Cool Stuff and Summary

CG10a, Lior Shapira, Lecture 12

התכנית להיום

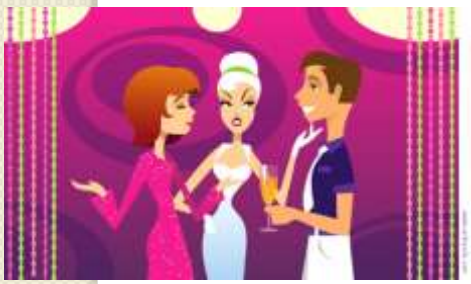
- עבודות מעניינות מהזמן האחרון
  - Diffusion Curves
  - Symmetrization
- מבוא קצר ל-Programmable Pipeline Rendering
- סיכום הקורס

Orzan et al, SIGGRAPH 2008

DIFFUSION CURVES

Vector Graphics

- Vector Graphics is the use of geometrical primitives such as , , and , all of which are based on equations to represent images



A little history

- Calligraphic displays (Whirlwind I – 1950)

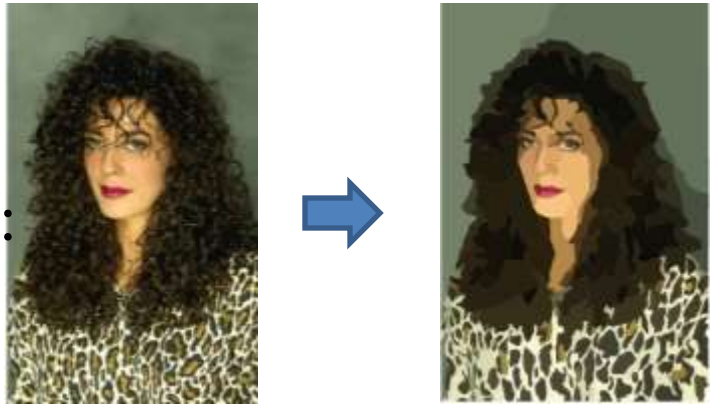
- Sketchpad, invented in 1963, by Ivan Sutherland

- Games like asteroids and space wars

Related Work

- ArDeco system [Lecot et al]

And not so good:



Related Work

- Gradient Meshes
  - First introduced in commercial tools like Adobe Illustrator and Corel CorelDraw

Original raster

LiveTrace by Adobe

Representation

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- Gradient Meshes
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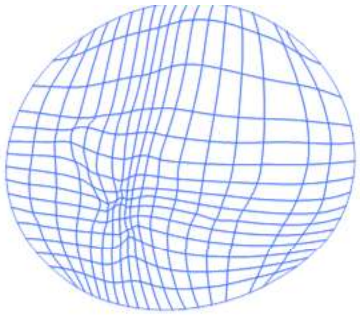
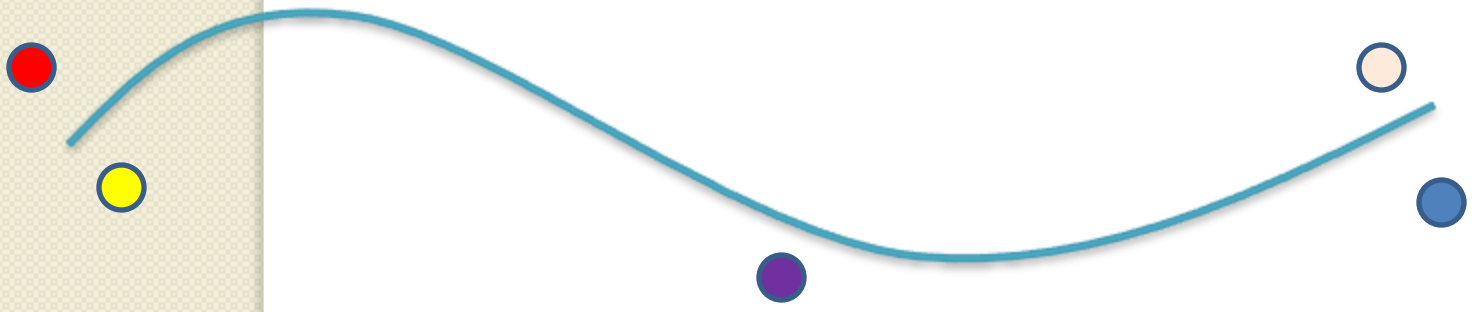
Original raster

Optimized Gradient Mesh



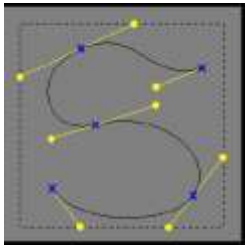
Representation

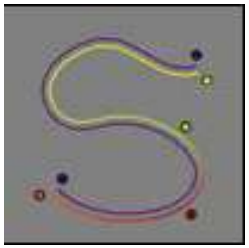
DIFFUSION CURVES



Definition

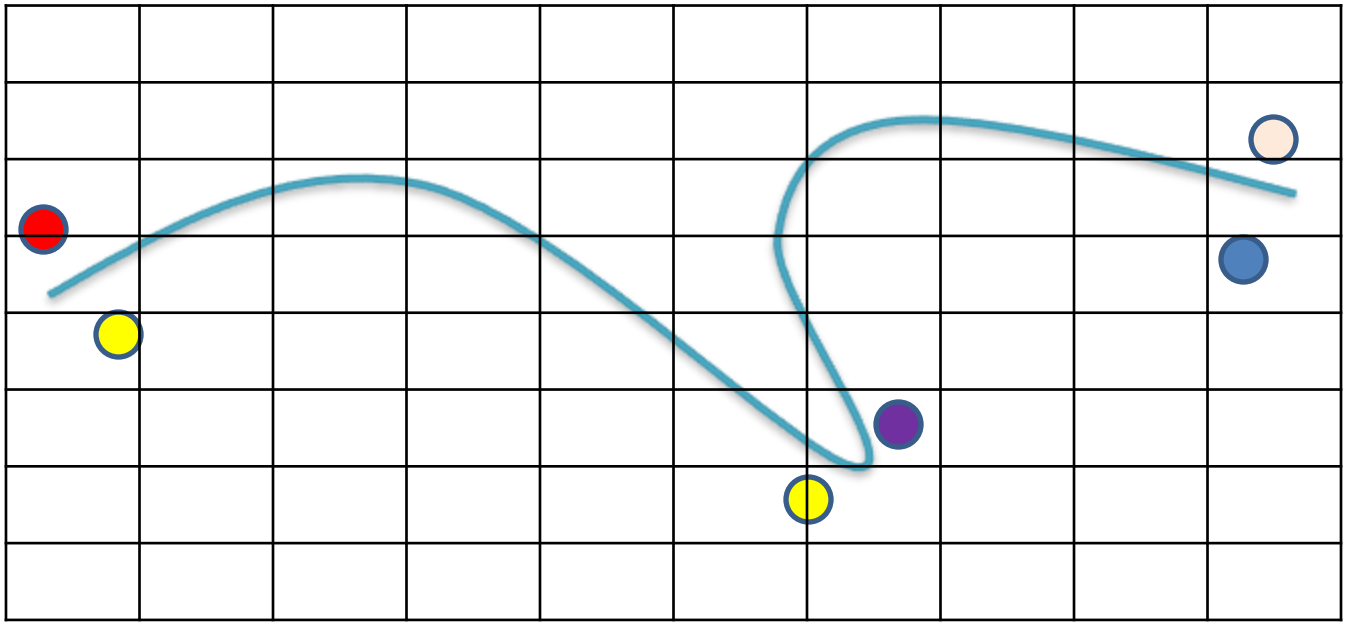
- A diffusion curve is a geometric curve defined as *cubic Bezier splines*
- The geometry is augmented with additional attributes
  - Two sets of color control points C_l and C_r
  - A set of blur control points (Σ)





Rendering Model

1. **Compute color sources image**
2. Diffuse color sources iteratively
3. Blur resulting sharp image



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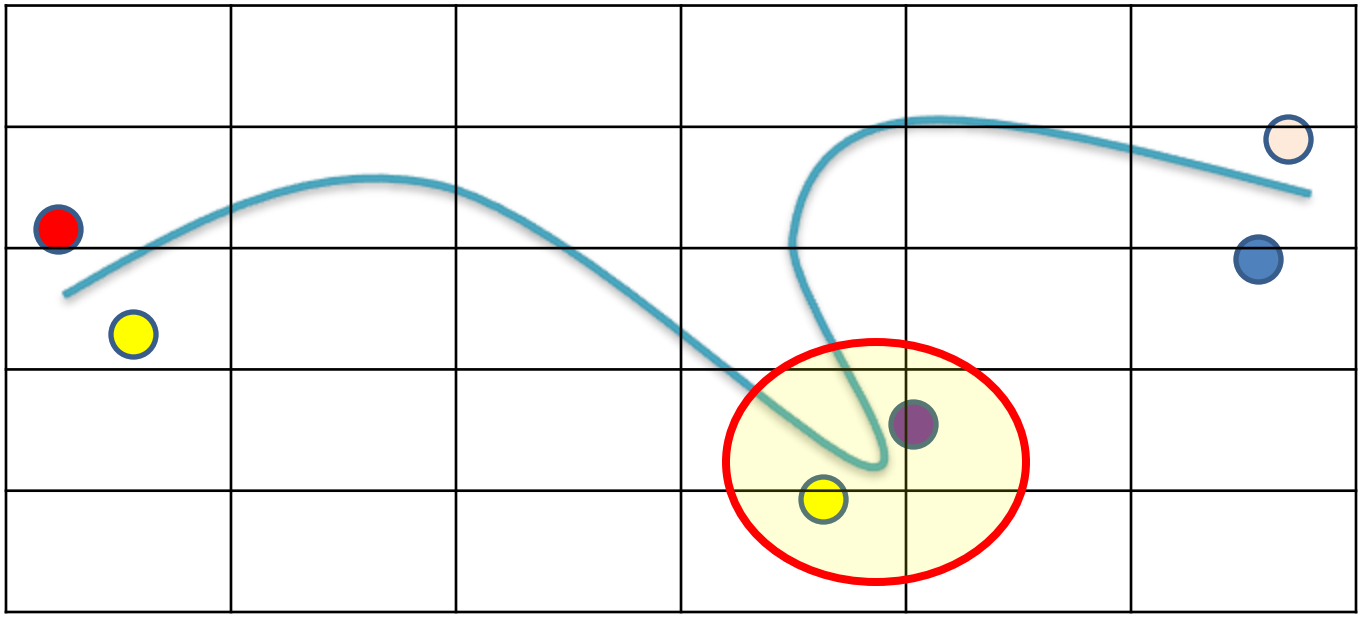

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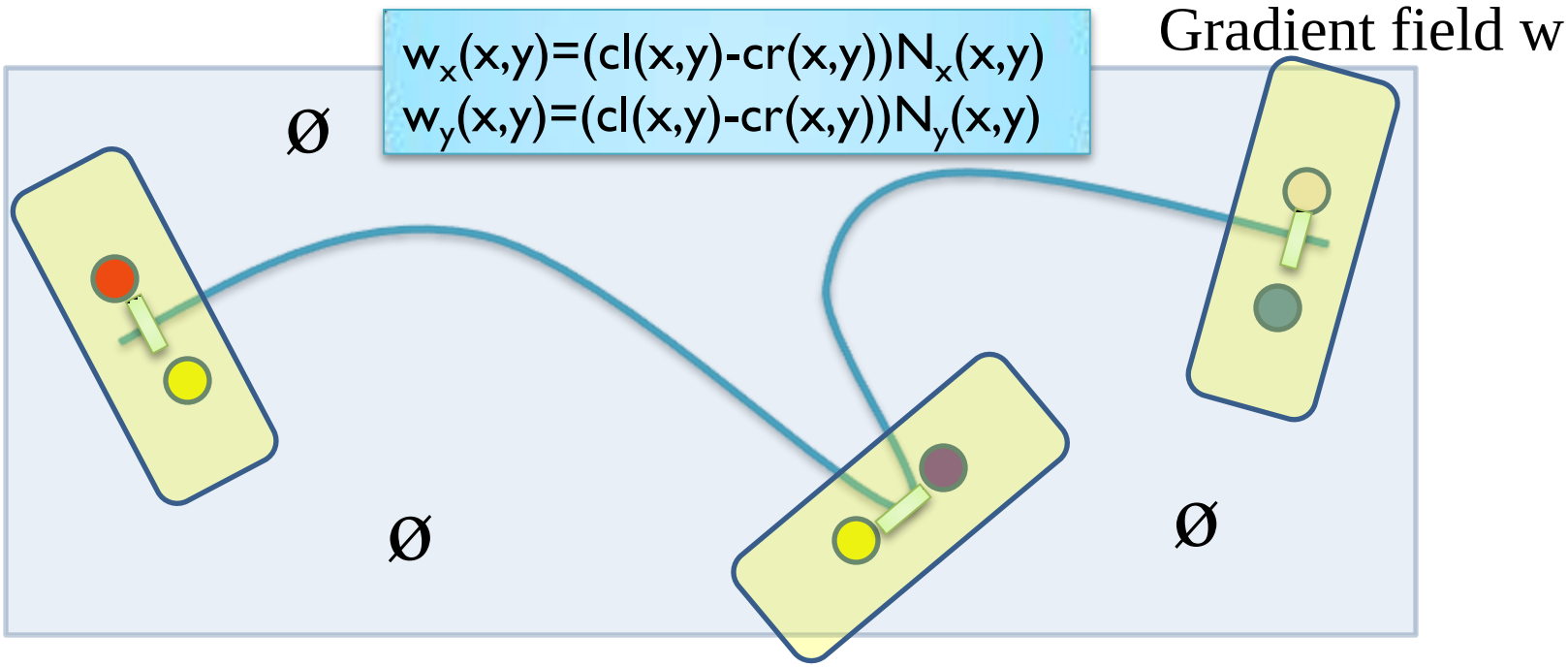
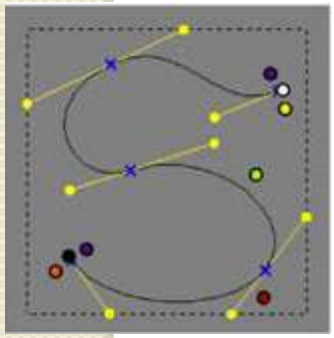


Compute color sources image



Diffusion curves

Color map

Wx

Wy

Diffusion

Diffuse color sources

- Target: Color image *I*
- Constraints:
  - $\Delta I = \text{div } w$
  - $I(x,y) = C(x,y)$ if pixel(x,y) stores a value

Partial differential equation a.k.a the Poisson equation

Partial differential equations

- The prototypical eliptic equation

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = \rho(x, y)$$

Poisson Equation

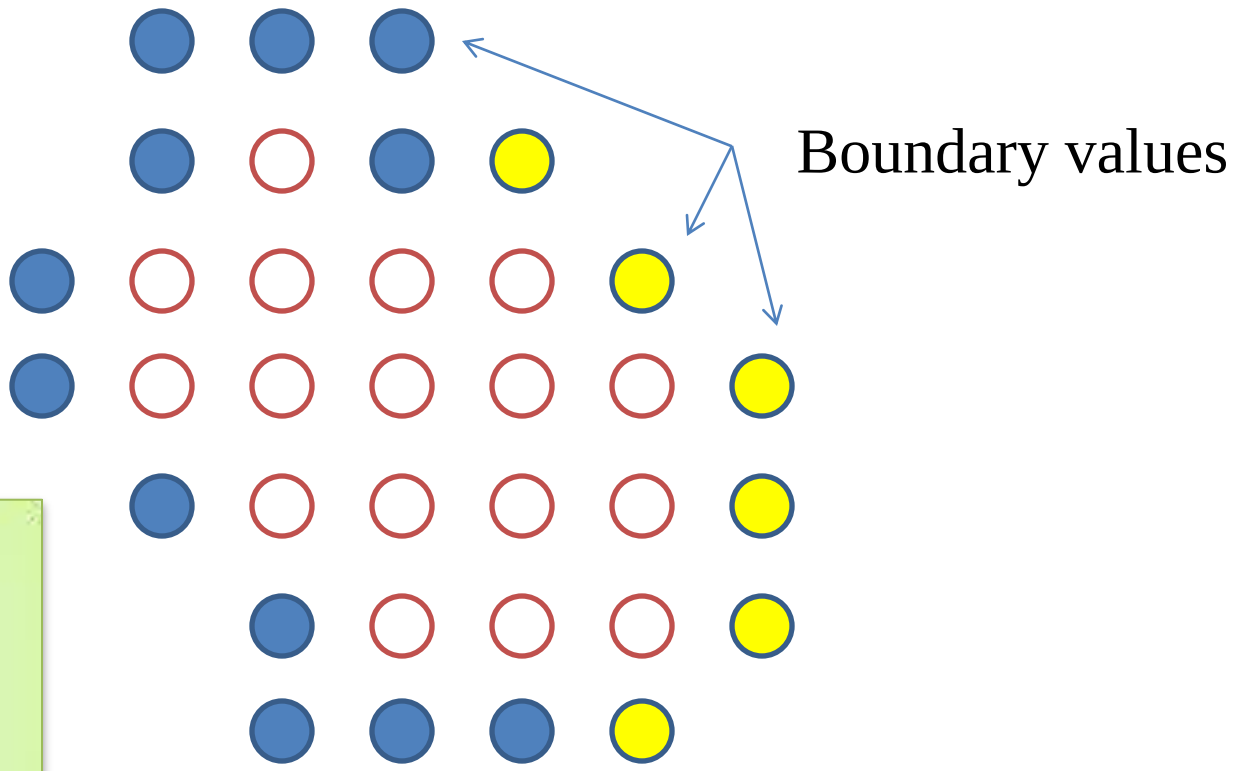
$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$$

Laplace's Equation

- Our goal: to find u(x,y) which satisfies the equation within a region of interest

Boundary value problems

Boundary value problems



Important questions:

1. What are the variables?
2. What equations should be satisfied in the interior?
3. What boundary conditions exist?

Solving by finite-differences

- u(x,y) is known at a discrete set of points

$$x_j = x_0 + j\Delta, \quad j = 0,1,\ldots,J$$

$$y_i = y_0 + i\Delta, \quad j = 0,1,\ldots,L$$

- Can rewrite the Poisson equation

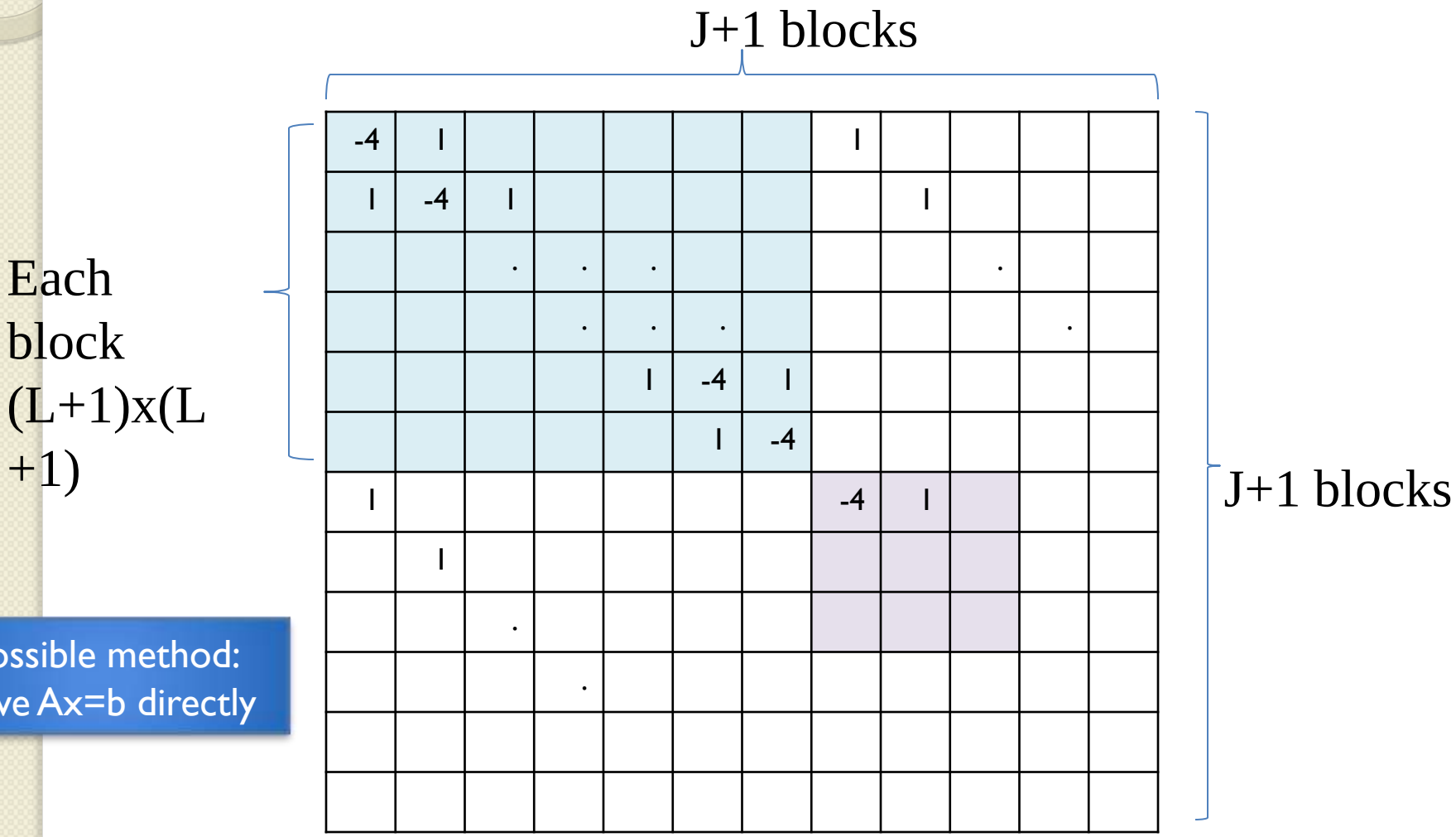
$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = \rho(x,y) \quad \Rightarrow \quad \frac{u_{j+1,l} - 2u_{j,l} + u_{j-1,l}}{\Delta^2} + \frac{u_{j,l+1} - 2u_{j,l} + u_{j,l-1}}{\Delta^2} = \rho_{j,l}$$

- And formulate as a set of equations

$$A \cdot u = b$$

Solving by finite-differences

- A is a "tri-diagonal with fringes" matrix

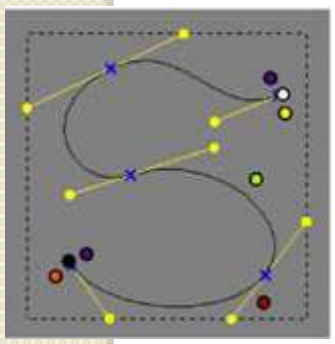


Possible method: solve Ax=b directly

Multigrid

- First introduced by Brandt in the 1970's
- Benefits
  - Solve elliptic PDE's on N grid points in O(N)
  - Solve with non-constant coefficients with hardly any loss in efficiency
  - Solve nonlinear equations with "good" speed
  - Implemented on the GPU [Goodnight et al 2003]

Blur resulting sharp image



Color map

Wx

Wy

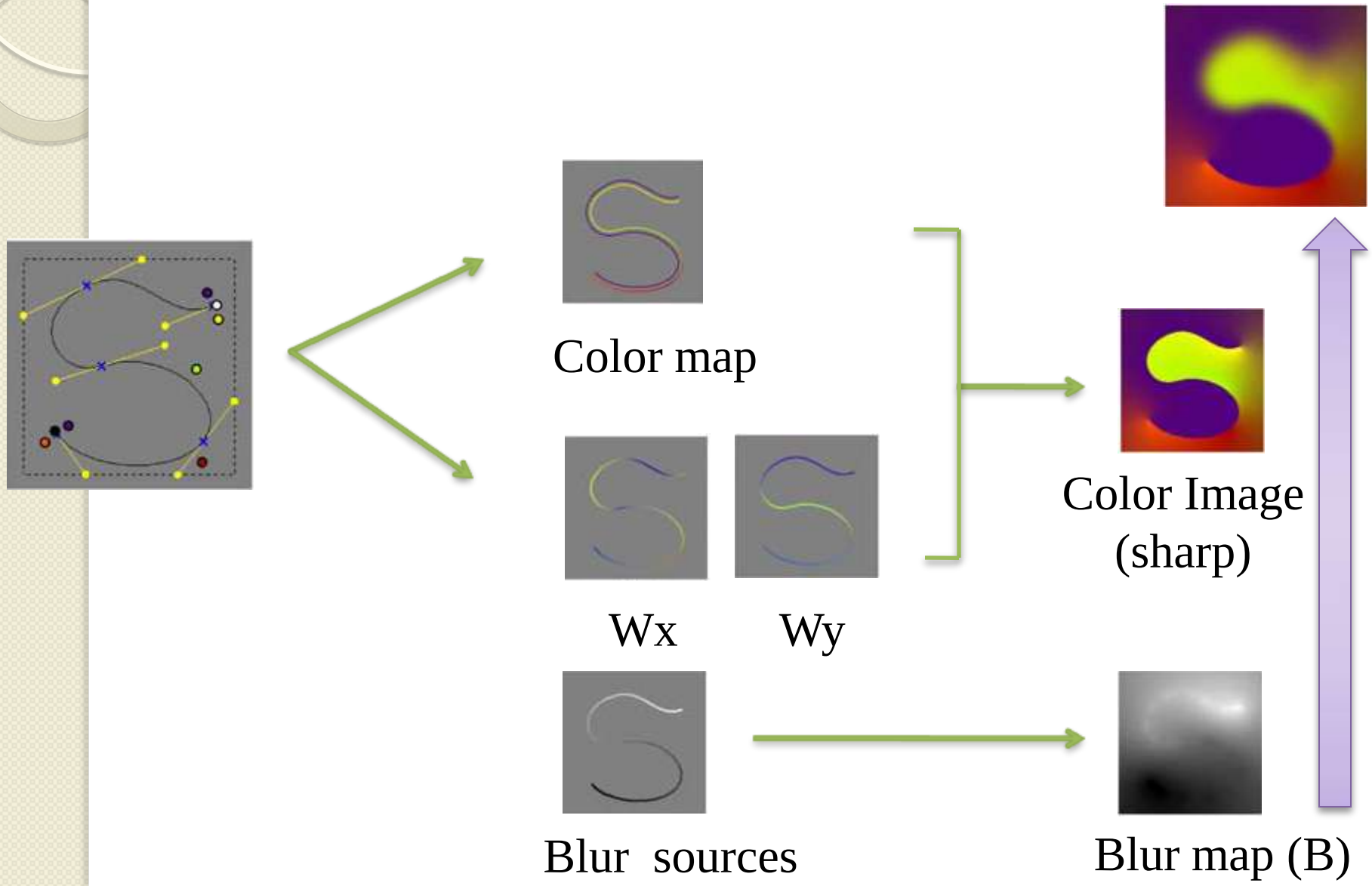
Color Image (sharp)

- ΔB=0
- B(x,y)=σ(x,y) if pixel (x,y) is on curve

Blur sources

Blur map (B)

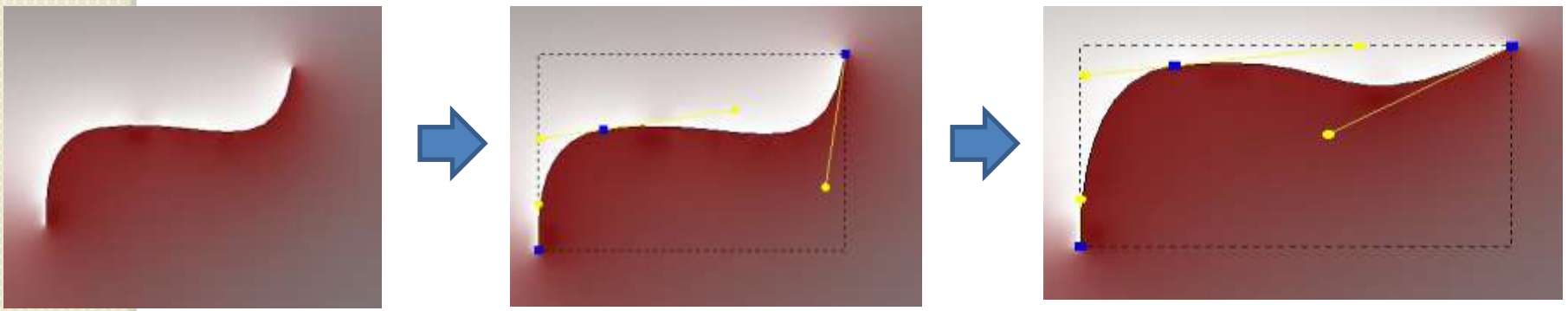
Create final color image (blurred)

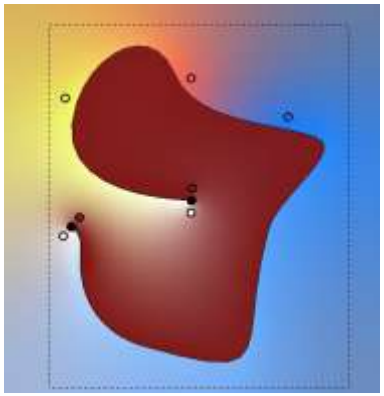


CREATING DIFFUSION CURVES

Manual creation

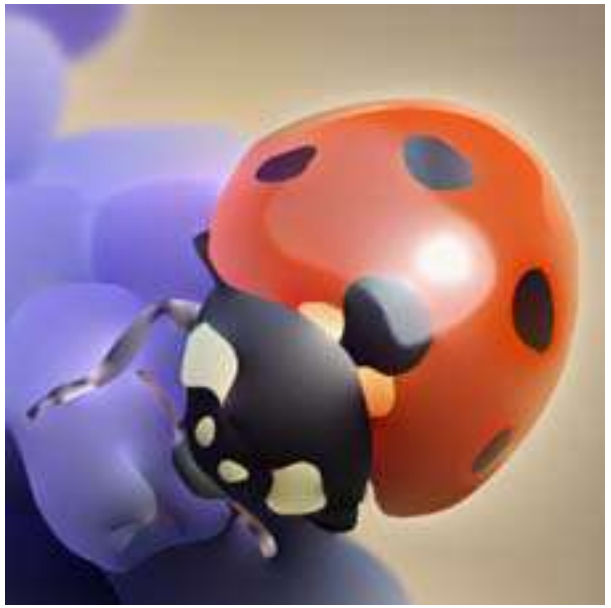
- Curves are intuitive and easy to create





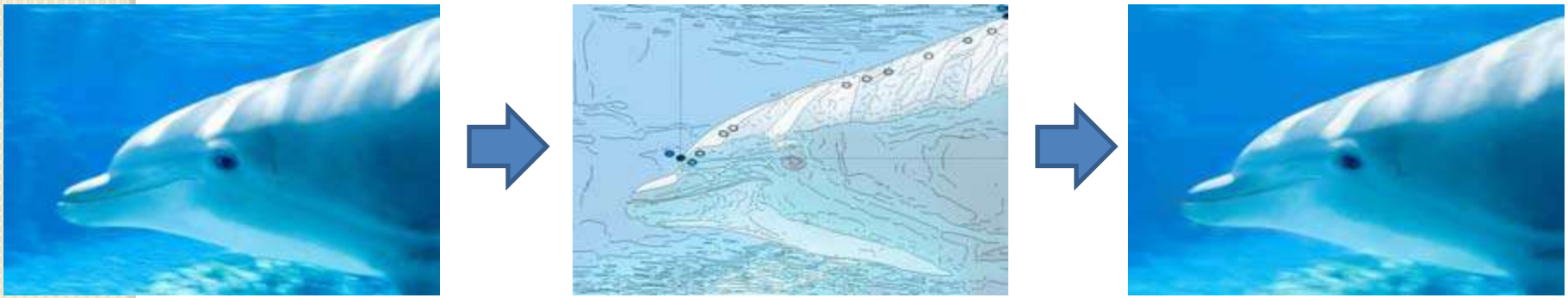
Tracing an image

- Hand drawn curves sample colors from the image
- Active contours **snap** the curves to high gradient values



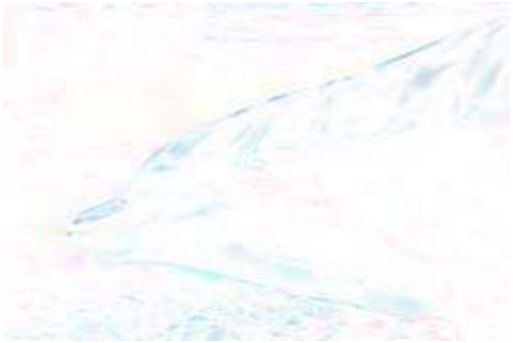
Automatic extraction

- Edge detection + Gaussian scale space are used to extract edges.
- Pixel chains are converted to Bezier curves, colors are sampled along the curves.



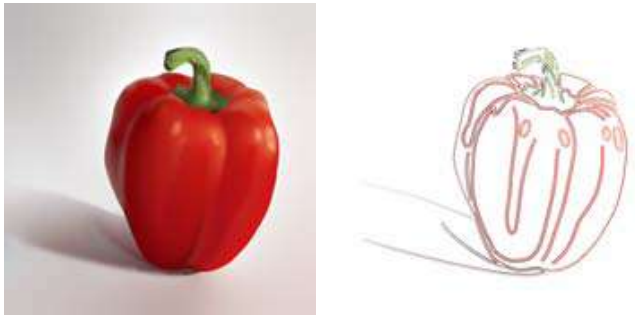
And to compare

Original



Diffusion Curves

Results



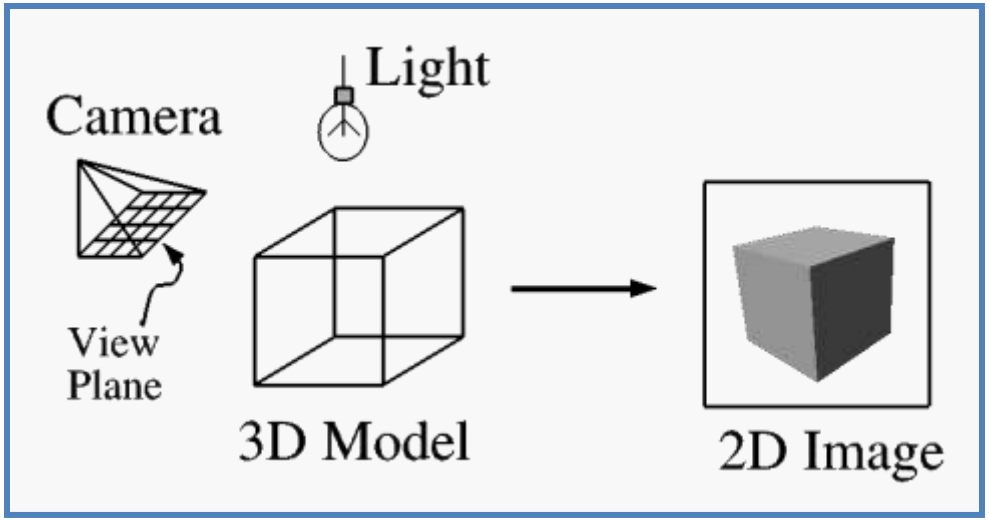
Gradient Meshes

Diffusion Curves

COURSE SUMMARY

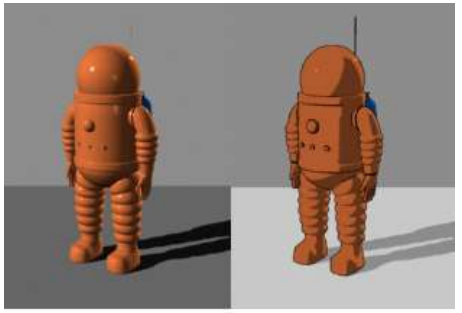
מטרות הקורס

- מהי גרפיקה ממוחשבת?
  - Imaging = *representing 2D images*
  - Modeling = *representing 3D objects*
  - Rendering = *constructing 2D images from 3D models*
  - Animation = *simulating changes over time*

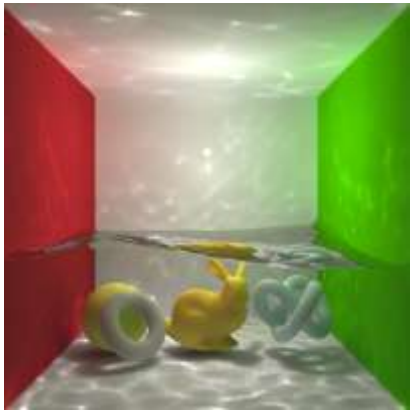


מה לא למדנו?

- Computer Vision
- Non-photorealistic rendering



- Advanced rendering techniques (shaders)
- Video processing and manipulation



- Computational Photography
- … oh so much more

ללמוד עוד

- באוניברסיטת תל אביב
  - נושאים מתקדמים במידול וחישוב ויזואלי (דניאל כהן-אור), סמסטר ב' (4164)
  - סמינר בחישוב ויזואלי ומידול גיאומטרי (דניאל כהן אור), סמסטר ב' (3327)
  - תזה לתואר שני
    - פרופסור דני כהן-אור (גרפיקה ממוחשבת, עיבוד תמונה)
    - ד"ר ליאור וולף (ראייה ממוחשבת, זיהוי תבניות, עיבוד תמונה)
- האינטרנט

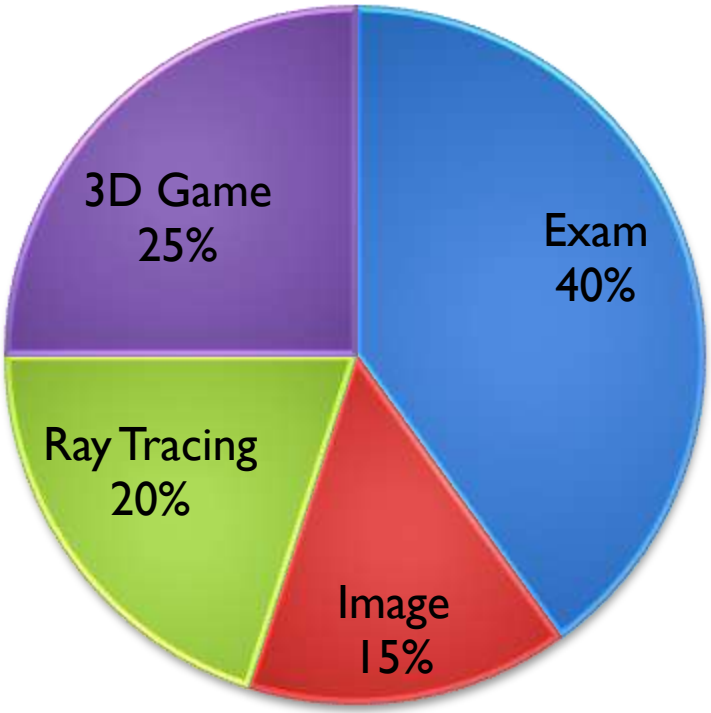
המבחן

- Date: 10/2/10 (Bet – 12/03/10)
- Similar to last year's exam (links on course website)
- Exam consists of
  - Multiple choice questions (20-25)

מה המטרה של Ambient lighting?

1. קירוב מאוד גס ל-Global illumination
2. תוספת אור לגופים אשר הנם מקורות אור בסצינה
3. יצירת אווירה רכה בסצינה, סוג של blurring
4. אור הנכנס לגופים שקופים למחצה ומתפזר לכיוונים שונים

הציון



שימו לב שהציון הסופי בקורס יינתן רק כחודש לאחר הגשת תרגיל 3!