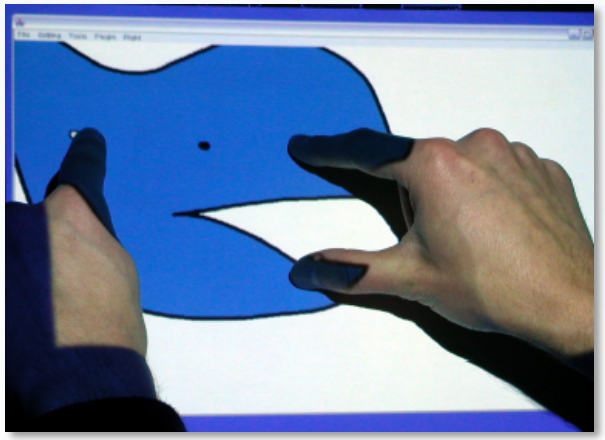
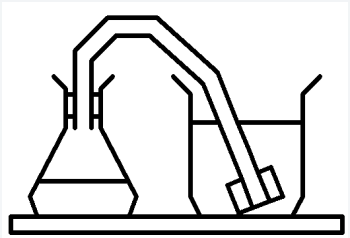
Week 2

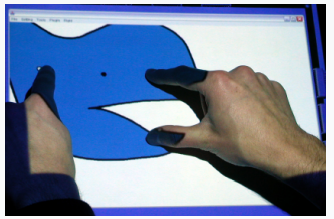
2D Drawings and Animations

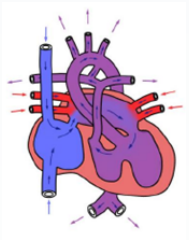


2D Drawings and Animations

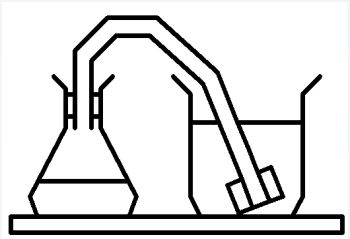
- Diagram Beautification
- Pen-and-ink Textures
- Shape Manipulation
- Dynamic Illustrations







2D Drawings and Animations

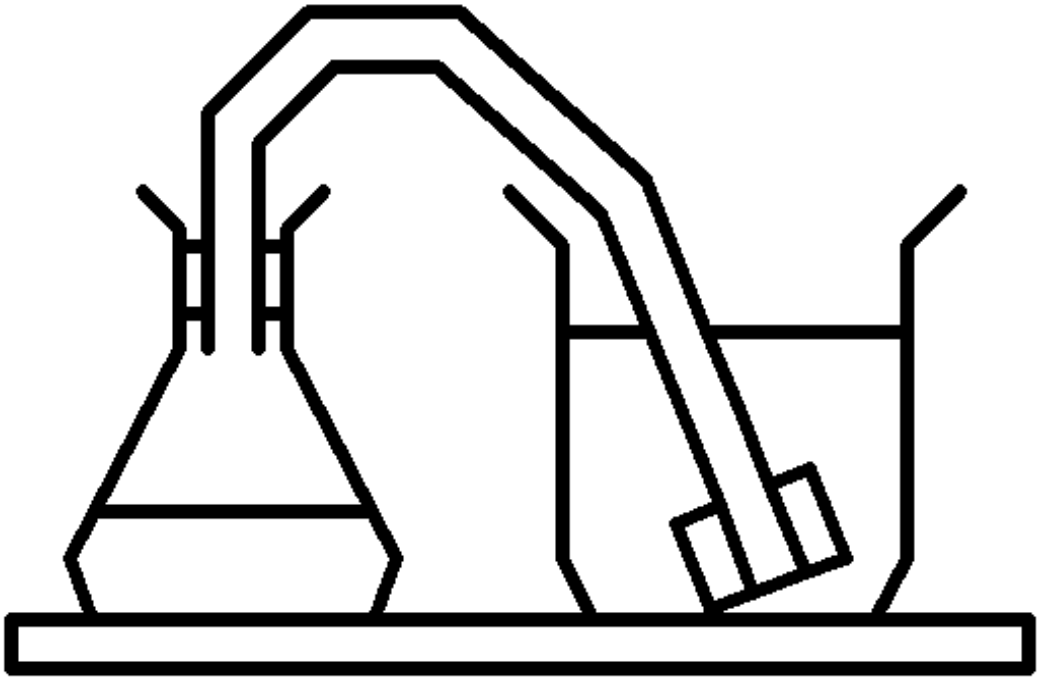


- Diagram Beautification
- Pen-and-ink Textures
- Shape Manipulation
- Dynamic Illustrations

Pegasus:
a Drawing System for Rapid Geometric Design

Takeo Igarashi, Sachiko Kawachiya,
Satoshi Matusoka, Hidehiko Tanaka

Problem



How do you draw this?

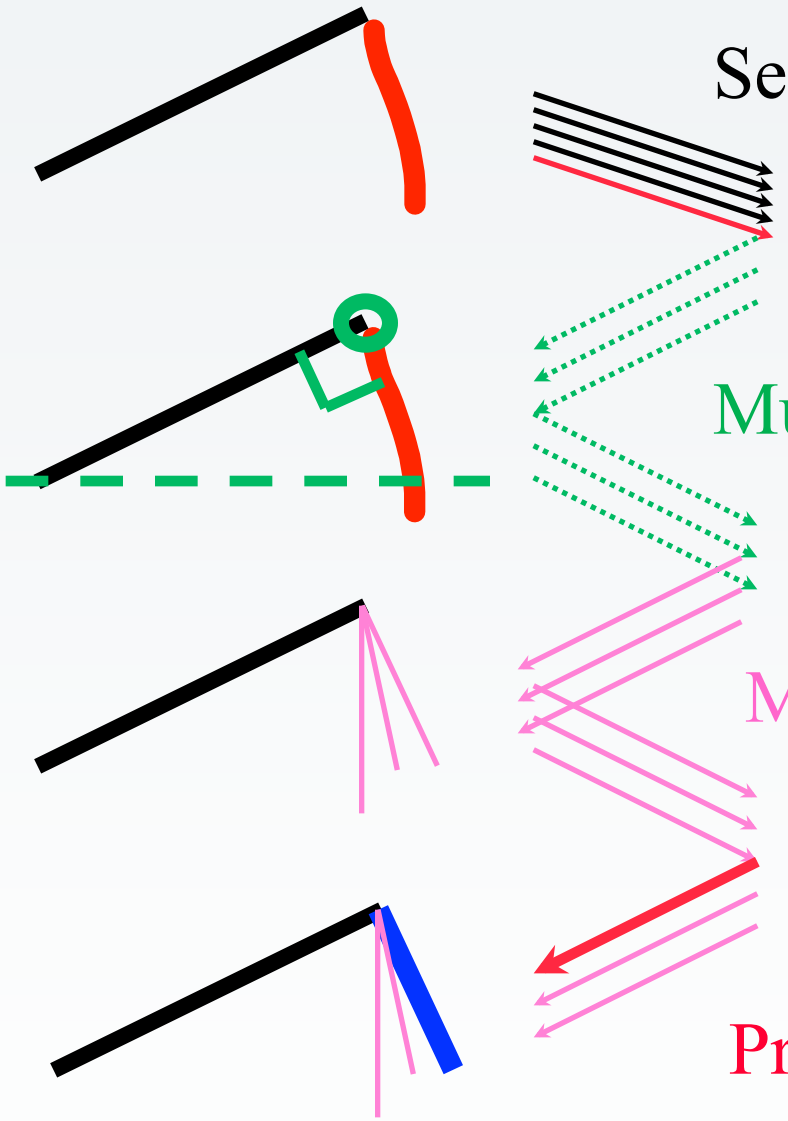
Demo

pegasus

Algorithm

1. Beautification
2. Prediction

1. Beautification Algorithm



Segment coordinates

Constraint Inference

Multiple equations

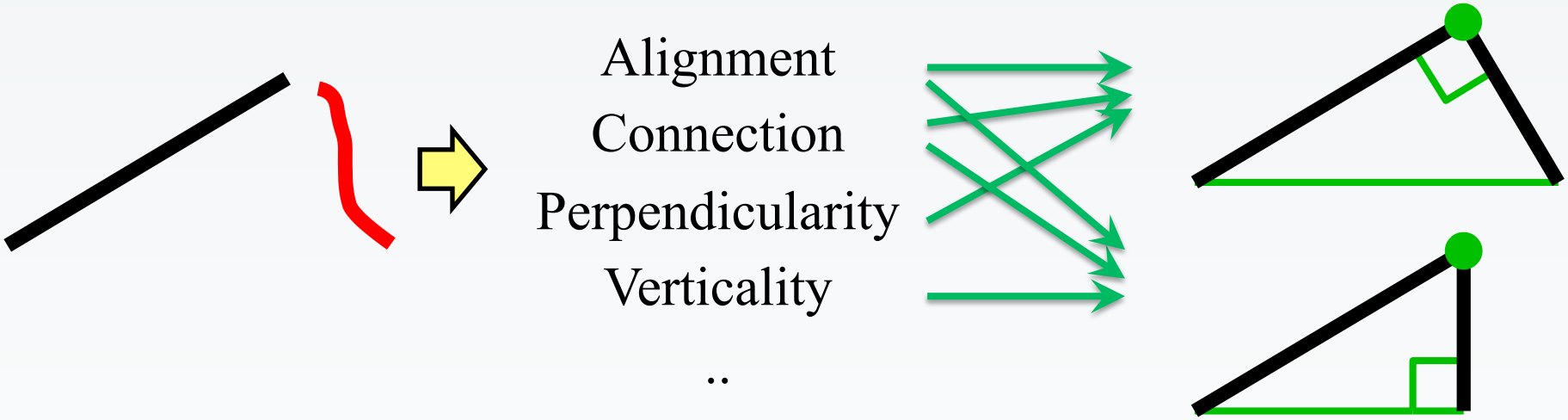
Constraint Solver

Multiple candidates

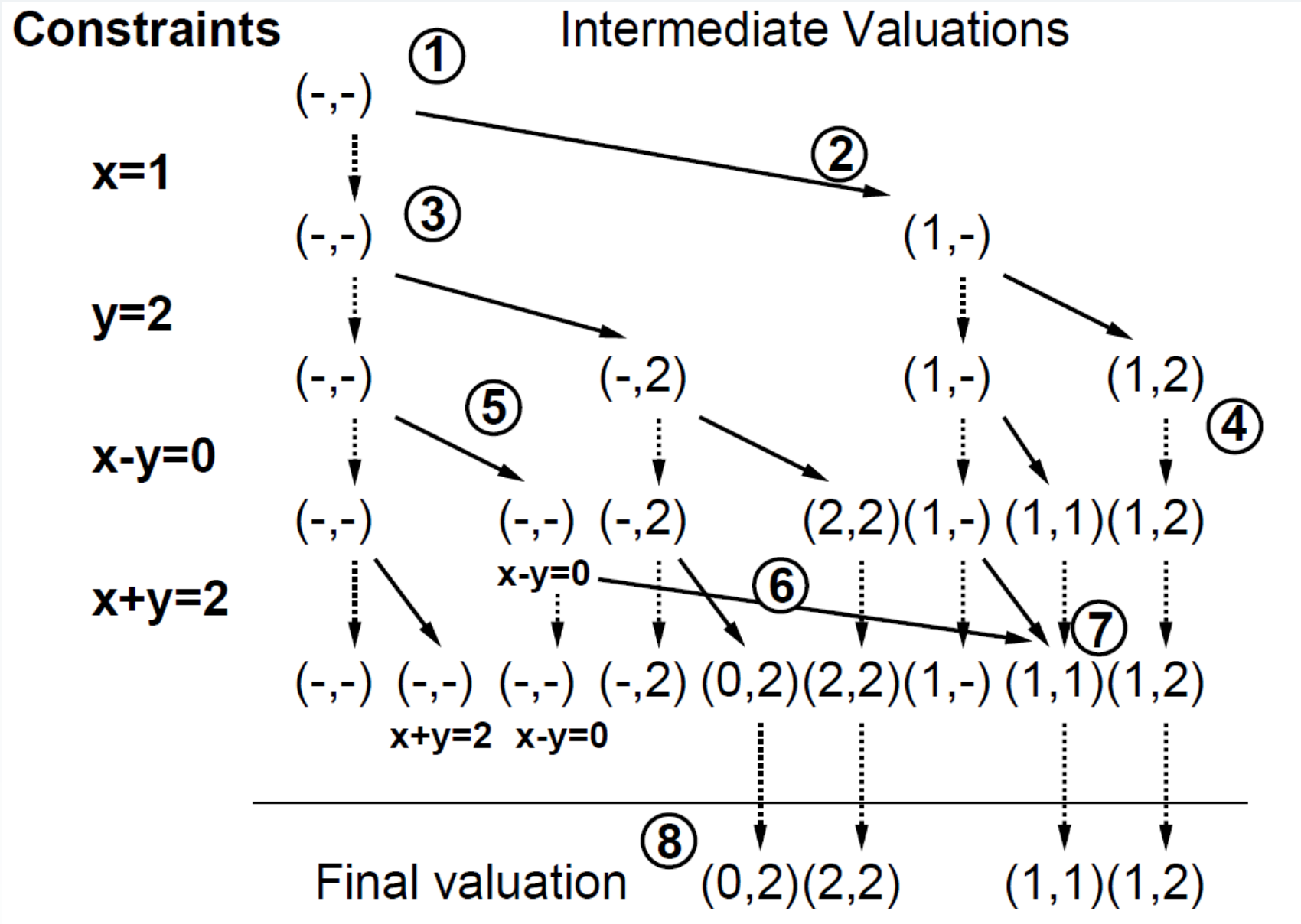
Candidate Evaluation

Primary candidate

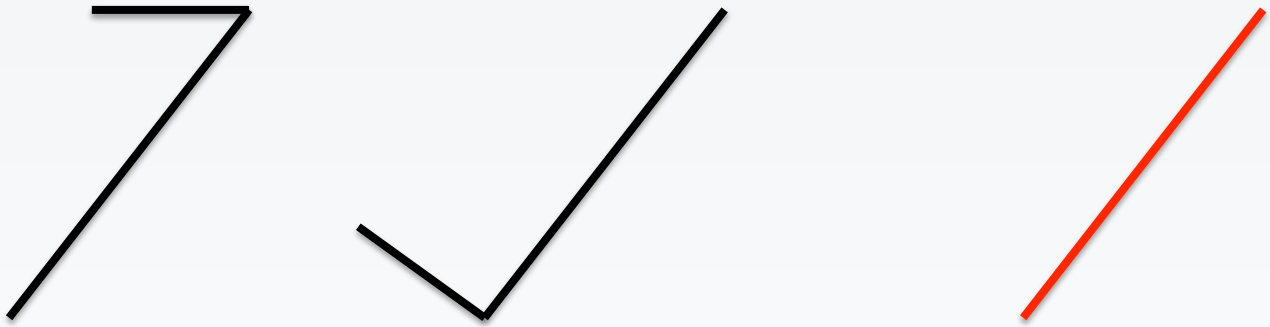
Constraint Solver



Find valid combination of constraints.


Constraints
Intermediate Valuations
x=1
y=2
x-y=0
x+y=2
①
②
③
④
⑤
⑥
⑦
⑧
(-,-)
(1,-)
(1,2)
(-,2)
(2,2)
(1,1)
(0,2)
x-y=0
x+y=2
Final valuation

2. Prediction Algorithm



Existing segments

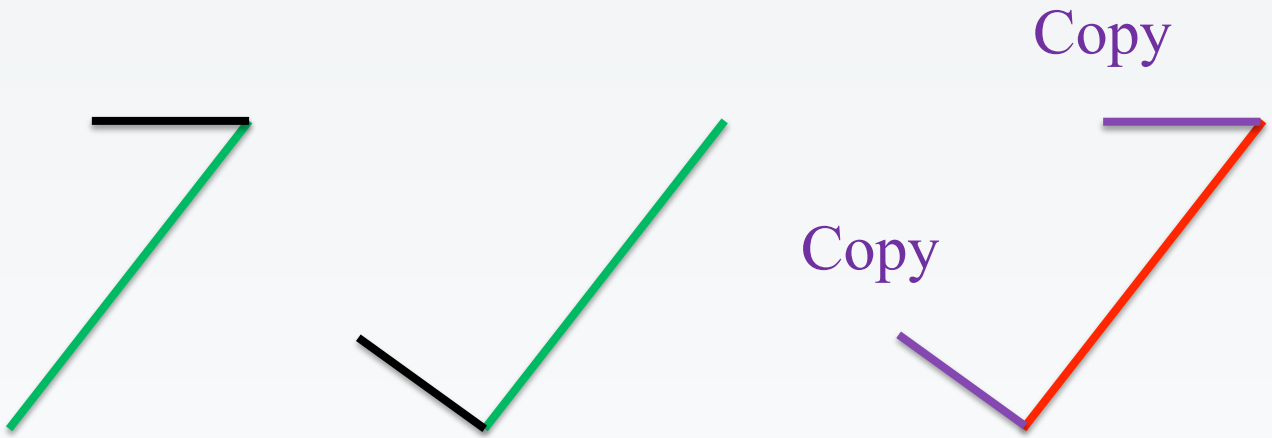
New segment

2. Prediction Algorithm

Existing segments

New segment

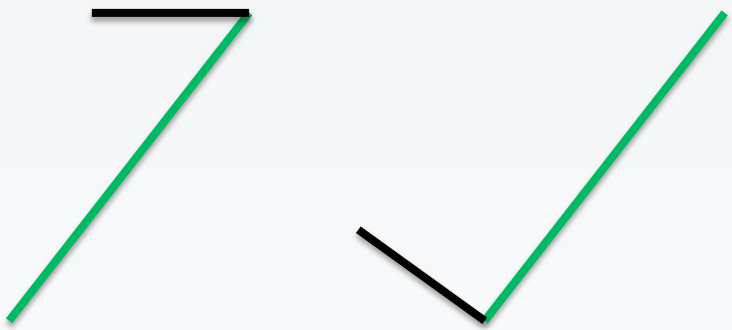
2. Prediction Algorithm



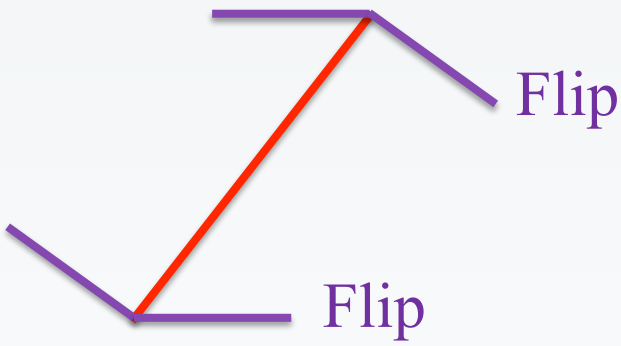
Existing segments

New segment

2. Prediction Algorithm



Existing segments

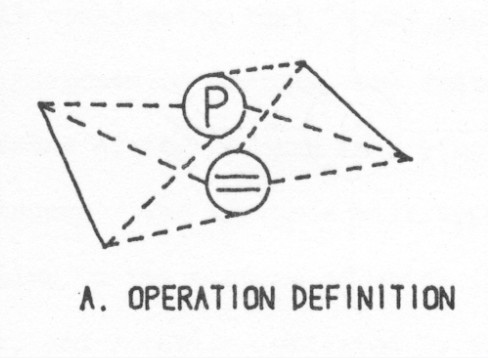


New segment

To Learn More…

The original paper:

- Igarashi, et al. Interactive Beautification: A Technique for Rapid Geometric Design. UIST 1997.

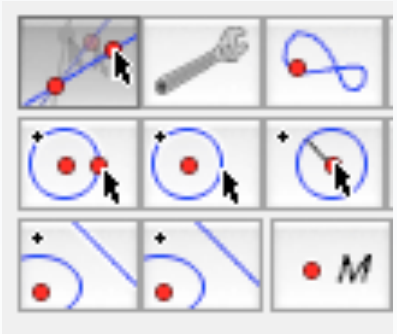


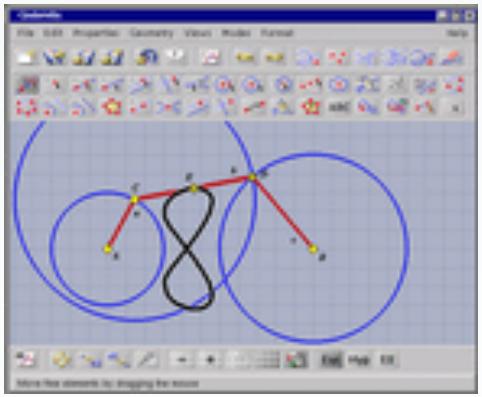
[Sutherland 1963] CC-BY-SA

Constraint-based Drawing:

- Sutherland. Sketchpad: A Man-Machine Graphical Communication System, Spring Joint Comp. Conf. 1963.
  http://www.youtube.com/watch?v=BKM3CmRqK2o

- Richter-Gebert. Cinderella.2.
  http://cinderella.de/

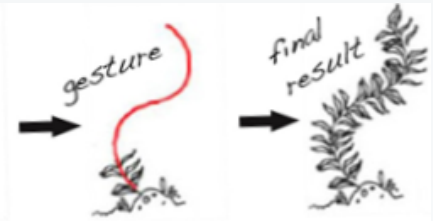




©1997-2011 Jürgen Richter-Gebert and Ulrich Kortenkamp
(Figure obtained from cinderella.de with permission)

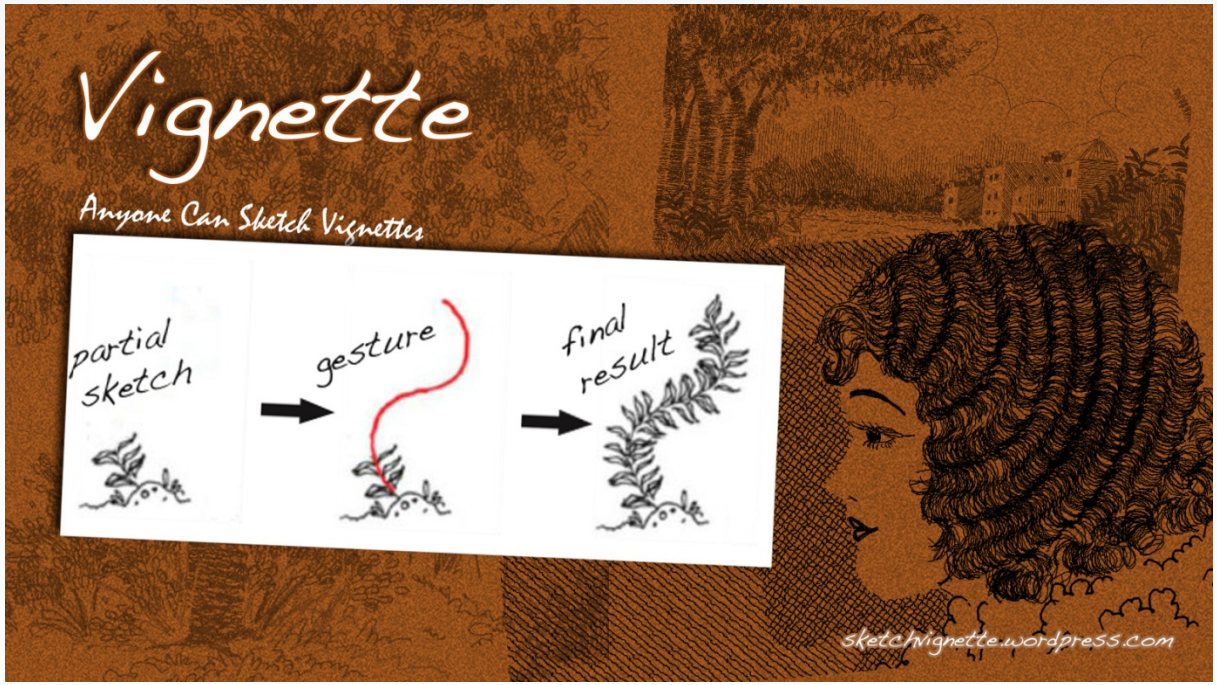
2D Drawings and Animations

- Diagram Beautification
- Pen-and-ink Textures
- Shape Manipulation
- Dynamic Illustrations



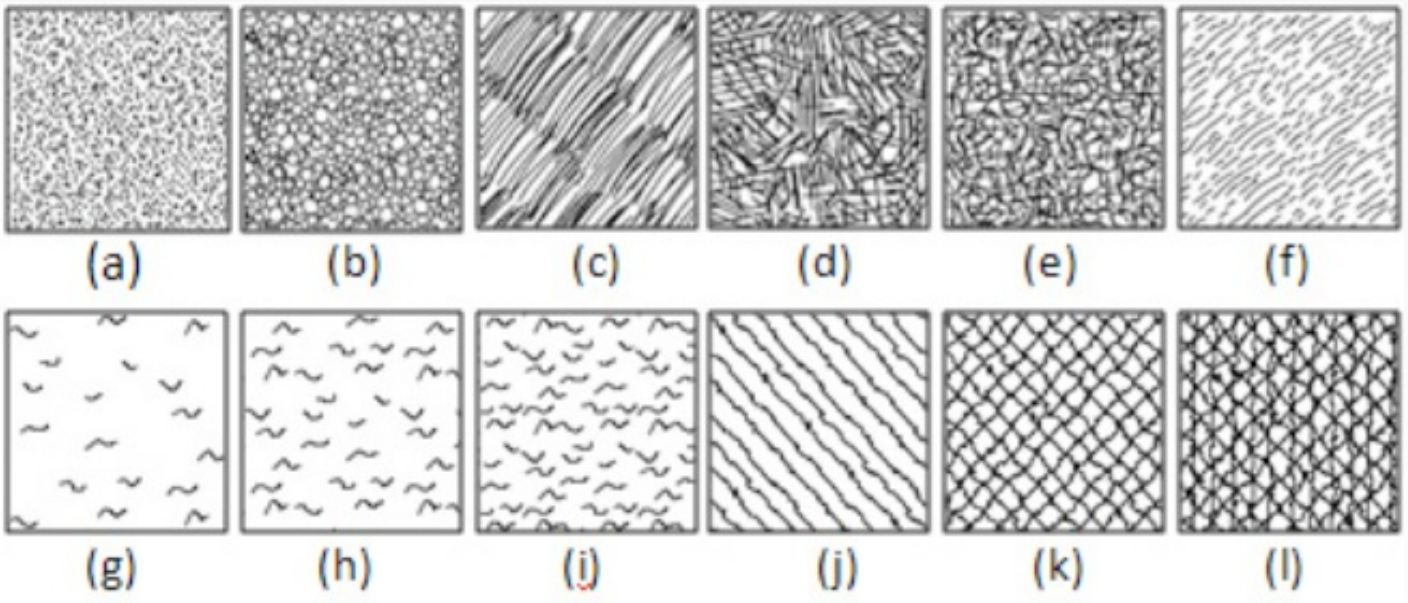
Vignette: Interactive Texture Design and Manipulation with Freeform Gestures for Pen-and-ink Illustration

Rubaiat Habib Kazi, Takeo Igarashi, Shengdong Zhao, Richard Davis



Problem

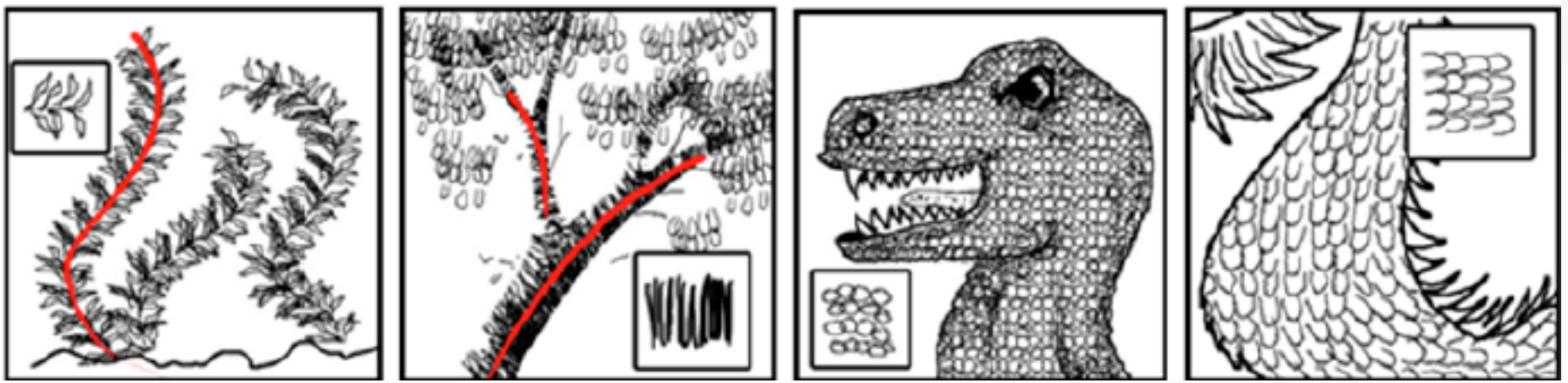
It is tedious to draw detailed patterns manually.
Naïve copy-and-paste looks artificial.



Our Approach

Leverage example-based texture synthesis.

[Ma, et al Discrete Element Textures 2011]



The user draws a part, and the system synthesizes the rest.

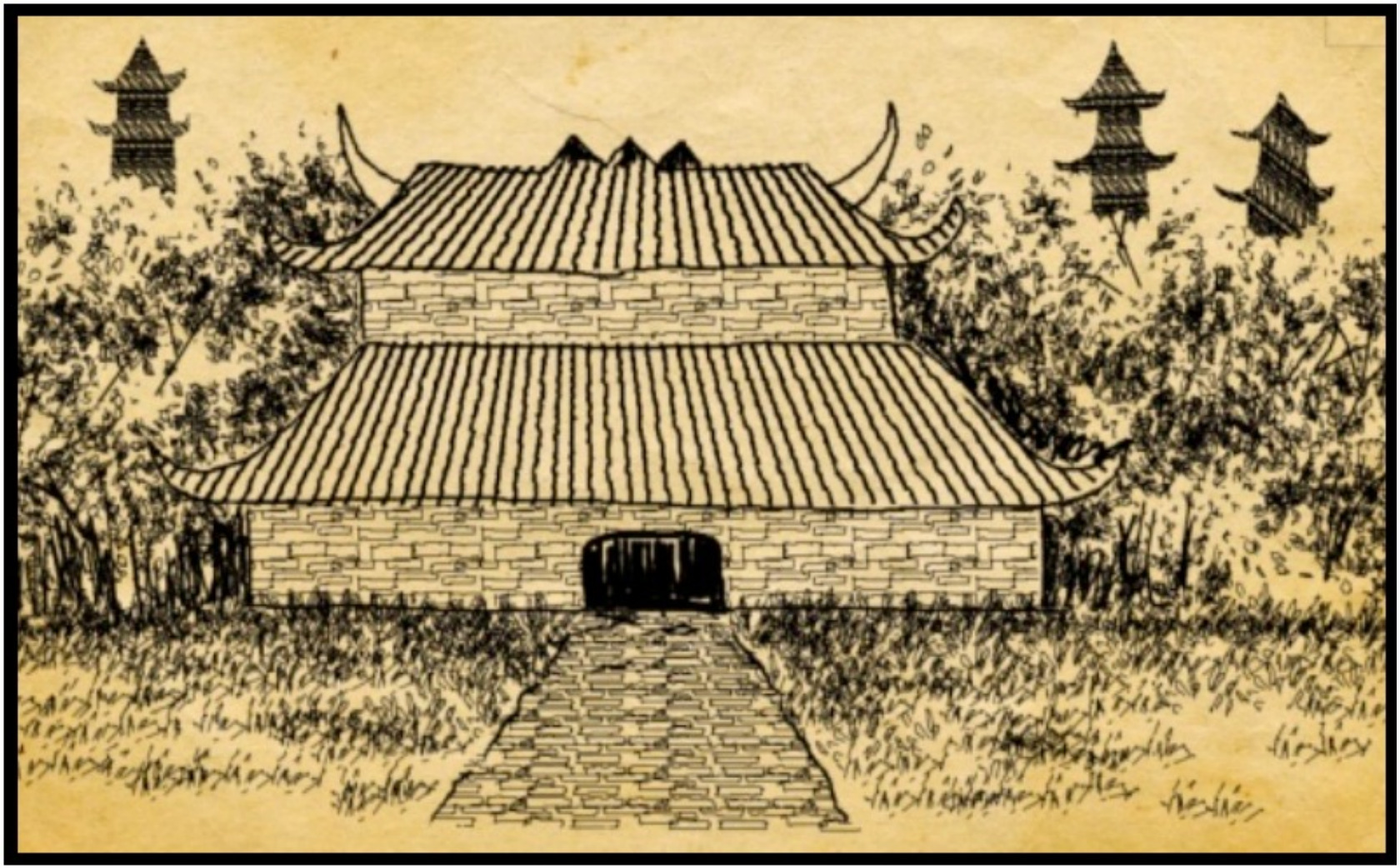
Video

vignette

Results

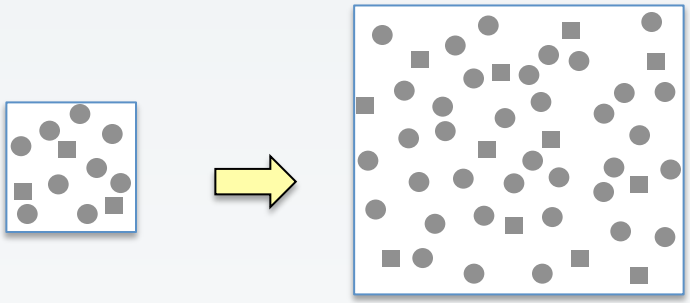
Results

Results



Discrete Element Texture Synthesis

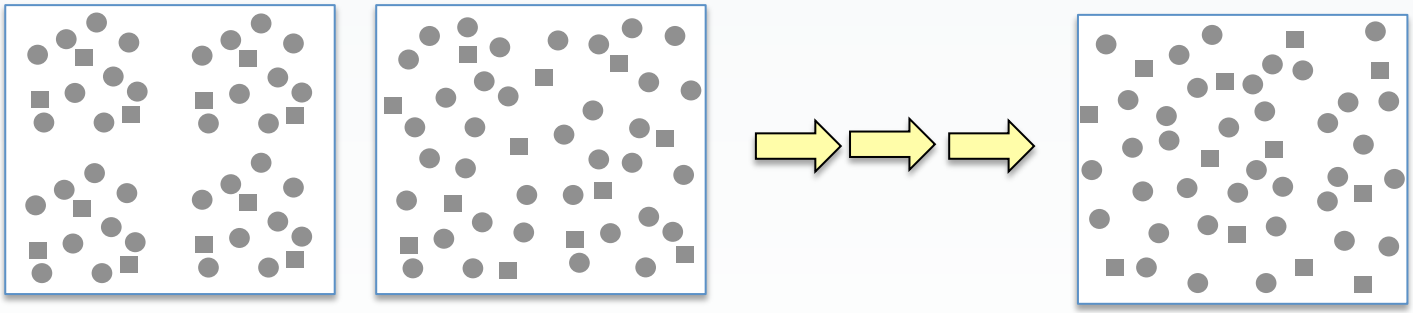
[Ma, et al 2011]



Input {Si}

Output {So}

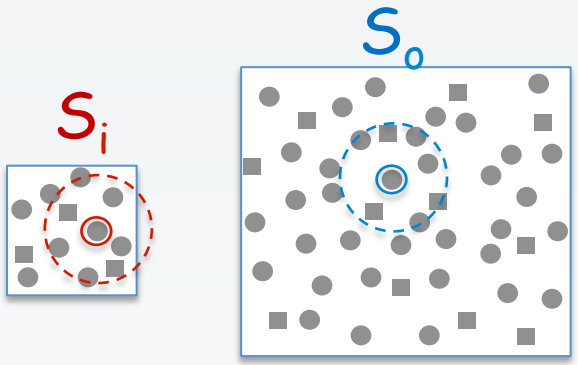
Start with patch-copy, and then iteratively refine it.



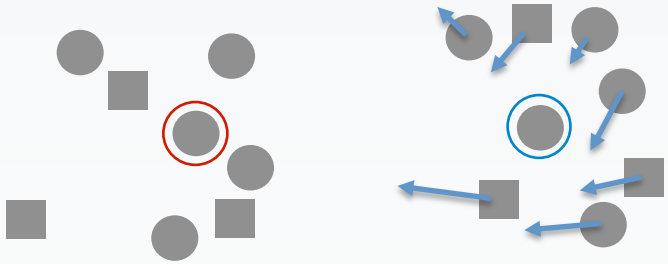
Iterative Refinement

Repeat {

1. For each S_o, find S_i that has similar neighborhood (match).



2. For each match, compute ideal position for neighbors $\{S'_o\}$.



3. Update S_o as average of the ideal positions.

}

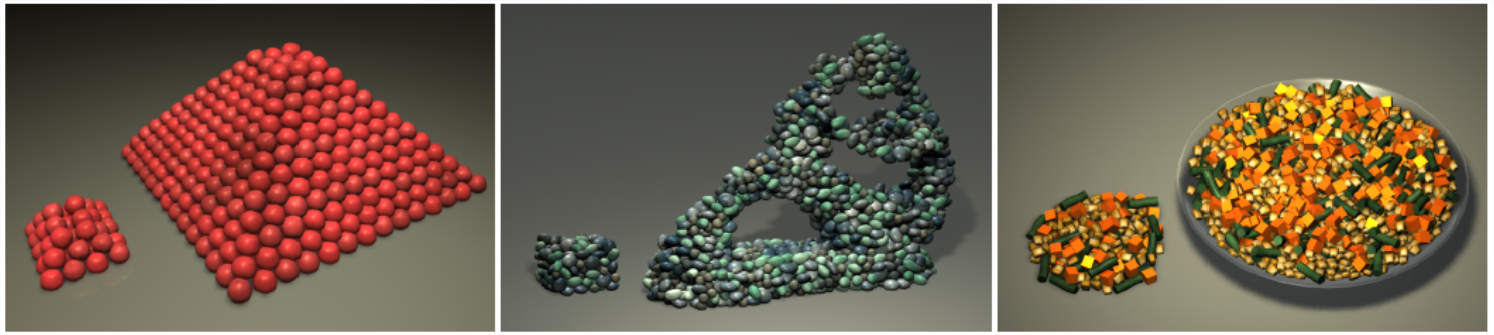
To Learn More…

The original paper:

- Kazi, et al. Vignette: Interactive Texture Design and Manipulation with Freeform Gestures for Pen-and-ink Illustration. CHI 2012.

Element Texture Synthesis:

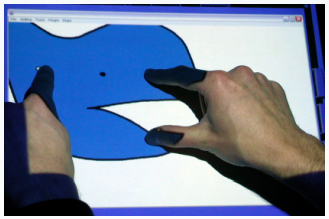
- Ma, et al. Discrete Element Textures. SIGGRAPH 2011.



[Ma, et al. 2011]

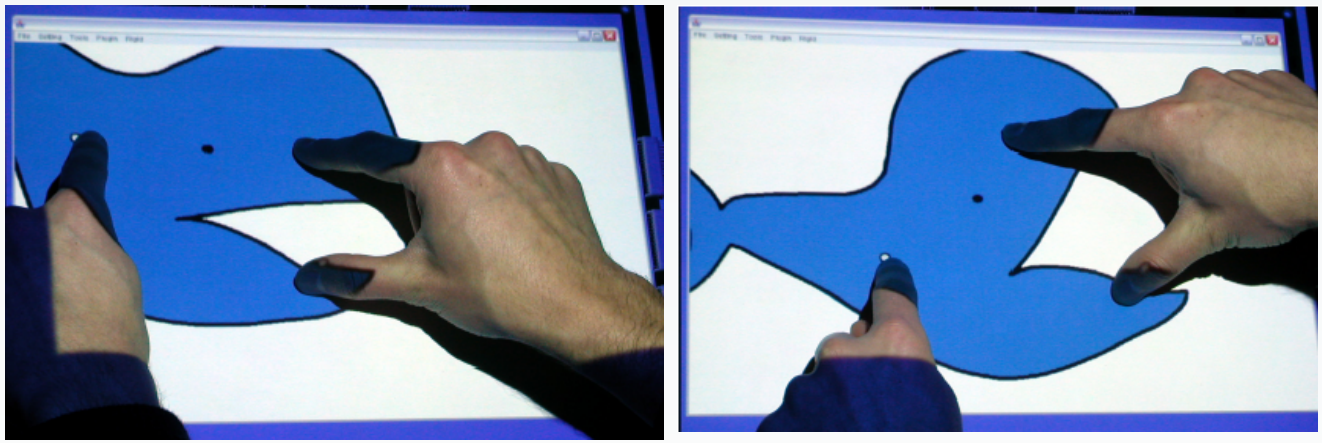
2D Drawings and Animations

- Diagram Beautification
- Pen-and-ink Textures
- Shape Manipulation
- Dynamic Illustrations



SIGGRAPH2005

As-Rigid-As-Possible Shape Manipulation



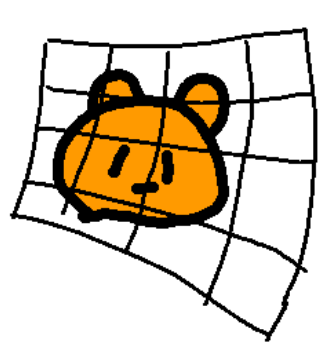
Takeo Igarashi, Tomer Moscovich, John F. Hughes

The University of Tokyo / Brown University

Goal

Move and deform 2D shapes as if manipulating real objects

Space-Warp



Deform space, not object.
Different from reality…

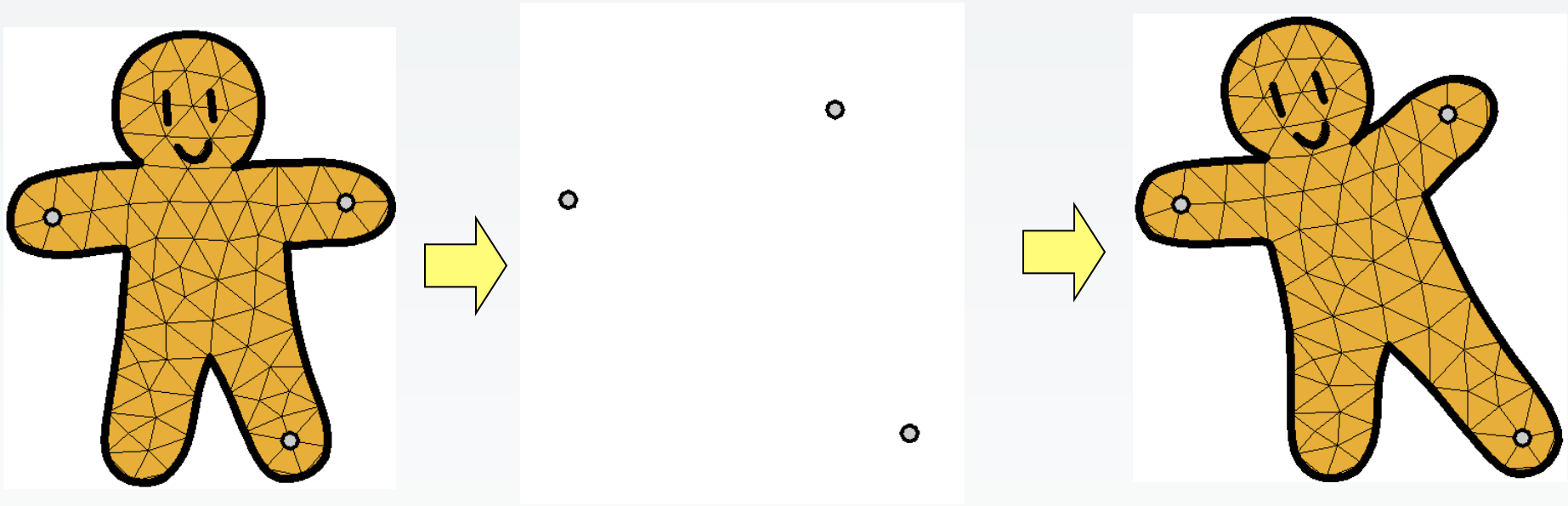
Physics (mass-spring model)

Slow to converge…
Unstable, need tuning…

Demo

rigid

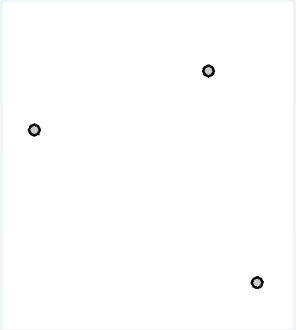
Algorithm



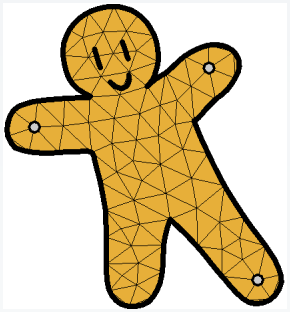
Rest shape Handles Output

Minimize shape distortion, satisfying constraints.
Closed-from solution, not iterative.

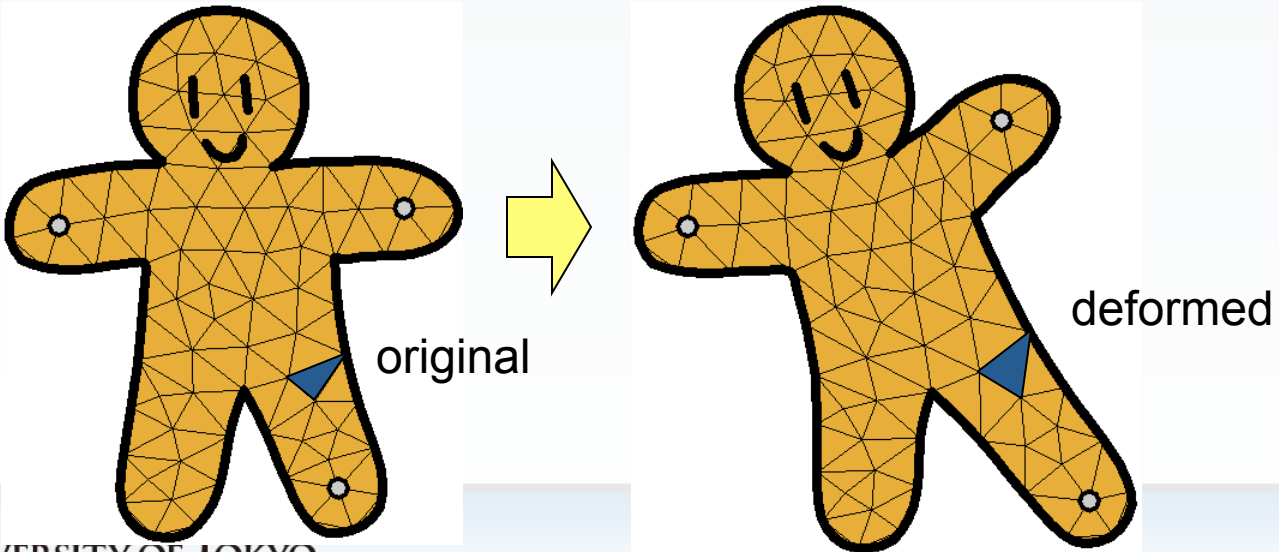
Input: coordinates of handles (**q**)



Output: coordinates of mesh vertices (**u**)



Minimize: distortion of triangles



Minimize Distortion of Triangles

$$\arg\min_{u \in MeshVertices} \sum_{t \in Triangles} E_t(u)$$

We want such *E* that…

Translation, Rotation (rigid transformation) ~ $E=0$
Scale, Stretch, Shear ~ $E>0$

E should be quadratic in **u**

Ideally,

Translation, Rotation	~	$E = 0$
Scale, Stretch, Shear	~	$E > 0$

Ideally,

Translation, Rotation	~	$E = 0$
Scale, Stretch, Shear	~	$E > 0$

Unfortunately, there is no such “quadratic” energy!

We therefore combine two complementary energies.

Ideally,

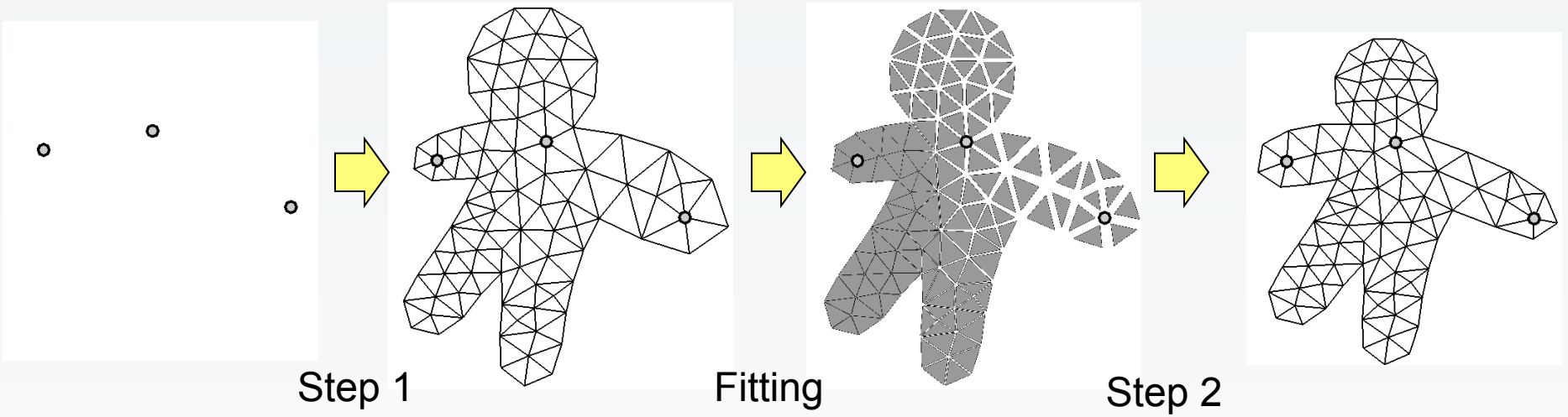
Translation, Rotation ~ $E = 0$
Scale, Stretch, Shear ~ $E > 0$

We combine two quadratic energies.

E_1 Translation, Rotation, Scale ~ $E_1 = 0$
Stretch, Shear ~ $E_1 > 0$

E_2 Translation ~ $E_2 = 0$
Rotation, Scale, Stretch, Shear ~ $E_2 > 0$

Two-Step Algorithm



Step 1: Obtain intermediate result by using E_1, allowing scaling.

Fitting: Fit correct-sized individual triangle to the result.

Step 2: Stitch fitted triangles by using E_2.

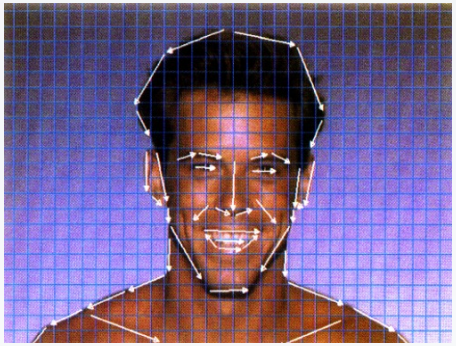
To Learn More…

The original paper:

- Igarashi, et al. As-Rigid-As-Possible Shape Manipulation, ACM Transactions on Computer Graphics. SIGGRAPH 2005.

Space warp deformation:.

- Beier and Neely. Feature-based image metamorphosis. SIGGRAPH 1992.



[Beier and Neely 1992]

Shape interpolation:

- Alexa, et al. As-rigid-as-possible shape interpolation. SIGGRAPH 2000.

Shape deformation:

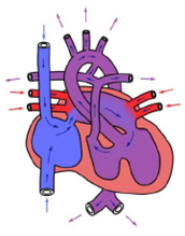
- Botsch and Sorkine-Hornung. On Linear Variational Surface Deformation Methods, TVCG 2008.

[Alexa, et al. 2000]

(Figure obtained from http://www.math.tau.ac.il/~dcor/online_papers/abs.html with permission)

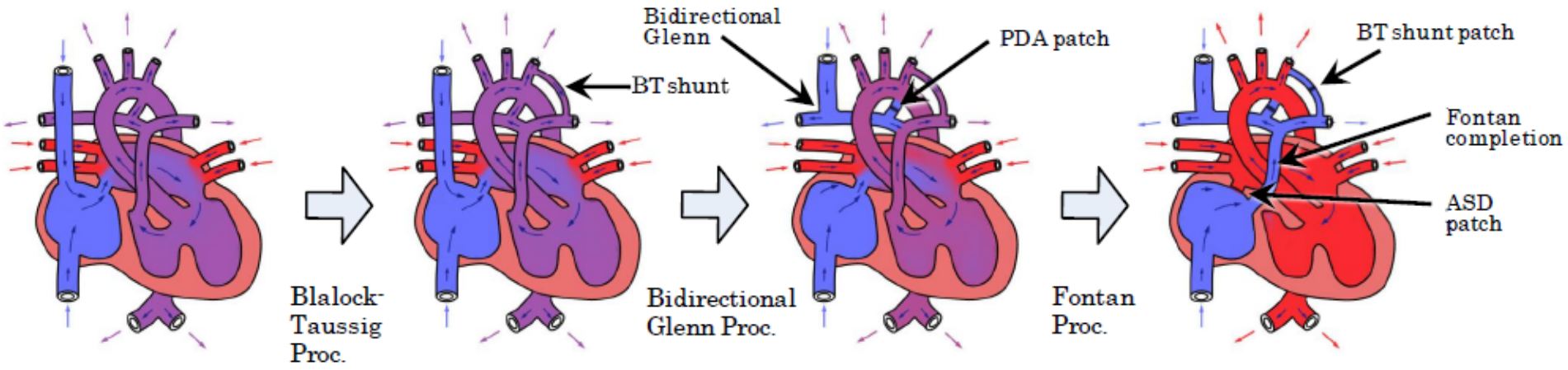
2D Drawings and Animations

- Diagram Beautification
- Pen-and-ink Textures
- Shape Manipulation
- Dynamic Illustrations

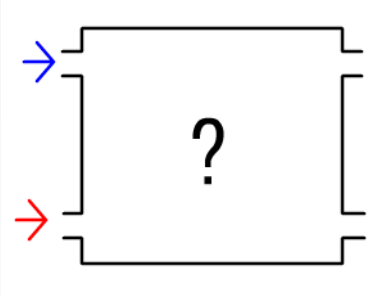


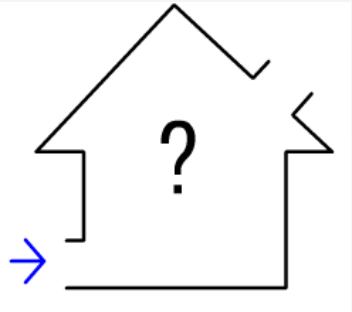
Sketch-based Dynamic Illustration of Fluid Systems

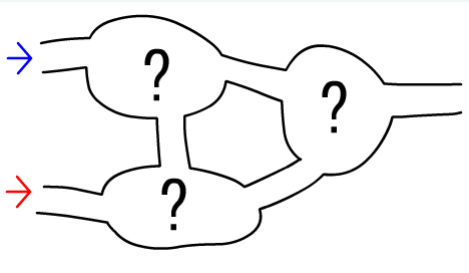
B. Zhu, M. Iwata, R. Haraguchi, T. Ashihara,
N. Umetani, T. Igarashi, K. Nakazawa

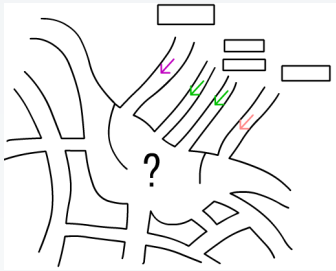


Tedious to illustate fluid flow…

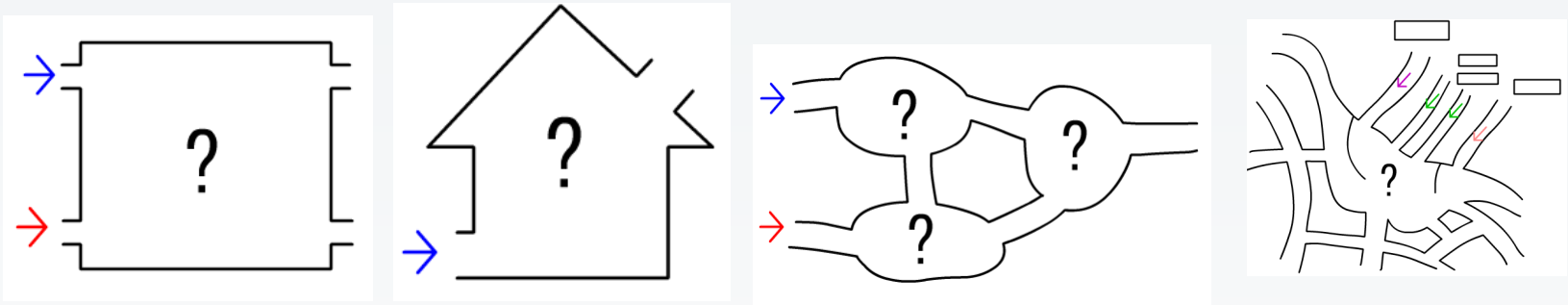




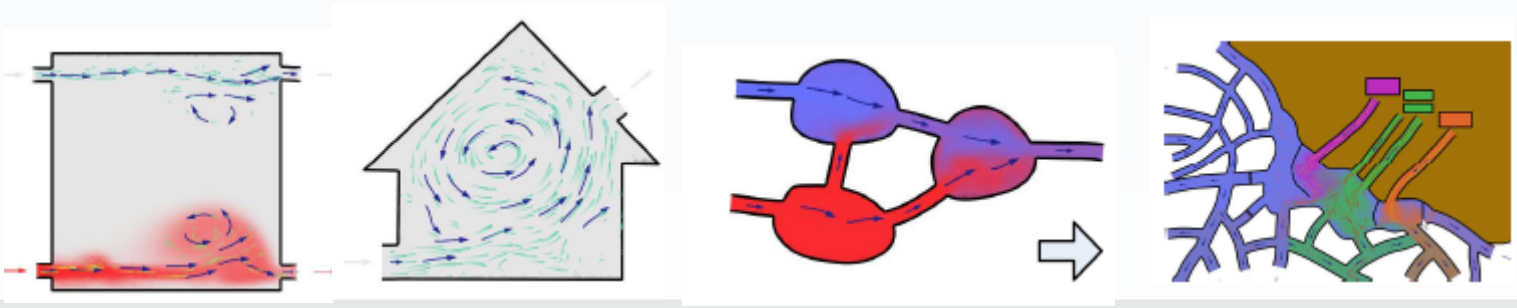




Tedious to illustate fluid flow...



Automatic flow visualizaition.



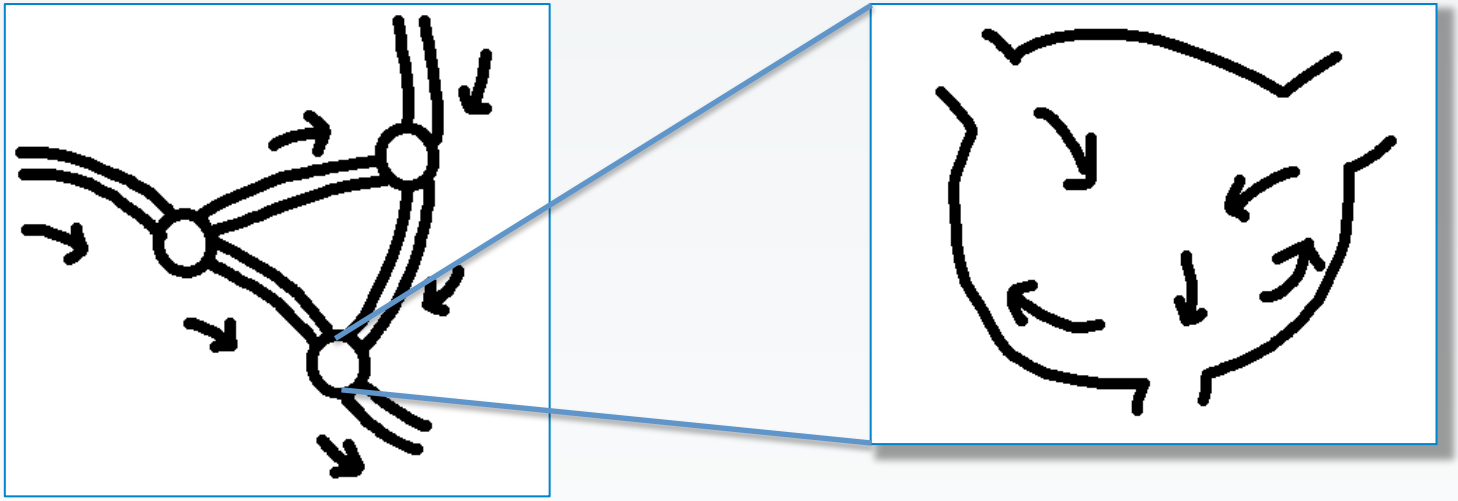
Video

fluid

Hybrid Fluid Simulation

Global network

Local region

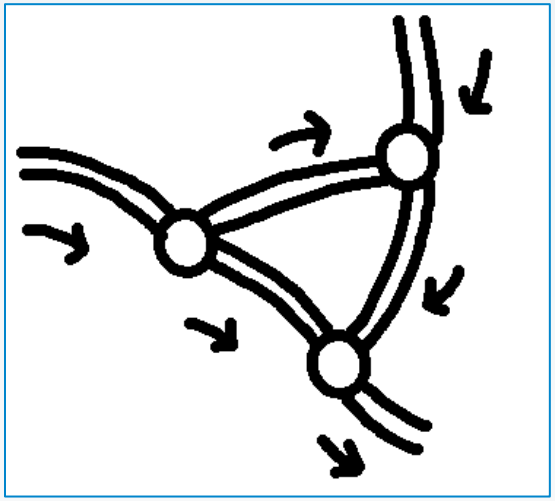


Hydraulics

Hydrodynamics

Node Inflow → Pipe Flow, Node Pressure → Details within regions

Global network



Hydraulics

Node Inflow → Pipe flow

$$Q_n = -\mathbf{M} Q_e$$

Pipe flow → Pipe pressure drop

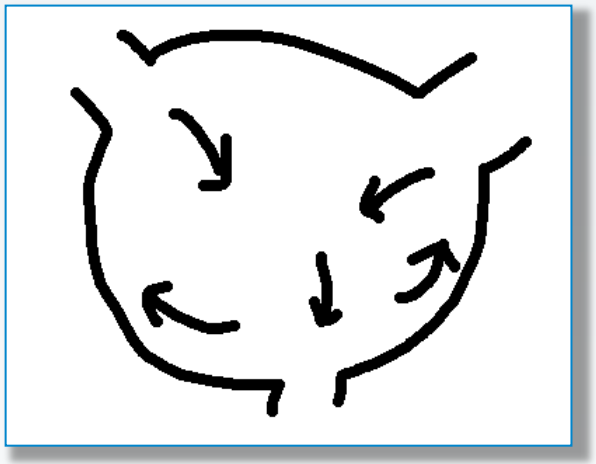
$$Q_e = \mathbf{D}_e P_e$$

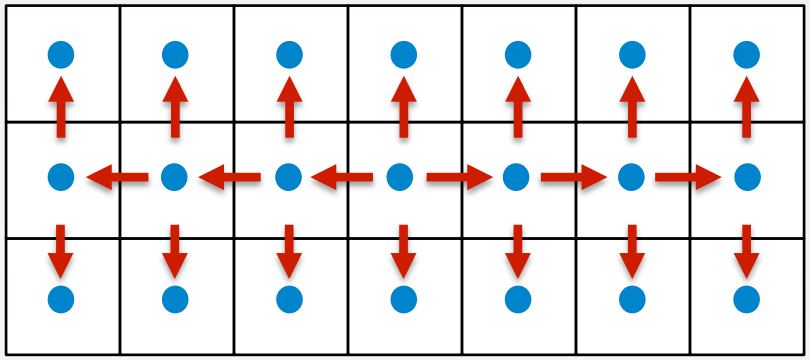
Pipe pressure drop → Node pressure

$$P_e = -\mathbf{M}^T P_n$$

Solve a global linear system.

Local region





Velocity ↑ Pressure •

Hydrodynamics

$$\frac{\partial \mathbf{u}}{\partial t} + \mathbf{u} \cdot \nabla \mathbf{u} = -\frac{1}{\rho} \nabla p + \mathbf{g} + \nu \nabla \cdot \nabla \mathbf{u},$$

$$\nabla \cdot \mathbf{u} = 0,$$

(Navier-Stokes Equation)

Solve this on grid cells inside each region.

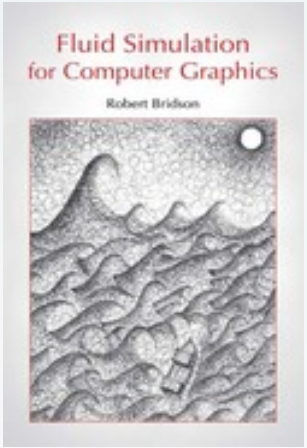
To Learn More…

The original paper:

- Zhu, et al. Sketch-based Dynamic Illustration of Fluid Systems. SIGGRAPH ASIA 2011.

Fluid Simulation:

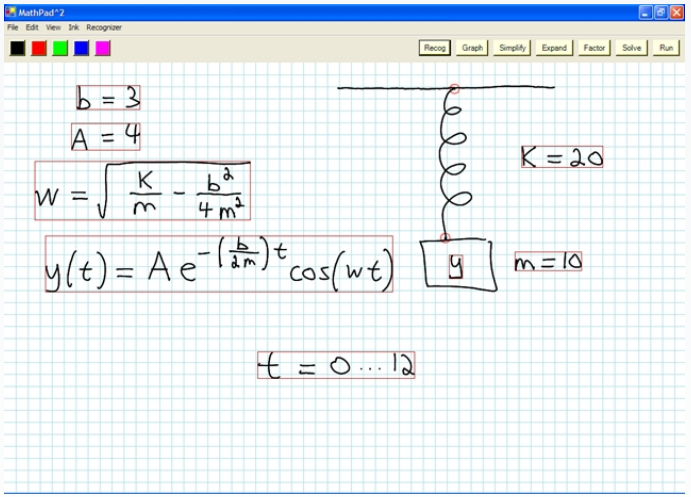
- Bridson. Fluid Simulation for Computer Graphics. AK Peters 2008.



[Bridson 2008]

Illustrative Animation:

- LaViola and Zeleznik. MathPad2: A System for the Creation and Exploration of Mathematical Sketches. SIGGRAPH 2004.



[LaViola and Zeleznik 2004]

2D Drawings and Animations

- Diagram Beautification
- Pen-and-ink Textures
- Shape Manipulation
- Dynamic Illustrations