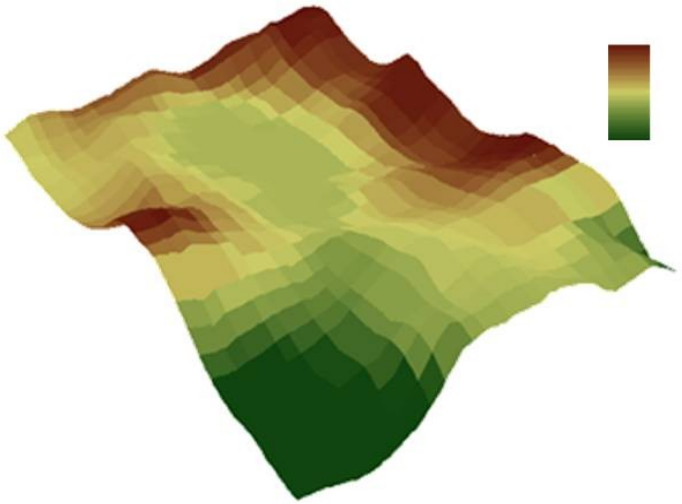
Number of Cores



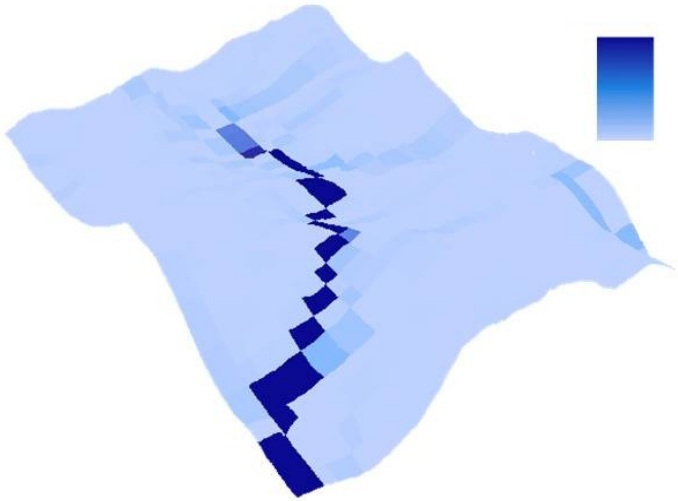
CPU vs. Memory



Specialized Hardware?

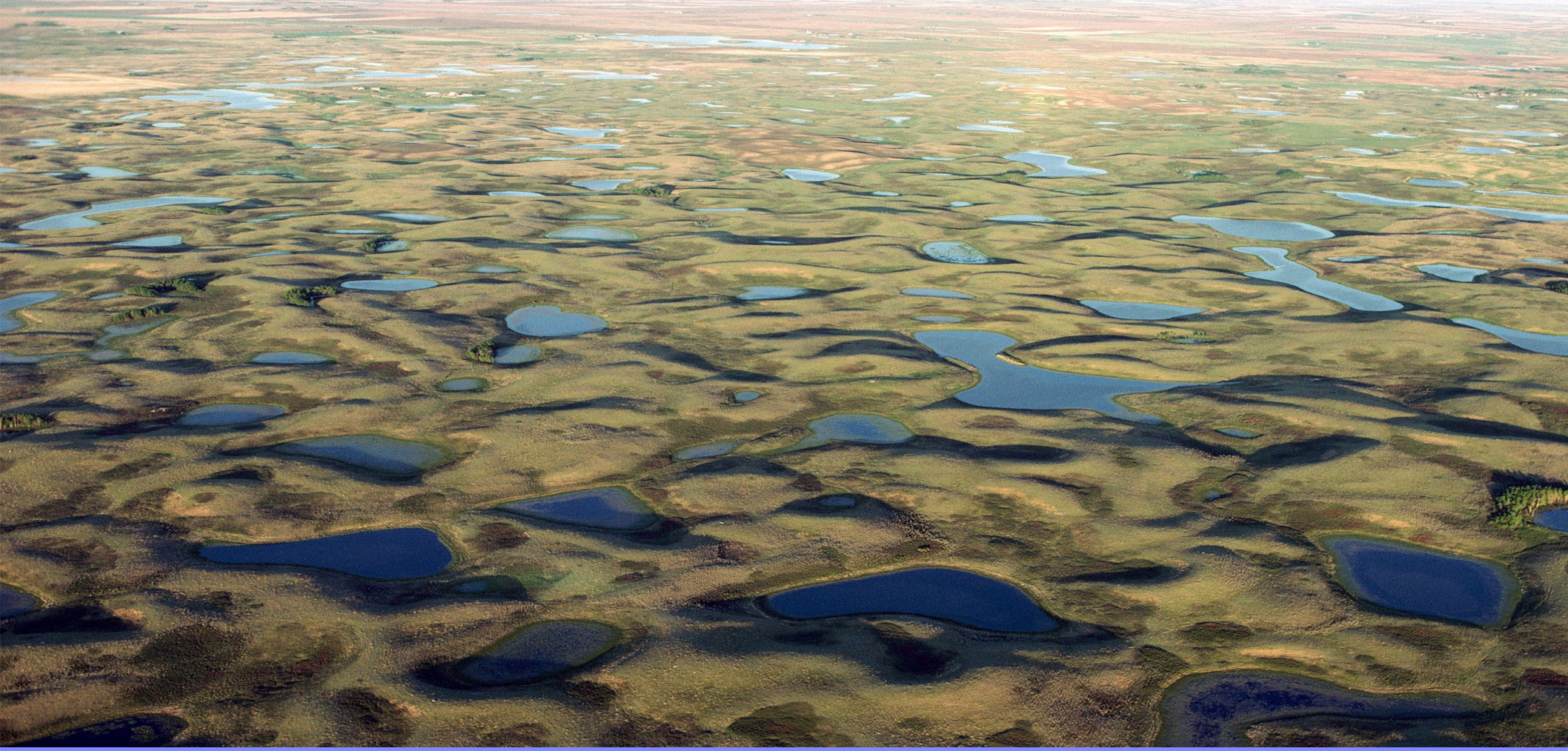


Elevation

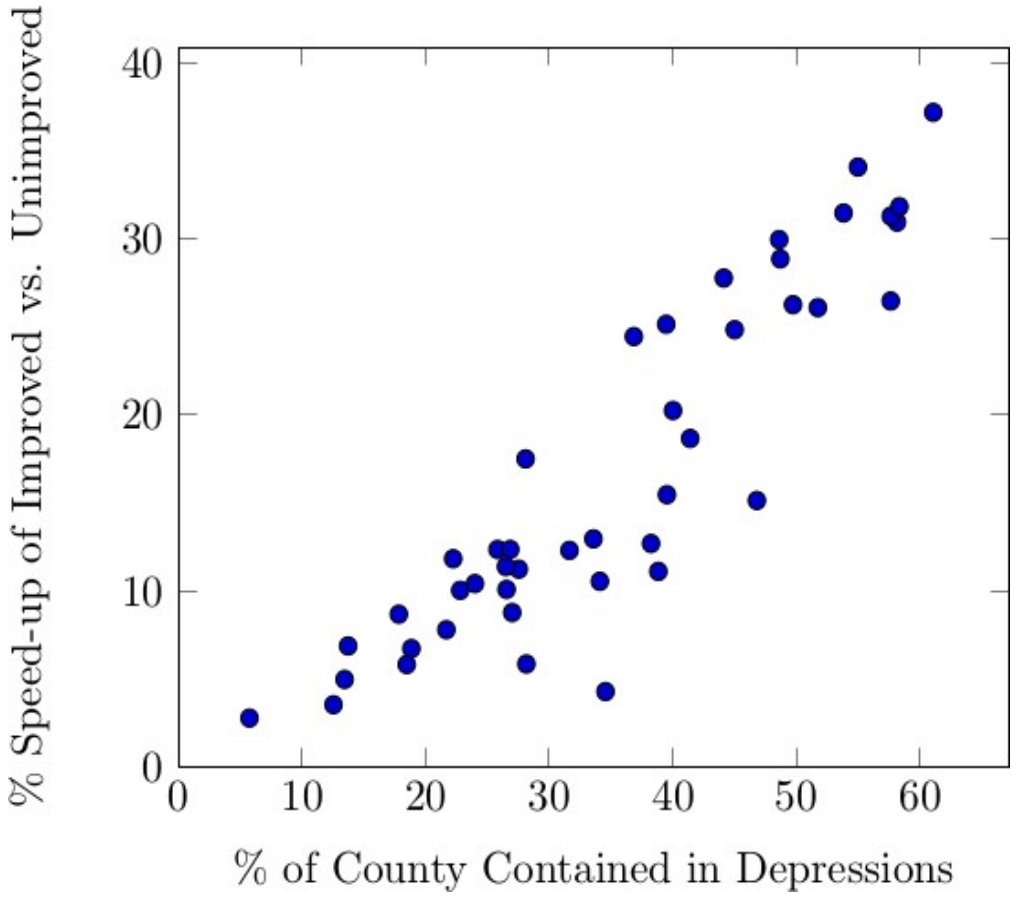


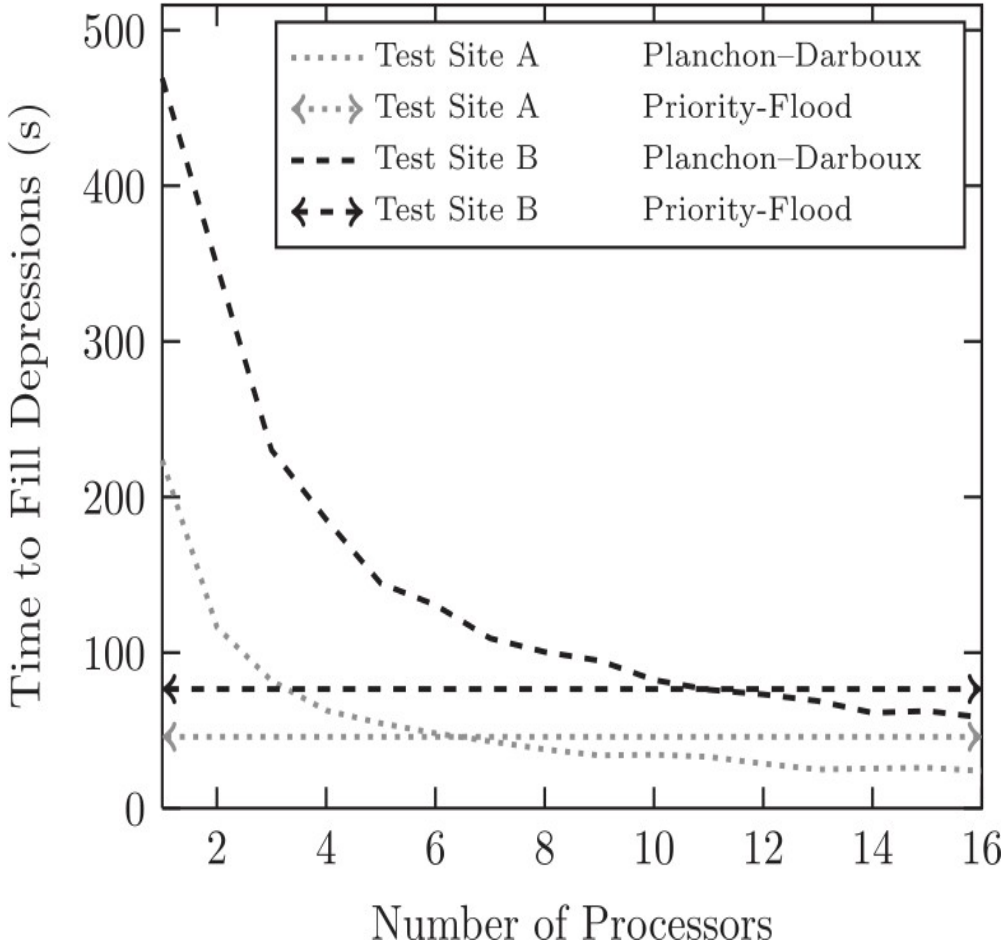
Flow Accumulation

Terrain Analysis



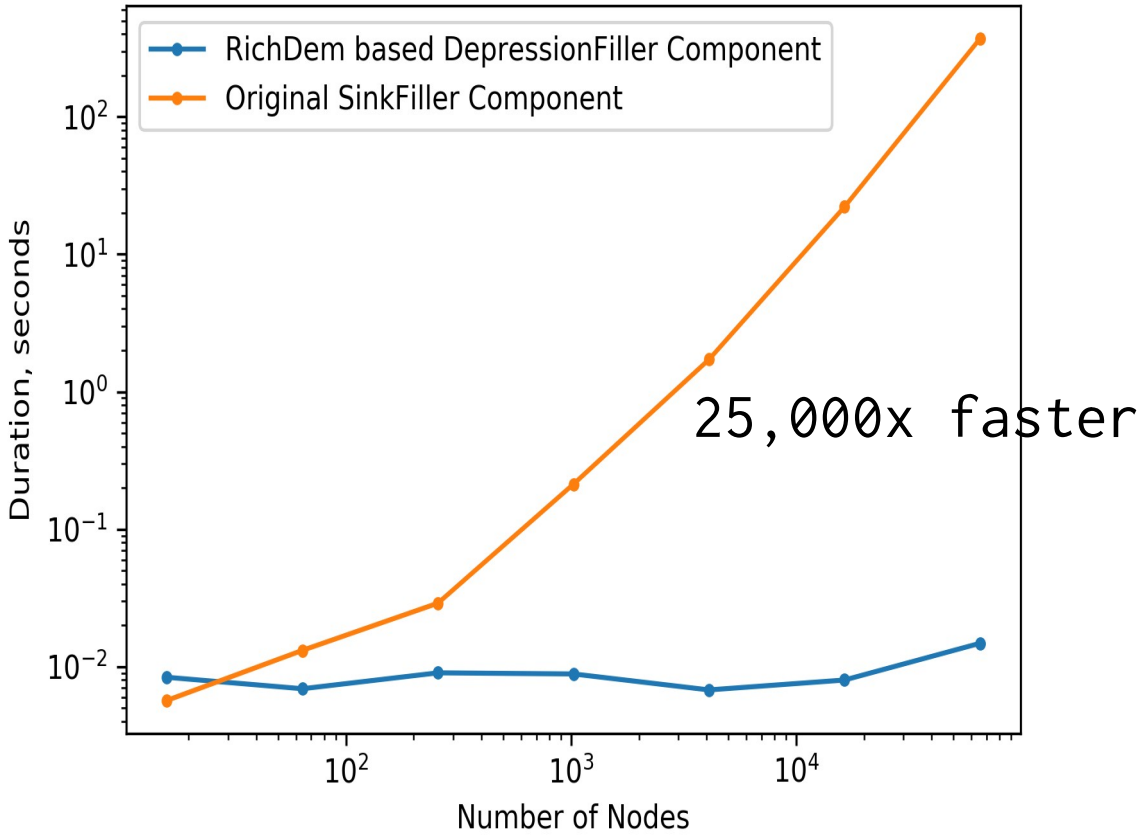
Depression-filling





Depression-filling with Priority-Flood

Barnes et al (2014a)



Depression-filling with Priority-Flood

Barnes et al (2014a)

Delineation and quantification of wetland depressions in the Prairie Pothole Region of North Dakota

Q Wu, CR Lane - Wetlands, 2016 - Springer

Abstract The Prairie Pothole Region of North America is characterized by numerous, small, wetland depressions that perform important ecological and hydrological functions. Recent studies have shown that total wetland area in the region is decreasing due to cumulative

☆ 99 Cited by 11 Related articles All 6 versions Import into BibTeX

Determining Murder Prone Areas Using Modified Watershed Model

J Khisha, N Zerin, D Choudhury… - Conference on …, 2017 - Springer

Abstract In this paper, we present an algorithm for cluster detection using modified Watershed model. The presented model for cluster detection works better than the k-means algorithm. The proposed algorithm is also computationally inexpensive compared to the k-

☆ 99 Import into BibTeX

Bubble size statistics during reionization from 21-cm tomography

SK Giri, G Mellema, KL Dixon, IT Iliev - arXiv preprint arXiv:1706.00665, 2017 - arxiv.org

Abstract: The upcoming SKA1-Low radio interferometer will be sensitive enough to produce tomographic imaging data of the redshifted 21-cm signal from the Epoch of Reionization. Due to the non-Gaussian distribution of the signal, a power spectrum analysis alone will not

☆ 99 Cited by 1 Related articles All 2 versions Import into BibTeX

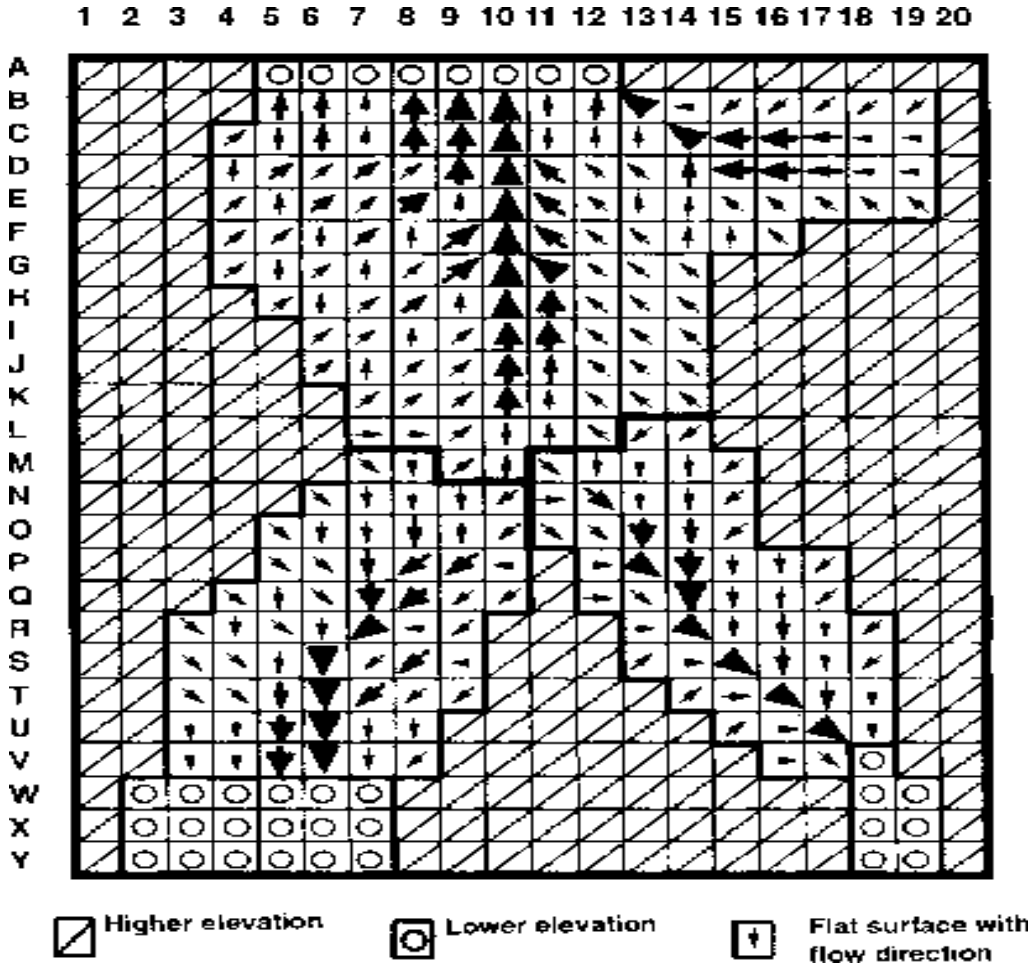
Analysis, Recognition, and Classification of Biological Membrane Images

M Kulbacki, J Segen, A Bak - … and Modified Biological Membranes and its …, 2017 - Springer

Abstract Biological membrane images contain a variety of objects and patterns, which convey information about the underlying biological structures and mechanisms. The field of image analysis includes methods of computation which convert features and objects

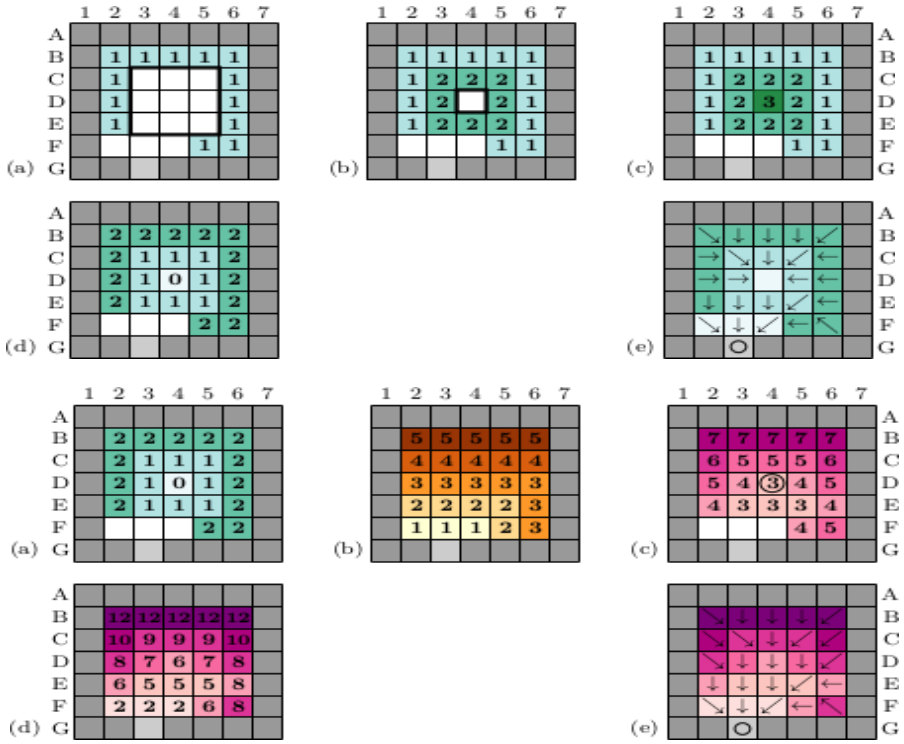
☆ 99 All 4 versions Import into BibTeX

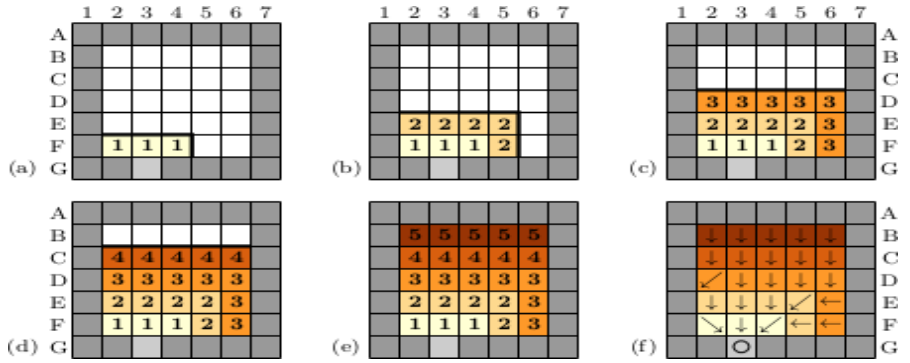
Flat Resolution



Flat Resolution

Garbrecht & Martz (1997), TauDEM





Steele County
10,891 x 13,914 cells
18% flats

TauDEM: 53.3 min (16 cpus)
My Work: 0.5 min (1 cpu)

Wall-time: 110x faster
CPU-time: 1,763x faster

Flat Resolution

Barnes et al (2014b)

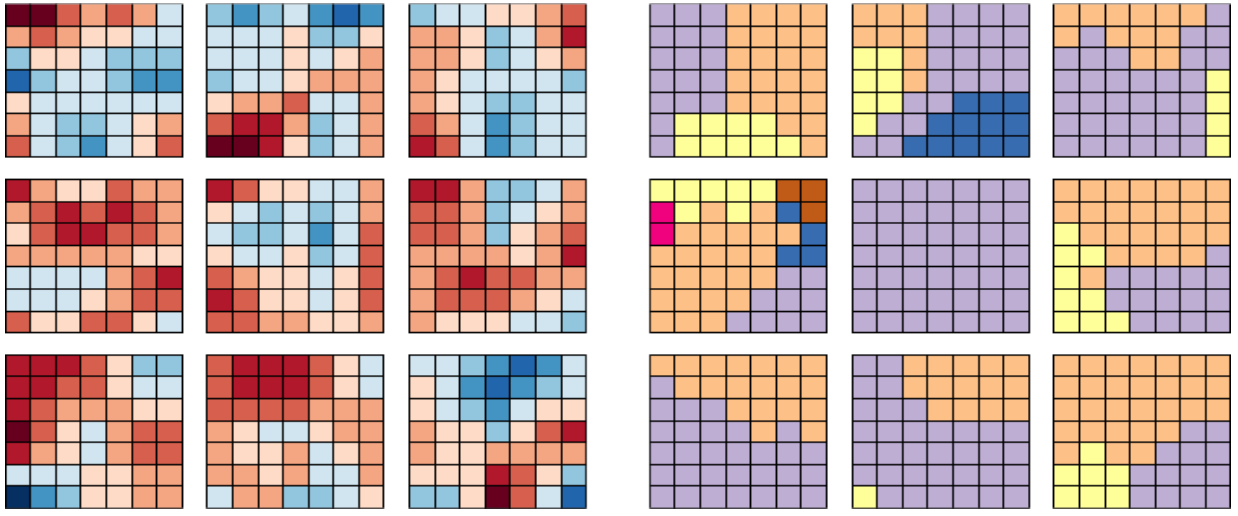
Real-time part detection in a virtually machined sheet metal defined as a set of disjoint regions

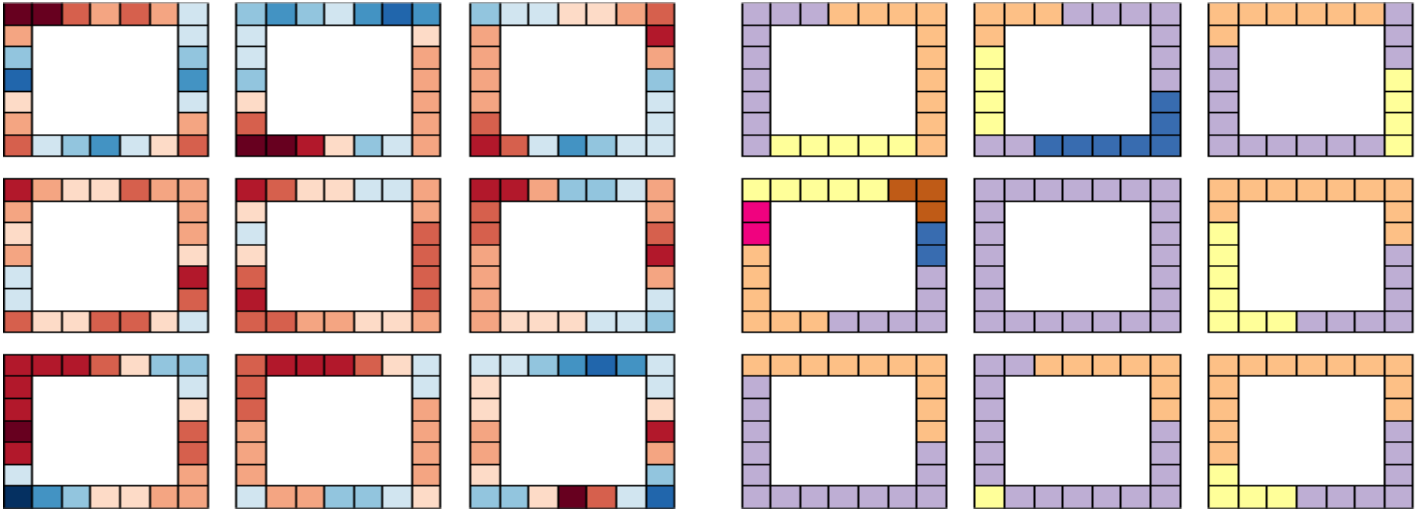
G Velez, A Moreno, Á Ruíz De Infante… - International Journal of …, 2016 - Taylor & Francis

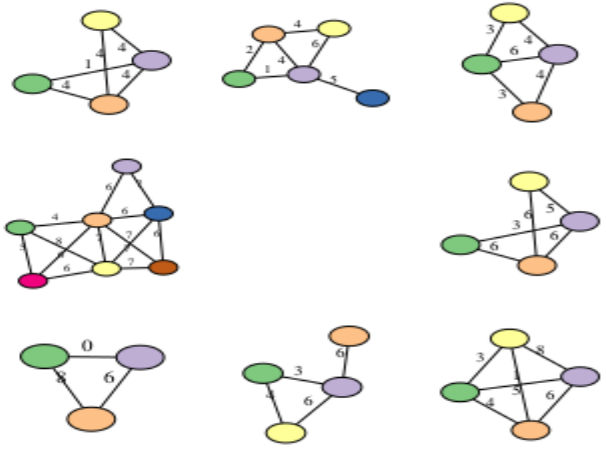
In sheet metal machining process, it is of extreme importance to be able to detect cut parts, differentiating the blank and processed elements. When the parts are cut from the rest of the sheet, such elements are prone to move freely and may jump or cause damage to the

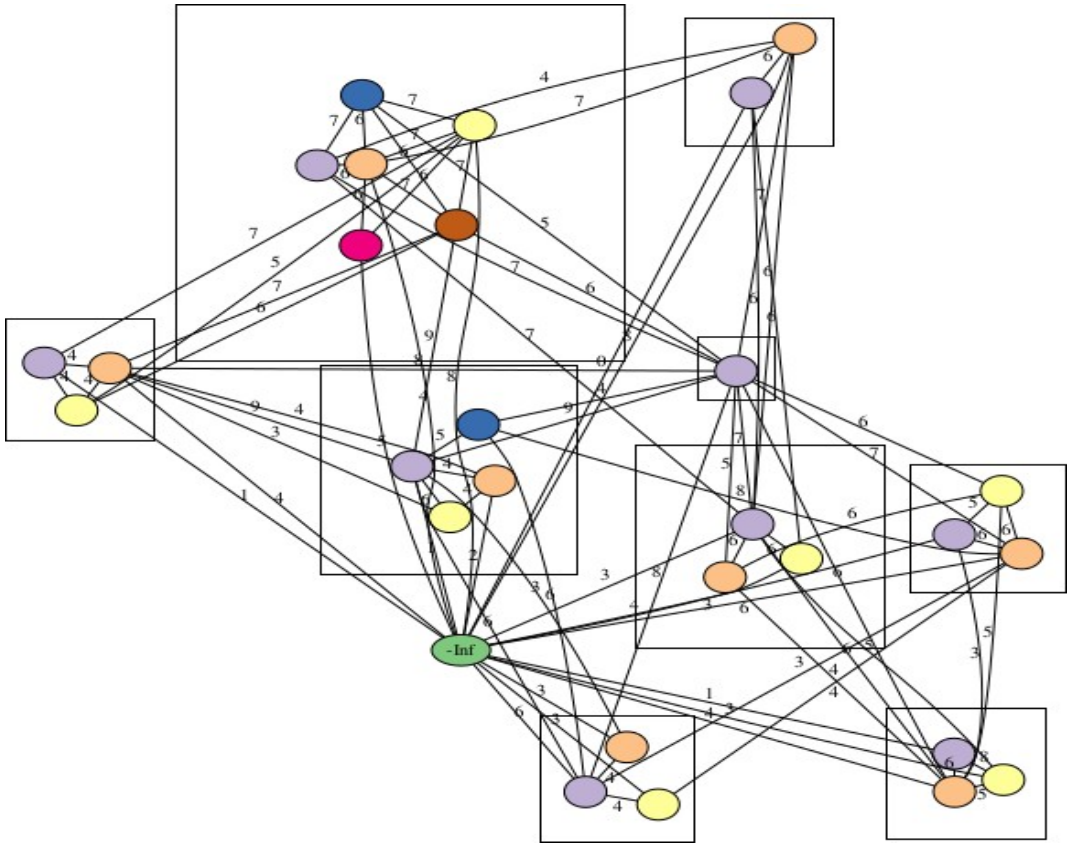
☆ 99 Cited by 2 Related articles All 2 versions Import into BibTeX

Continent Scale Analysis



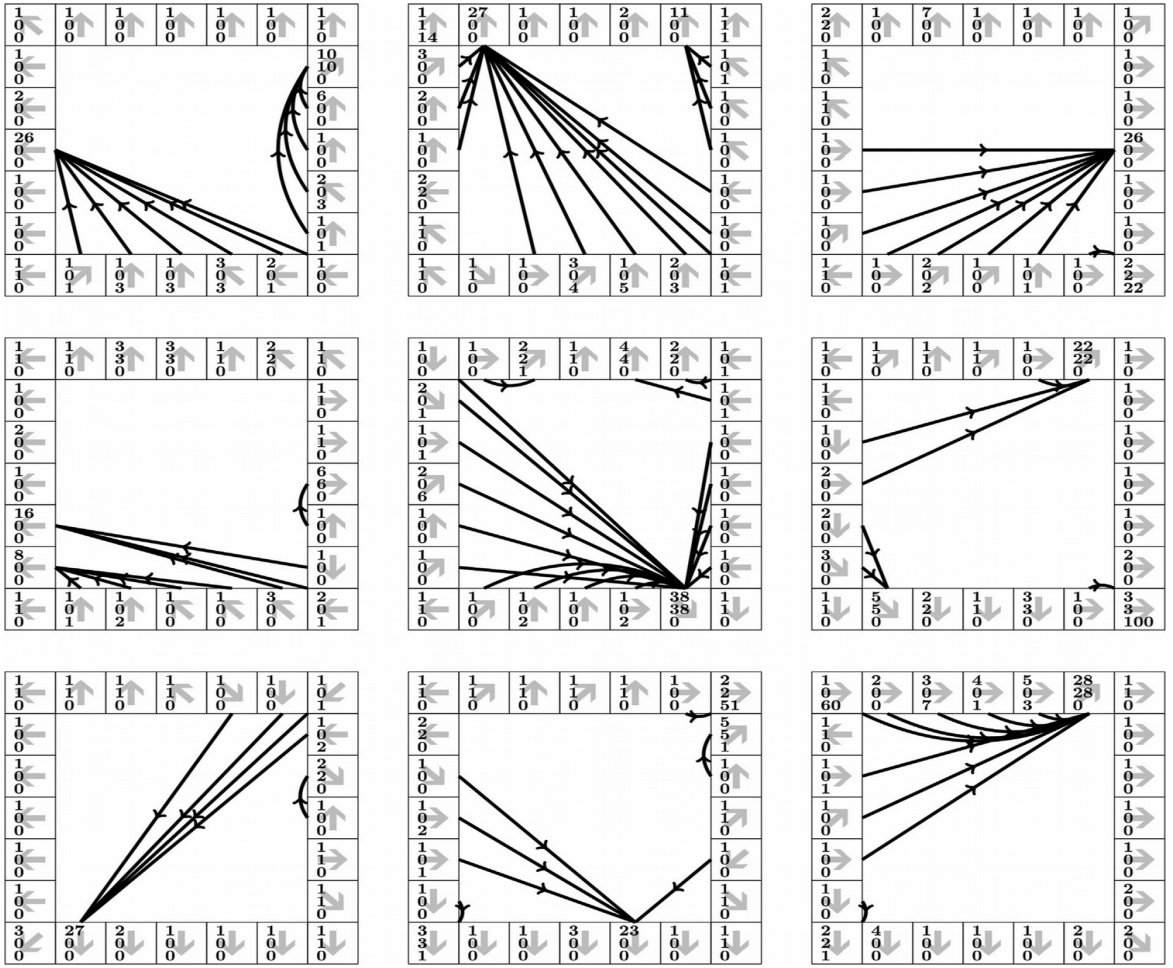






Depression Filling

Barnes (2016)



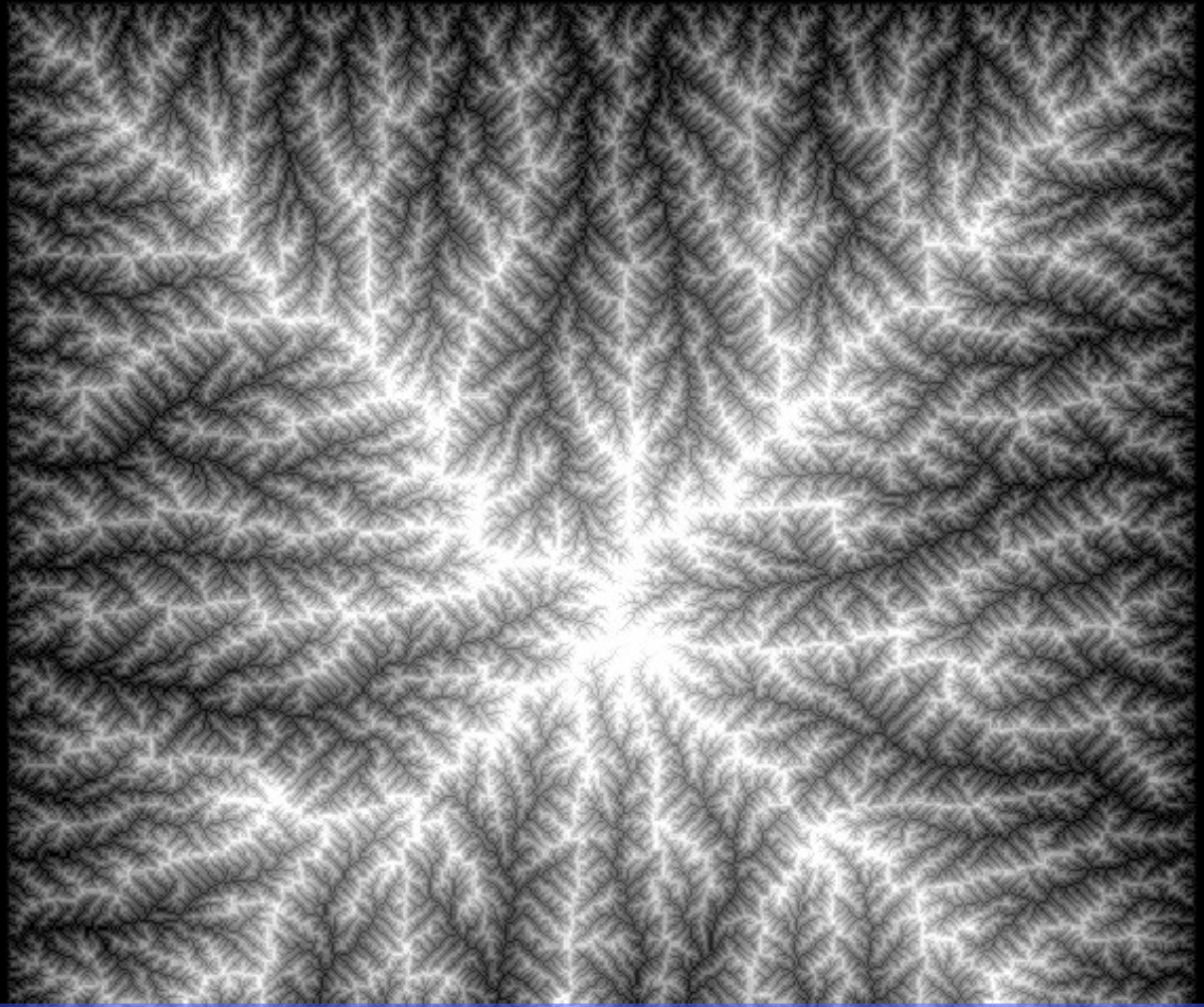
Flow Accumulation

Barnes (2017): Best Paper Award

Source	Year	Cells	Dimensions	Adjective
This paper (RichDEM)	2016	$2 \cdot 10^{12}$	$\sim$1,291,715^2	*rather* large
Gomes et al. [12]	2012	$3 \cdot 10^9$	50,000 x 50,000	huge
Do et al. [8]	2010	$2 \cdot 10^9$	36,002 x 54,002	huge
Do et al. [9]	2011	$2 \cdot 10^9$	36,002 x 54,002	huge
Yıldırım et al. [29] (TauDEM)	2015	$2 \cdot 10^9$	45,056 x 49,152	large
Arge et al. [2] (GRASS)	2003	$1 \cdot 10^9$	33,454 x 31,866	massive
Lindsay [16] (Whitebox GAT)	2015	$9 \cdot 10^8$	37,201 x 25,201	massive
Tesfa et al. [24]	2011	$6 \cdot 10^8$	24,856 x 24,000	large
Wallis et al. [26] (TauDEM)	2009	$4 \cdot 10^8$	14,949 x 27,174	large
Danner et al. [6]	2007	$3 \cdot 10^8$	??	massive
Metz et al. [19, 20] (GRASS)	2010	$2 \cdot 10^8$	??	massive

Large Digital Elevation Models

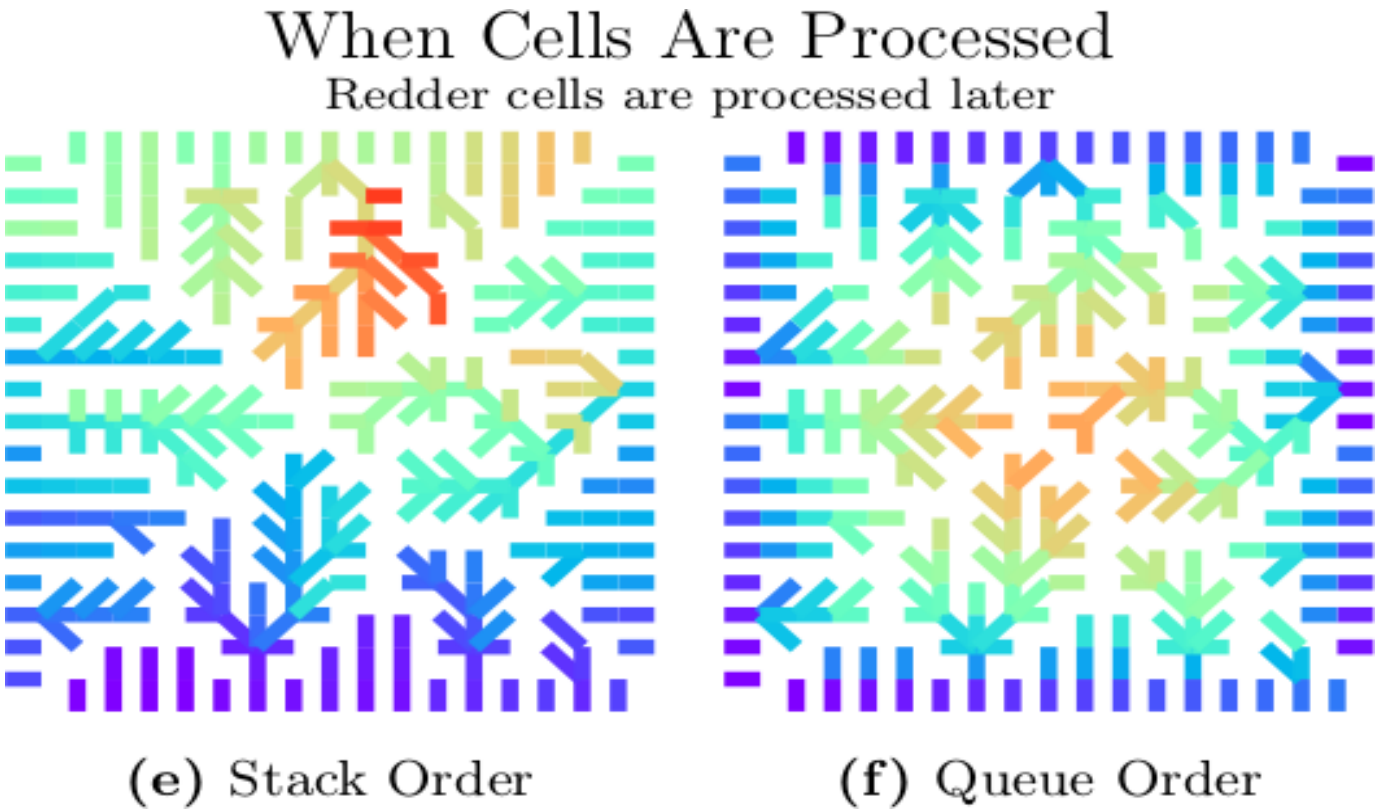
Barnes et al (2016)



Landscape Evolution Models

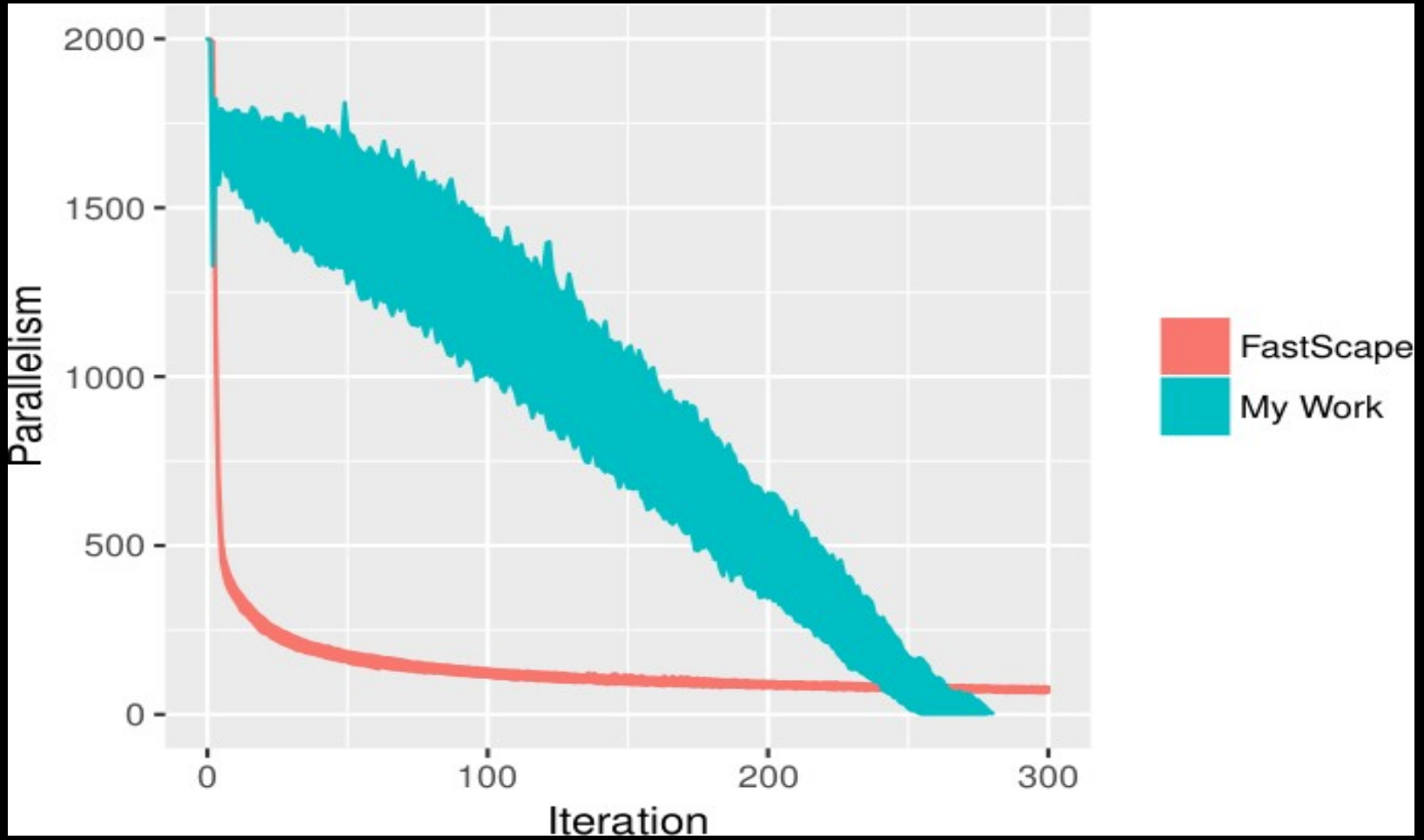
Application: Nuclear Storage

Tucker and Barnhart



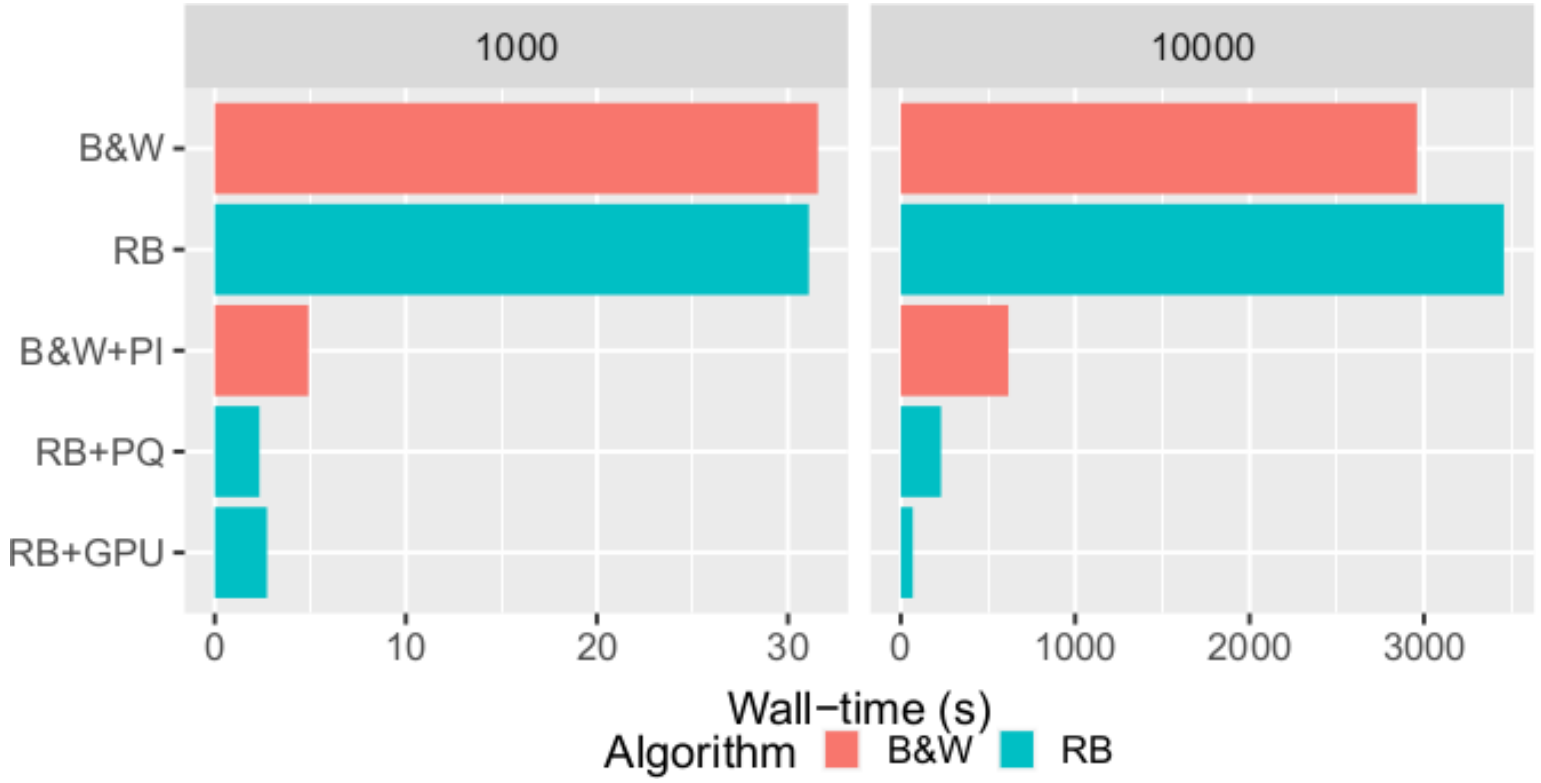
Graph Topology in Landscape Evolution

Barnes (2019a)



Landscape Evolution

Barnes (2019a)



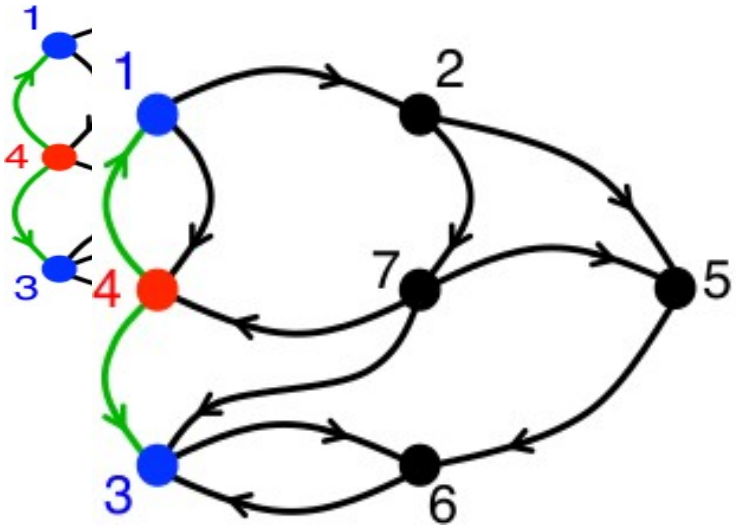
What about CPUs?

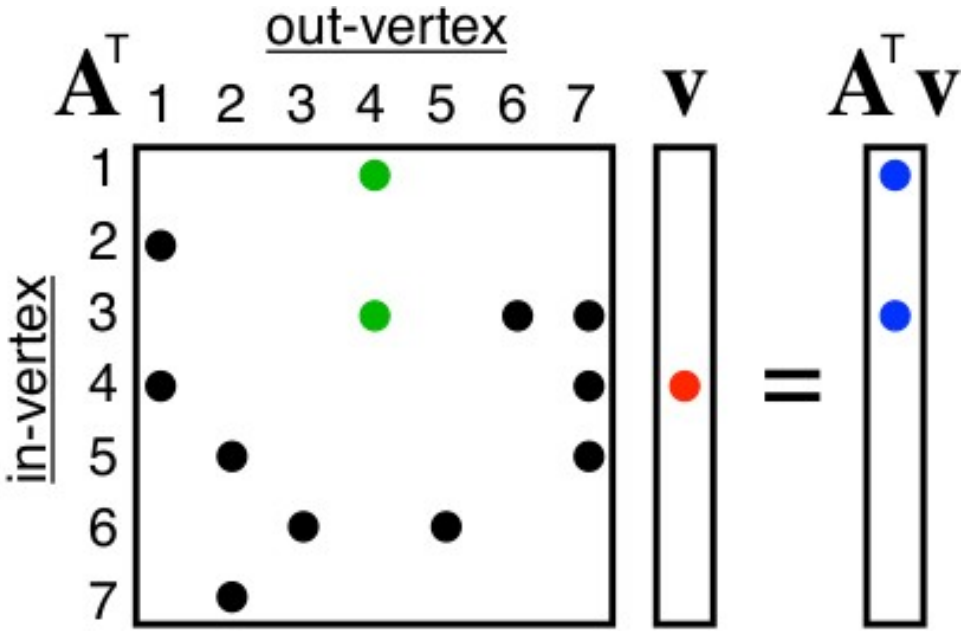
PGI-trs <trs@pgroup.com> Jan 2, 2018, 6:03 PM

to me

Thanks Richard. I was able to reproduce the error on both x86 and Power using a P100.

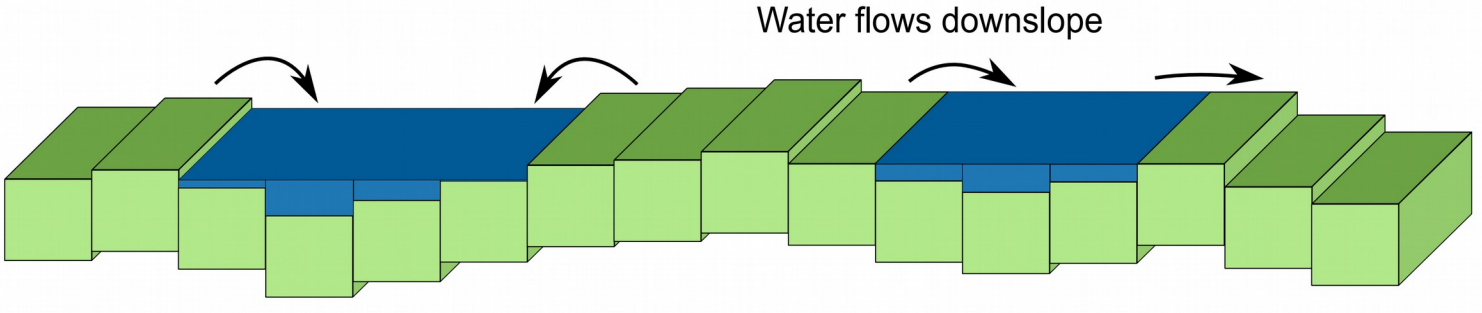
From what I can tell it looks like a compiler bug. The problem seems to be with the variables "level_top" and "level_bottom". For some reason they're getting bad values making the loop trip count be 0 (i.e. the loop isn't getting executed and why nstack isn't getting updated). I've reported the bug to our engineers as TPR#25056.

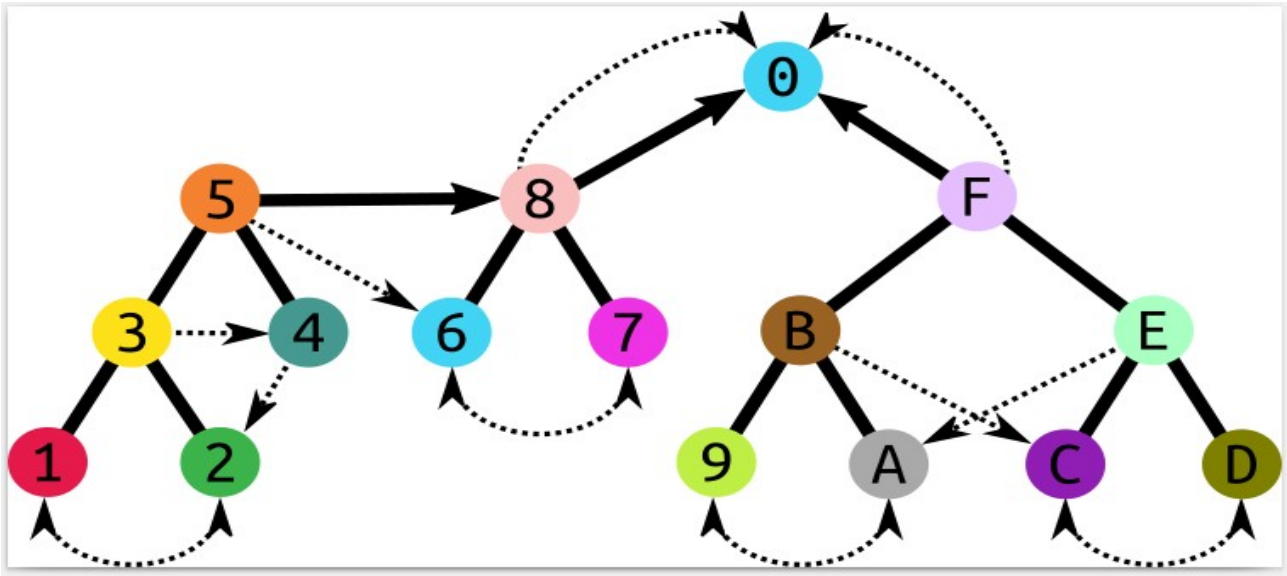




Linear Algebra of Graphs?

Values & Aesthetics



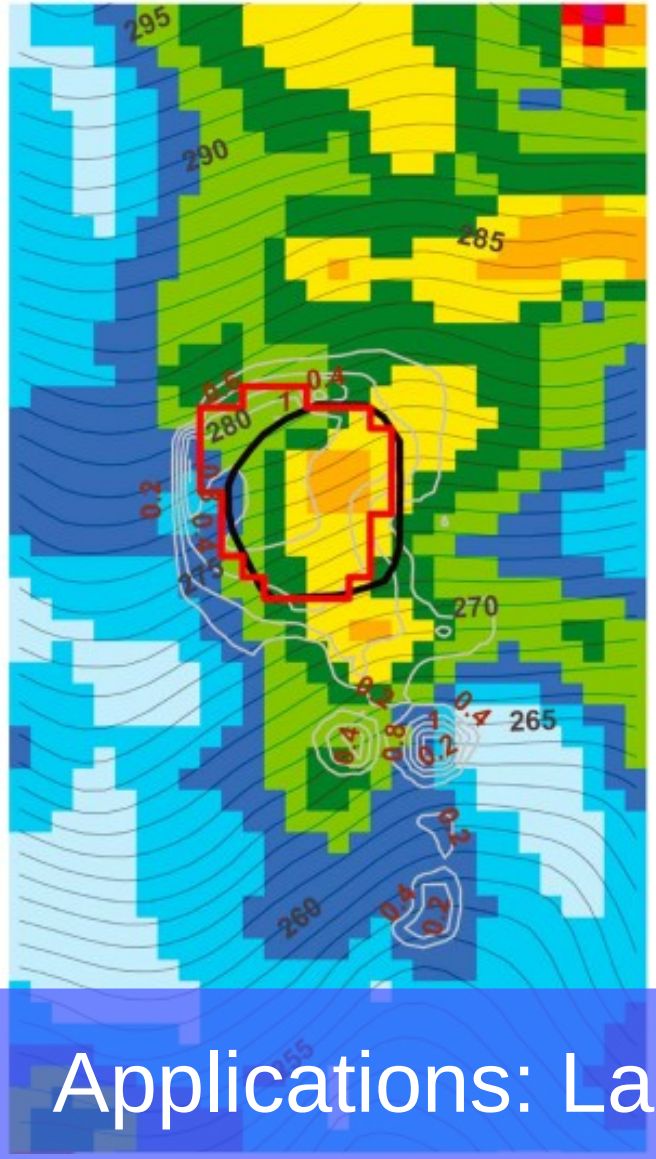


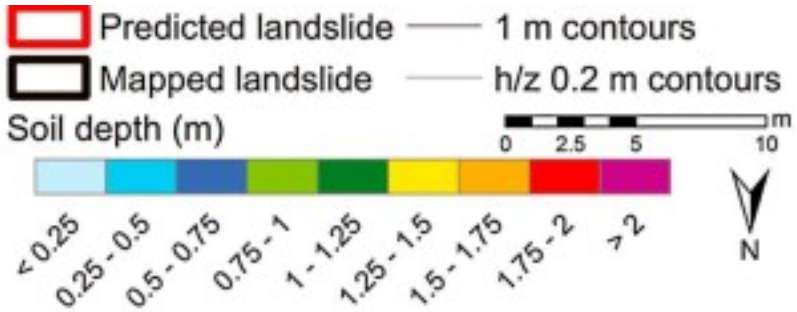
Applications: Global Groundwater Flow

Barnes, Callaghan, Wickert (2019 c,d)

Applications: Global River Migration

Bryk, Barnes, Dietrich (2019 - in-progress)





Applications: Landslide Prediction

Bellugi, Barnes (In-progress)

DOE
CSGF
NSF
BERKELEY LAB
Lawrence Berkeley National Laboratory
Berkeley
UNIVERSITY OF CALIFORNIA
ERG
Energy & Resources Group
XSEDE
Extreme Science and Engineering
Discovery Environment