Microsoft Research Cambridge

SIGGRAPH2004

GrabCut

Interactive Foreground Extraction using Iterated Graph Cuts

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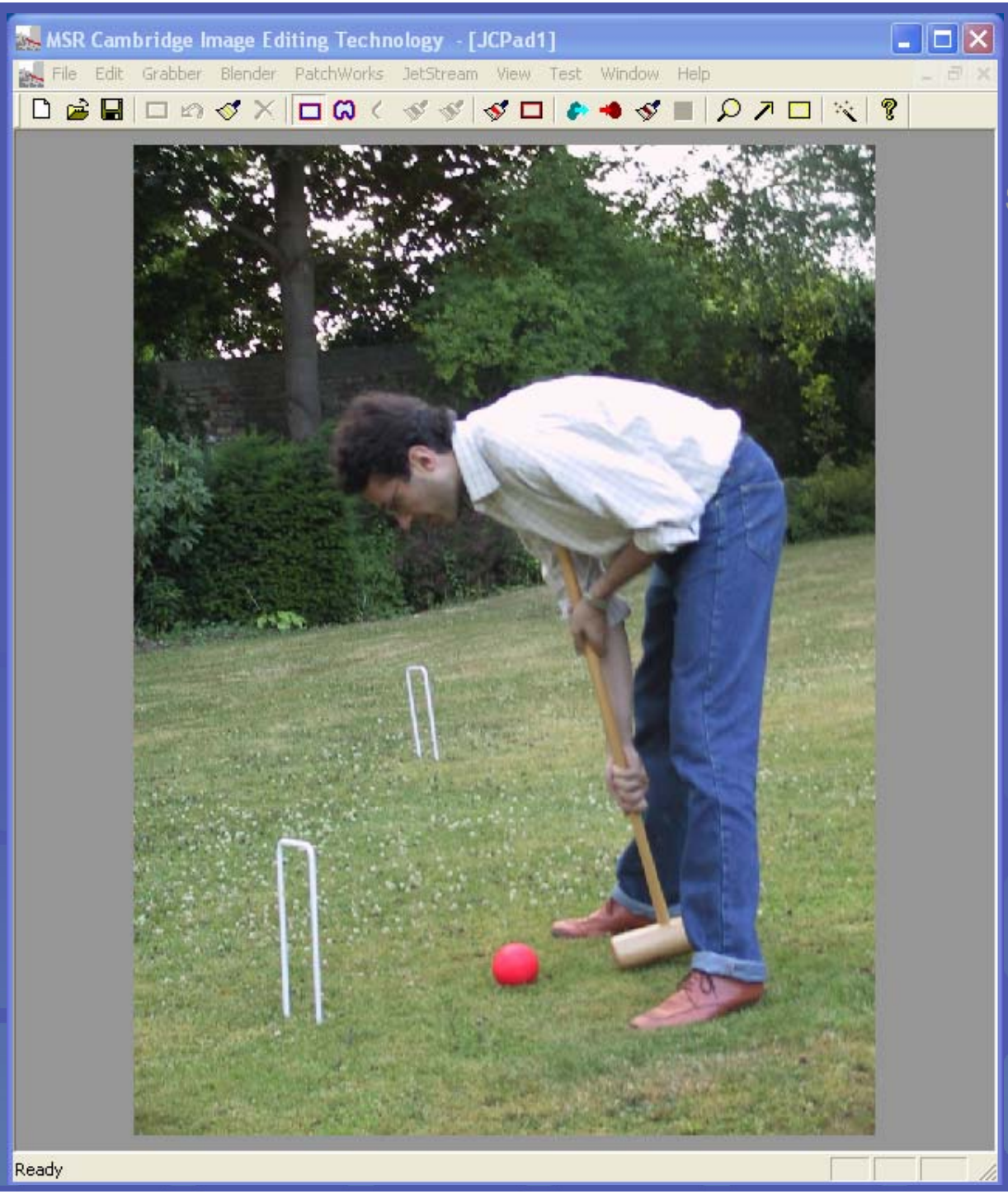

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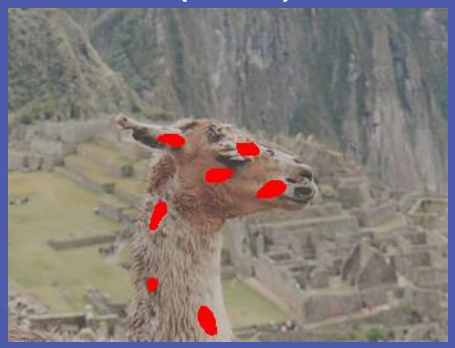
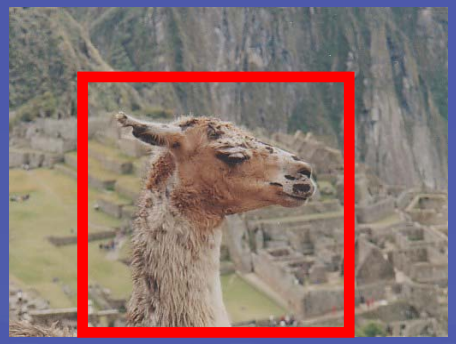
video

Problem

Fast &
Accurate ?

What GrabCut does

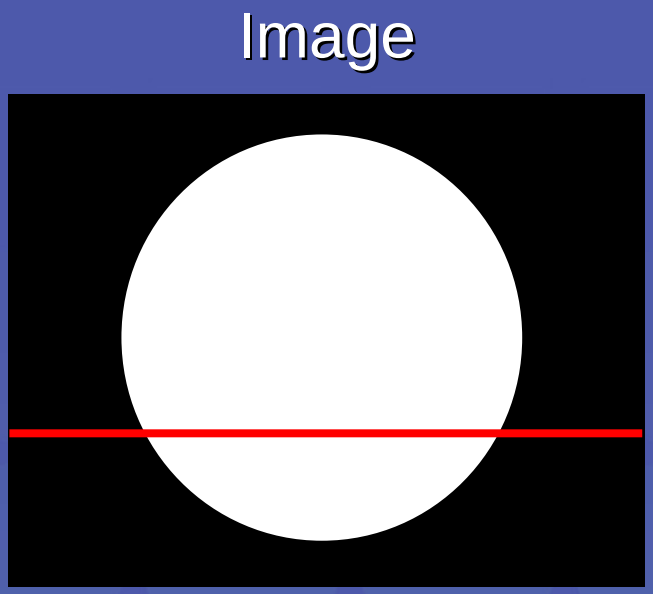
	Magic Wand (198?)	Intelligent Scissors Mortensen and Barrett (1995)	GrabCut
User Input			
Result	 Regions	 Boundary	 Regions & Boundary

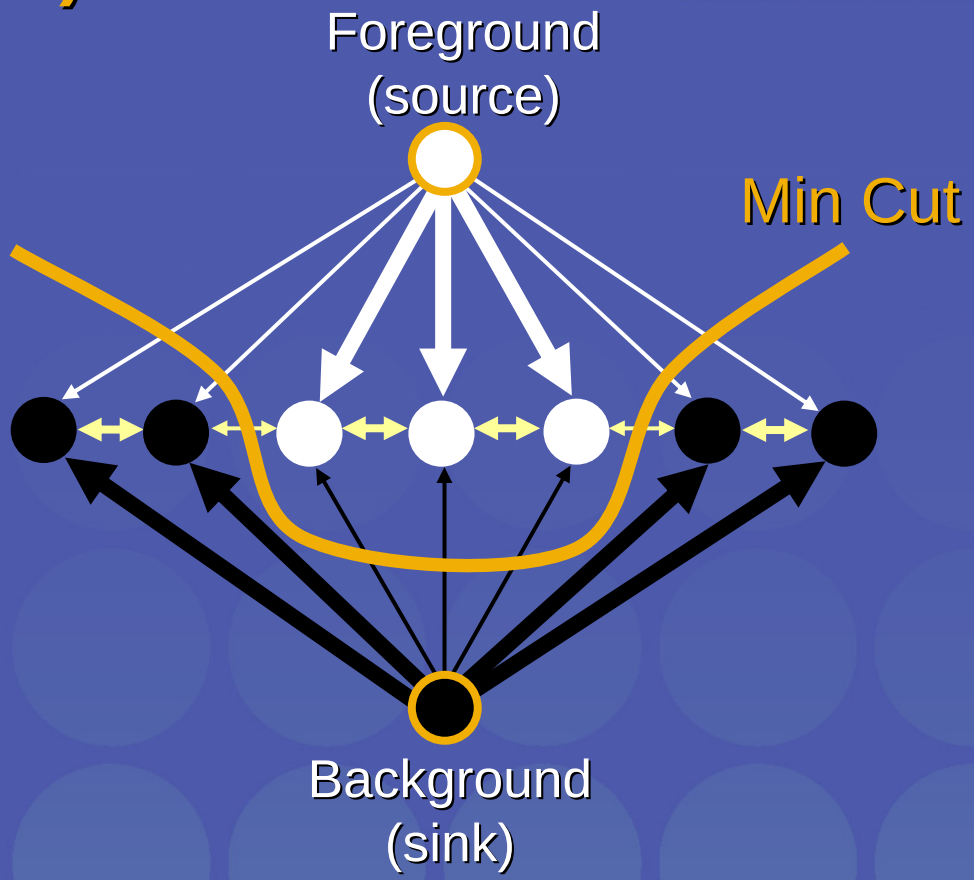
Framework

- **Input**: Image $\mathbf{x} \in \{\mathbf{R}, \mathbf{G}, \mathbf{B}\}^{\mathbf{n}}$
- **Output**: Segmentation $\mathbf{S} \in \{\mathbf{0}, \mathbf{1}\}^{\mathbf{n}}$
- **Parameters:** Colour $\boldsymbol{\Theta}$,Coherence λ
- **Energy:** $E(\boldsymbol{\Theta}, \mathbf{S}, \mathbf{x}, \lambda) = E_{Col} + E_{Coh}$
- **Optimization:** $\arg\min_{\mathbf{S}, \boldsymbol{\Theta}} E(\mathbf{S}, \boldsymbol{\Theta}, \mathbf{x}, \lambda)$

Graph Cuts

Boykov and Jolly (2001)





Cut: separating source and sink; Energy: collection of edges

Min Cut: Global minimal enegry in polynomial time

Iterated Graph Cut

User Initialisation

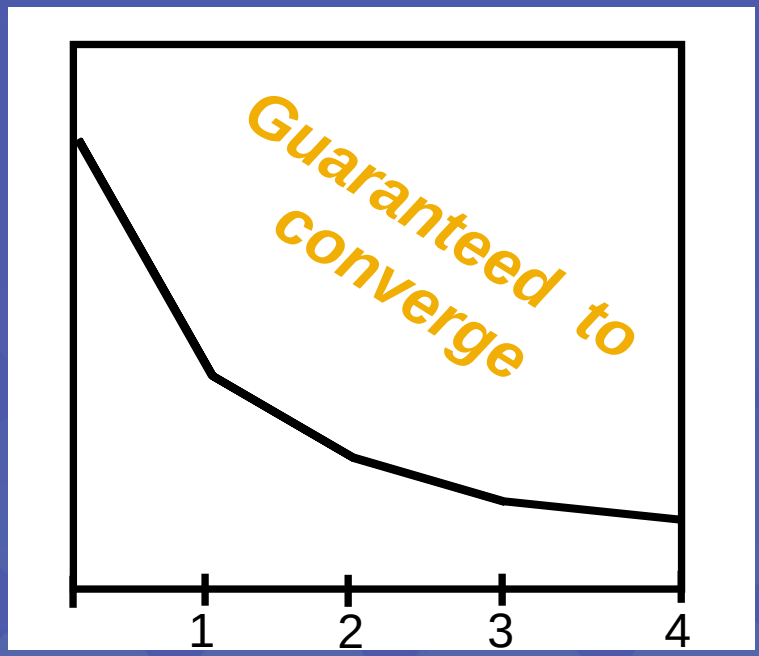
$$\arg\min_{\Theta} E(\mathbf{S}, \Theta, \mathbf{x}, \lambda)$$

$$\arg\min_{\mathbf{S}} E(\mathbf{S}, \Theta, \mathbf{x}, \lambda)$$

K-means for learning colour distributions

Graph cuts to infer the segmentation

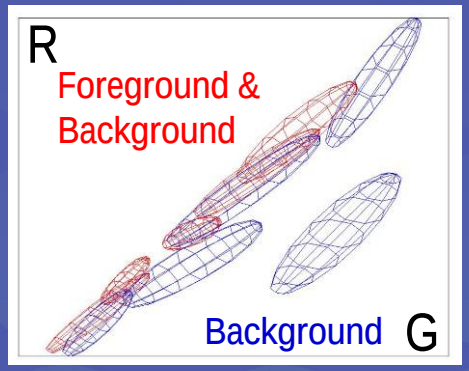
Iterated Graph Cuts



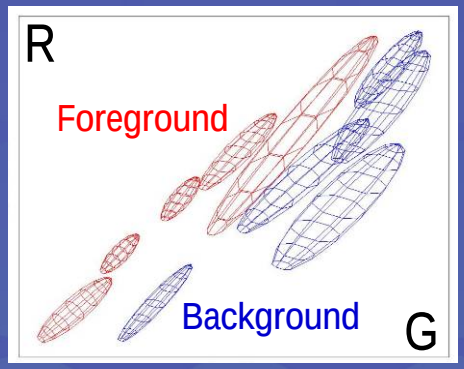
Result

Energy after each Iteration

Colour Model



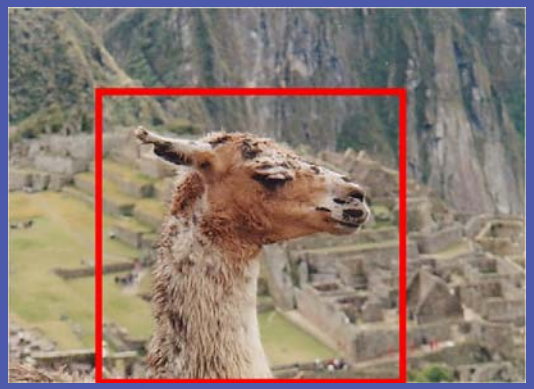
Iterated
graph cut



Gaussian Mixture Model (typically 5-8 components)

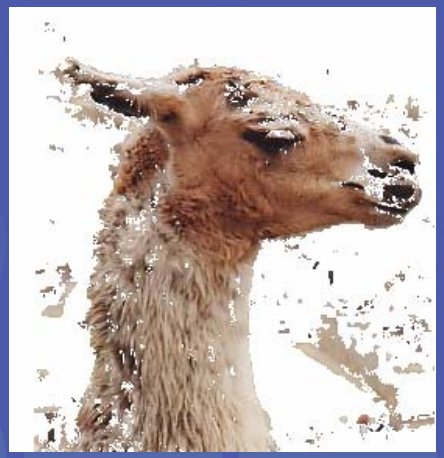
$$E_{Col}(\Theta, \mathbf{S}, \mathbf{x}) = \sum_{\mathbf{n}} \mathbf{D}(\mathbf{S_n}, \Theta, \mathbf{x_n})$$

Coherence Model



An object is a coherent set of pixels:

$$E_{coh}(\mathbf{S}, \mathbf{x}, \lambda) = \lambda \sum_{i,j \text{ adj.}} (S_i \neq S_j)\ exp\{-\frac{1}{2\sigma^2}||x_i - x_j||^2\}$$



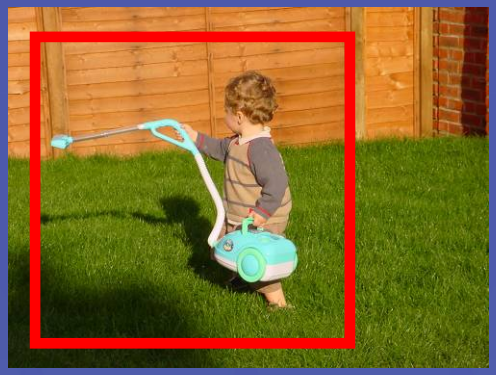
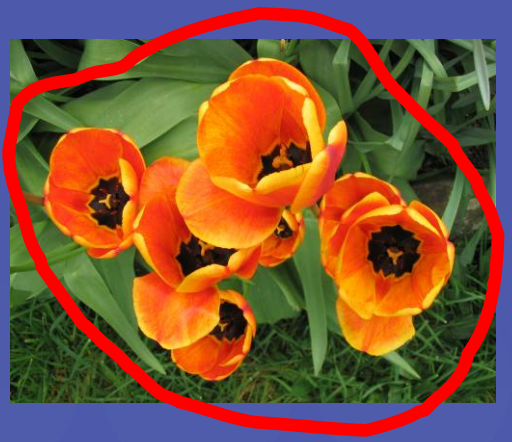
$\lambda = 0$

$\lambda = 50$

$\lambda = 1000$

Blake et al. (2004): Learn Θ, λ jointly

Moderately straightforward examples



… GrabCut completes automatically

Difficult Examples

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Camouflage & Low Contrast

Fine structure

No telepathy

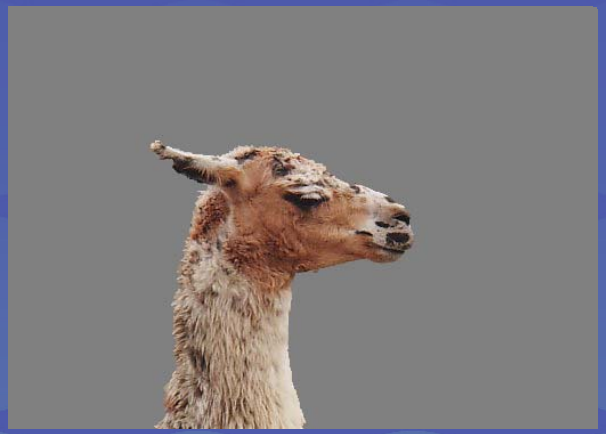
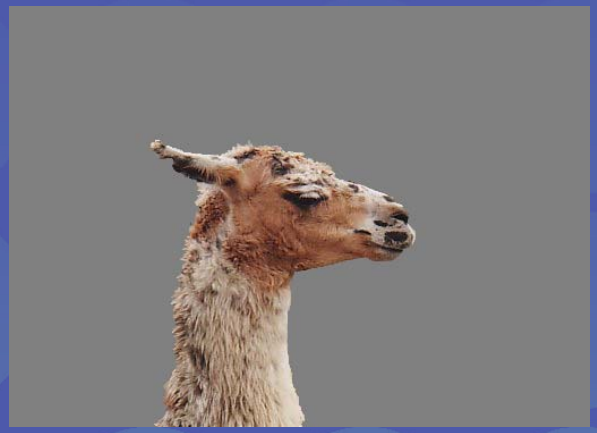
Initial Rectangle

Initial Result

Evaluation – Labelled Database

Available online: http://research.microsoft.com/vision/cambridge/segmentation/

Comparison

	Boykov and Jolly (2001)	GrabCut
User Input		
Result		
	Error Rate: 0.72%	Error Rate: 0.72%

Summary










Magic Wand (198?)

Intelligent Scissors Mortensen and Barrett (1995)

Graph Cuts Boykov and Jolly (2001)

LazySnapping Li et al. (2004)

GrabCut Rother et al. (2004)

Conclusions

- GrabCut – powerful interactive extraction tool
- Iterated Graph Cut based on colour and contrast
- Regularized alpha matting by Dynamic Programming