

Automated Reconstruction of Portuguese Tile Panels



Importance: Preservation of World Cultural Heritage

The reconstruction of wall paintings from numerous large repositories of fragmented artifacts, compiled over time due to natural deterioration, is of utmost importance in preserving world cultural heritage



Importance: Limited Human Resources

Today hundreds of thousands of Portuguese tiles are stored in boxes at the Portuguese National Tile Museum in Lisbon, awaiting manual reassembly.

Reconstructing these Portuguese panels manually by humans can take decades, and is thus infeasible!



Can Computers Help?

Current methods rely on high-quality tiles and coherent chromatic/texture, whereas Portuguese tiles are monochromatic and suffer from severe degradations.

Current puzzle solving methods achieve only 3.5% reconstruction on the Portuguese tiles.



Our Automated Hybrid Solution

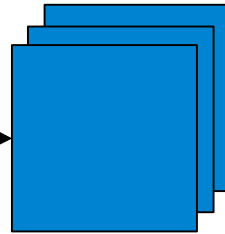
input pieces



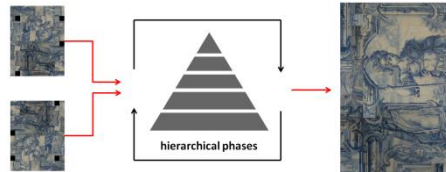
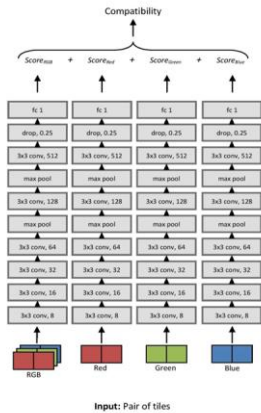
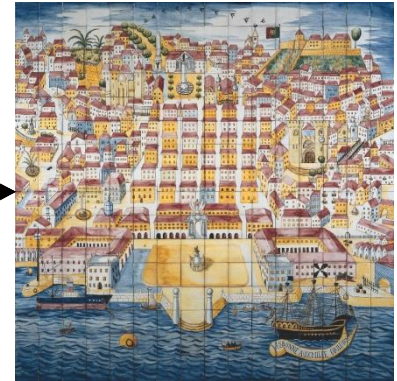
input pieces



pairwise scores

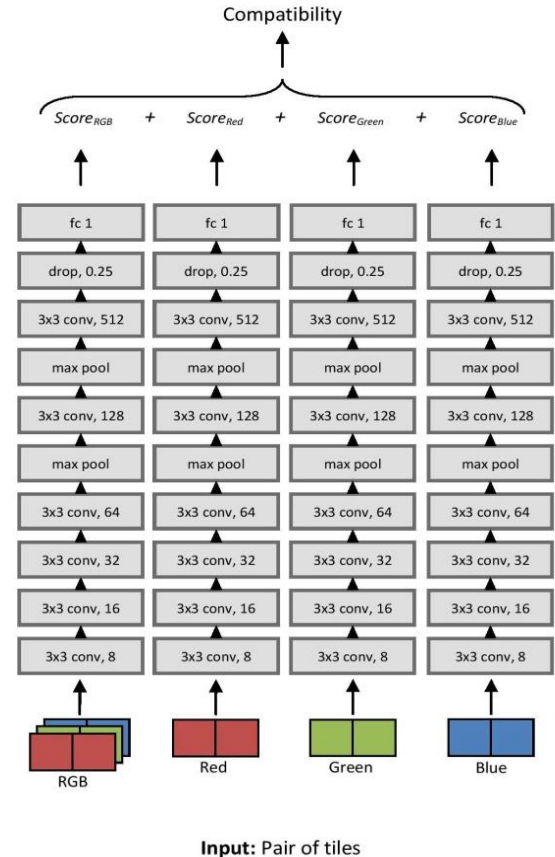
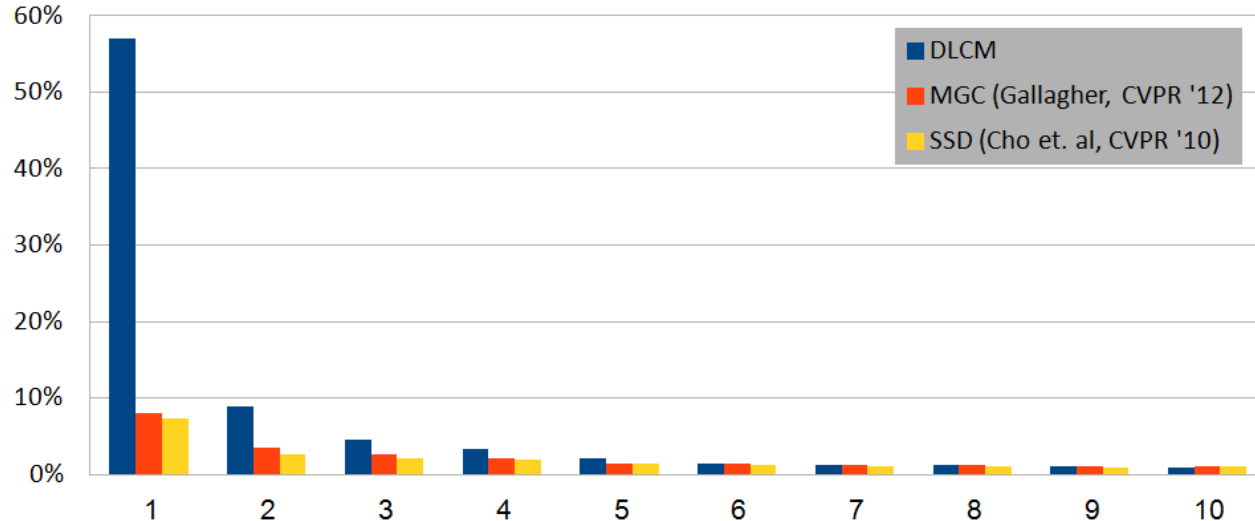


solution



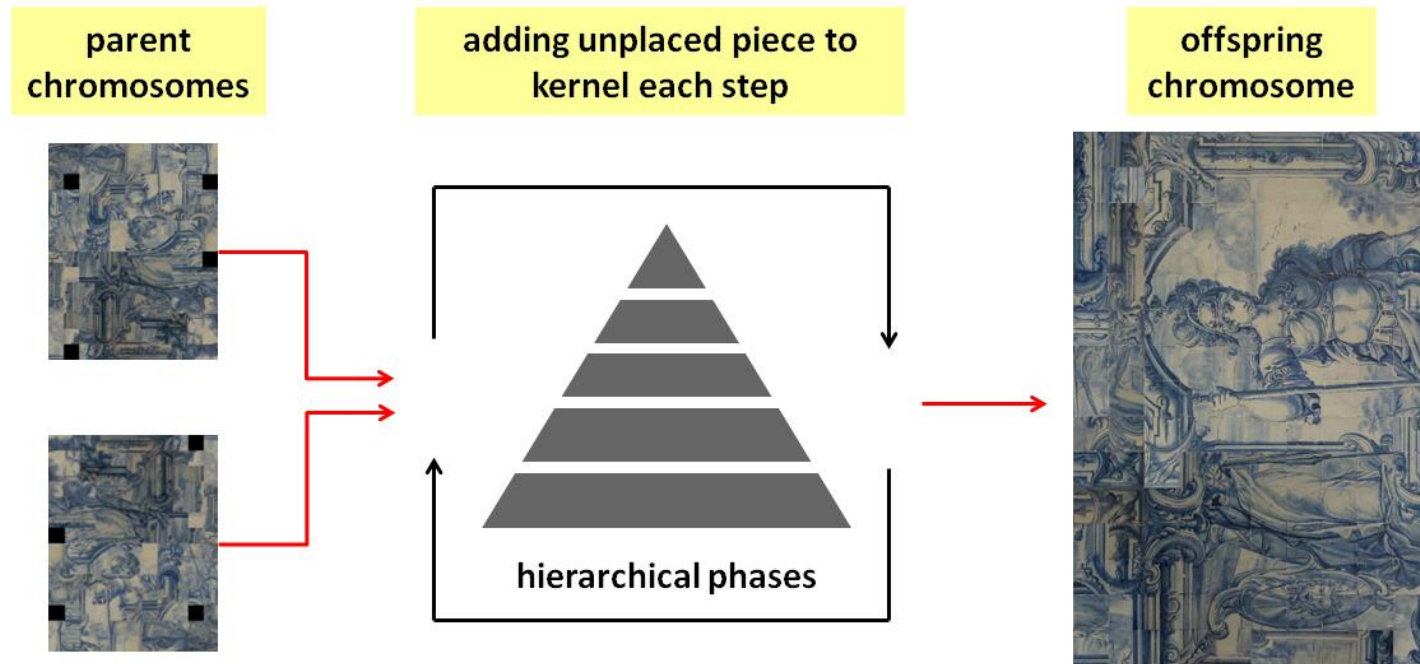
Our Solution (Cont'd)

Design a novel *compatibility* measure based on *deep neural networks* (DLCM)



Our Solution (Cont'd)

Employ *enhanced Genetic Algorithm* (GA) for tile placement, i.e., for eventual reconstruction of Portuguese tile panels



Results

The results obtained (for the hard) Type 2 problem variant on 7 test images acquired from the National Tile Museum in Lisbon ...



82% accuracy



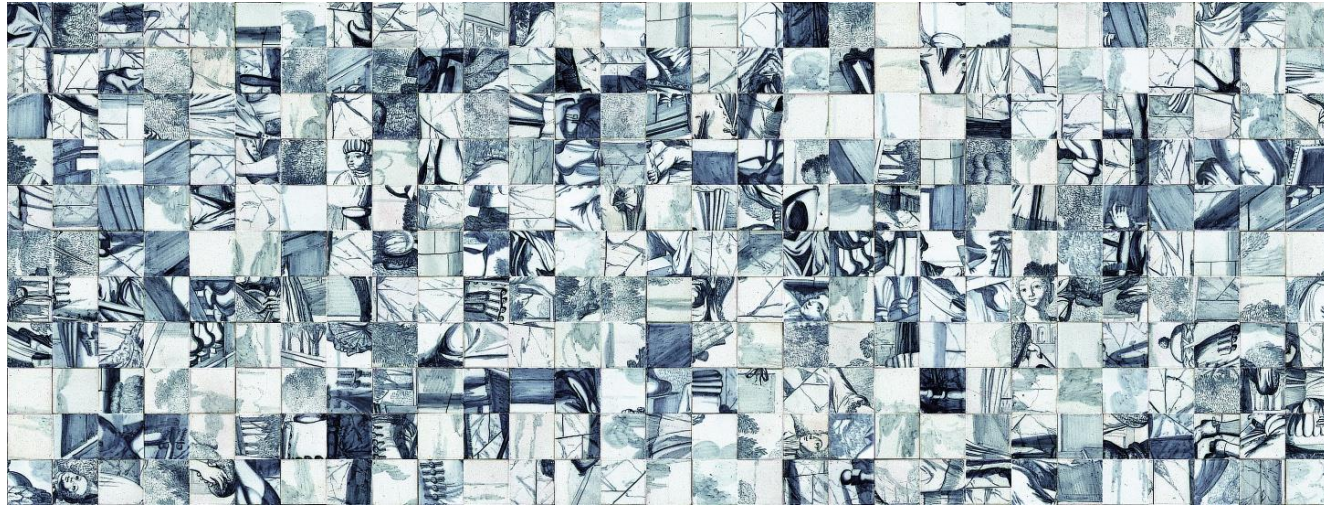
100% accuracy!





77% accuracy





82% accuracy





100% accuracy!





74% accuracy





91% accuracy



80% accuracy



Reconstruction Comparison

Reconstruction Algorithm (with DLCM)	Type 1		Type 2	
	Known dim	Unknown dim	Known dim	Unknown dim
Kernel-Growth ¹	84.5%	--	58.6%	--
Multi-Segments ²	--	--	--	62.9%
Enhanced Kernel-Growth	96.6%	96.5%	87.2%	82.3%

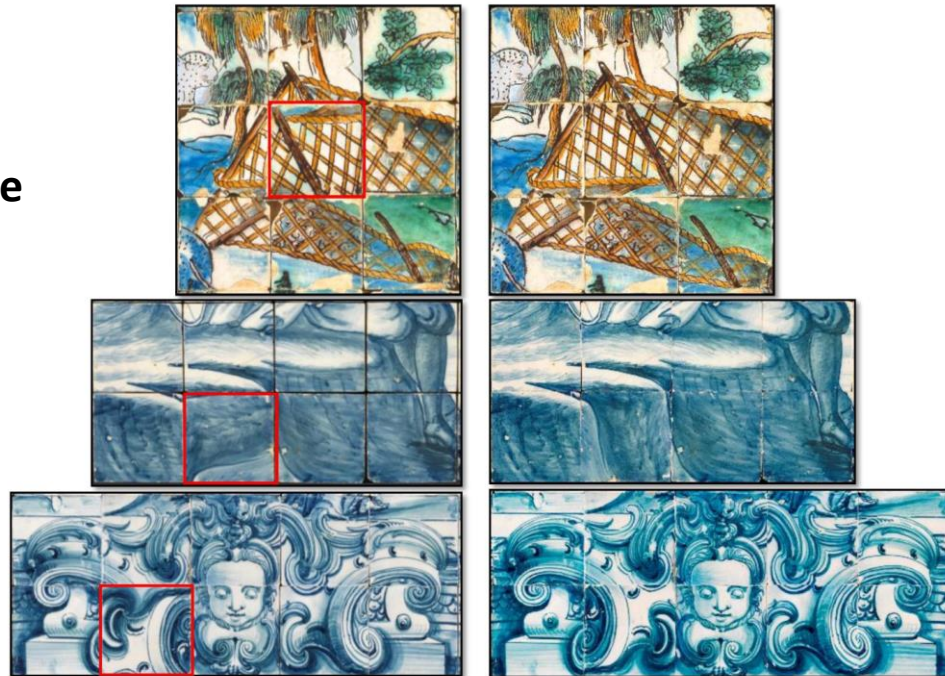
¹ Sholomon *et al.*, *AAAI '14*

² Sholomon *et al.*, *GECCO '14*

Better Performance Than Humans!

Our hybrid scheme detected mistakes by humans in 3 of the images! (Confirmed by the Museum Director.)

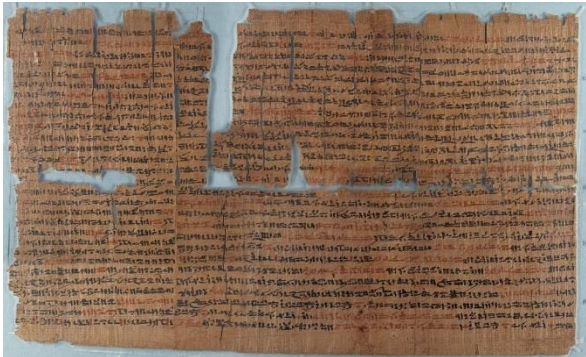
Mistakes due to manual reconstruction on LHS are highlighted by **red**



Specialty/Uniqueness of Our Work

Tackles a most important problem of the preservation of world cultural heritage

Novel hybrid approach; can be applied successfully also to other related important problems, e.g., shredded documents, reconstruction of ancient scrolls, etc.



Thank You!
