
Five Principles for Choosing Research Problems in Computer Graphics

Thomas Funkhouser
Princeton University

Why this Topic?

Possible alternative topics

- I did this, then I did that, then zzz
- What are the five biggest open problems ... ???

My talk is somewhere in the middle

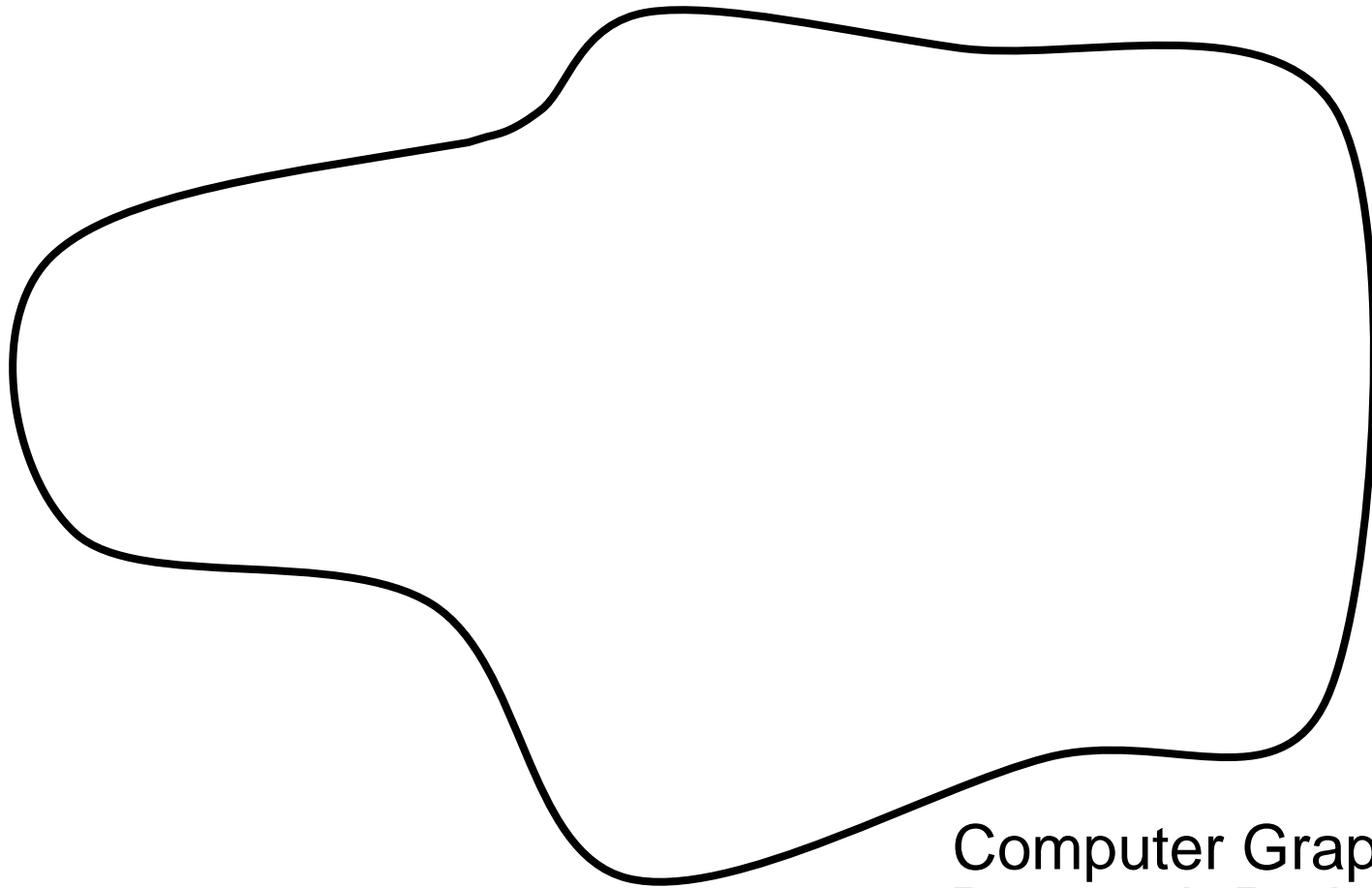
- Suggest five principles for choosing research problems
- Explain how I've used these principles in my own choices

Five Principles

1. Consider non-traditional problems
2. Anticipate disruptive technologies
3. Think beyond algorithms
4. Work on real applications
5. Work with good collaborators

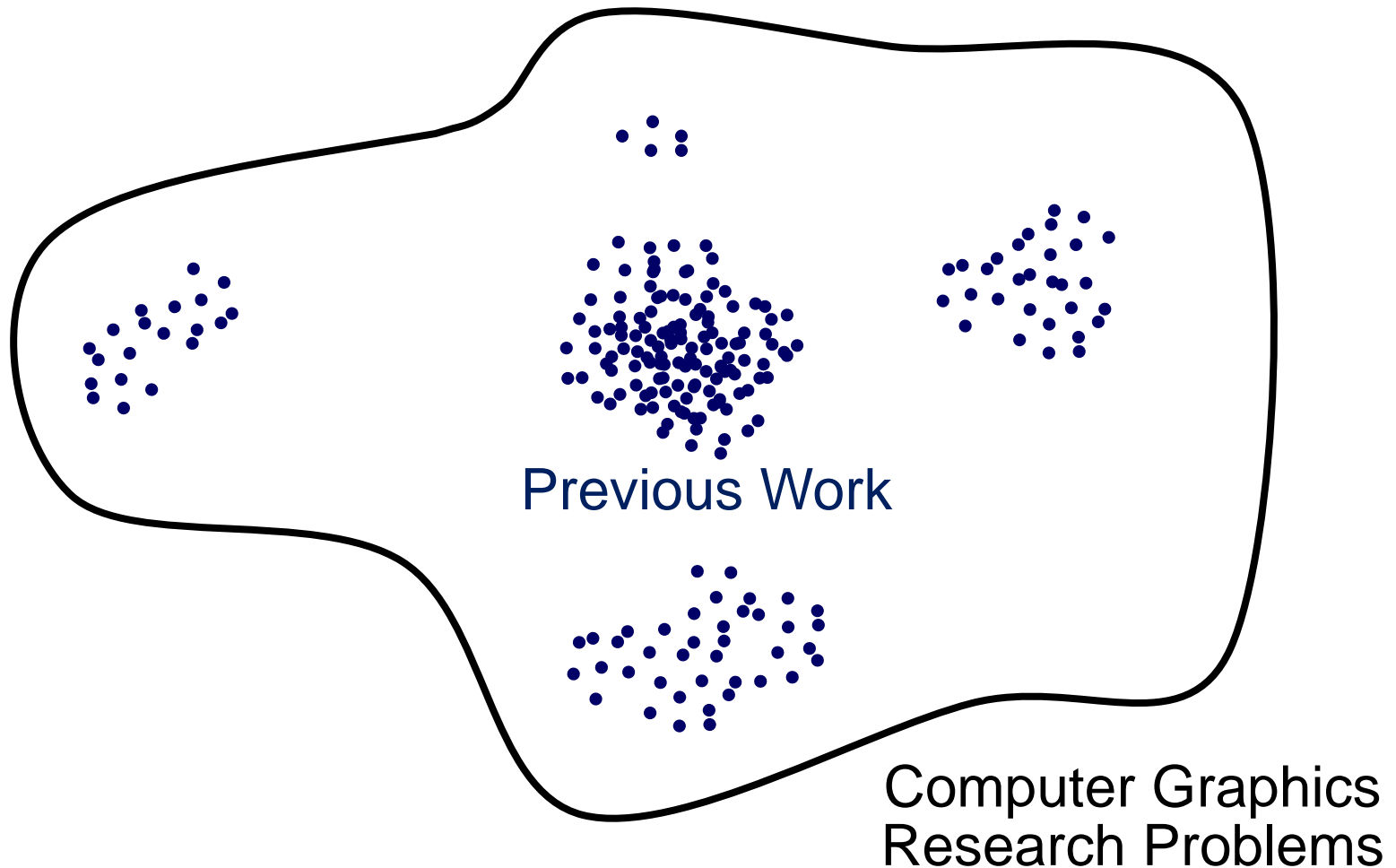
1. Consider Non-Traditional Problems

1. Consider Non-Traditional Problems

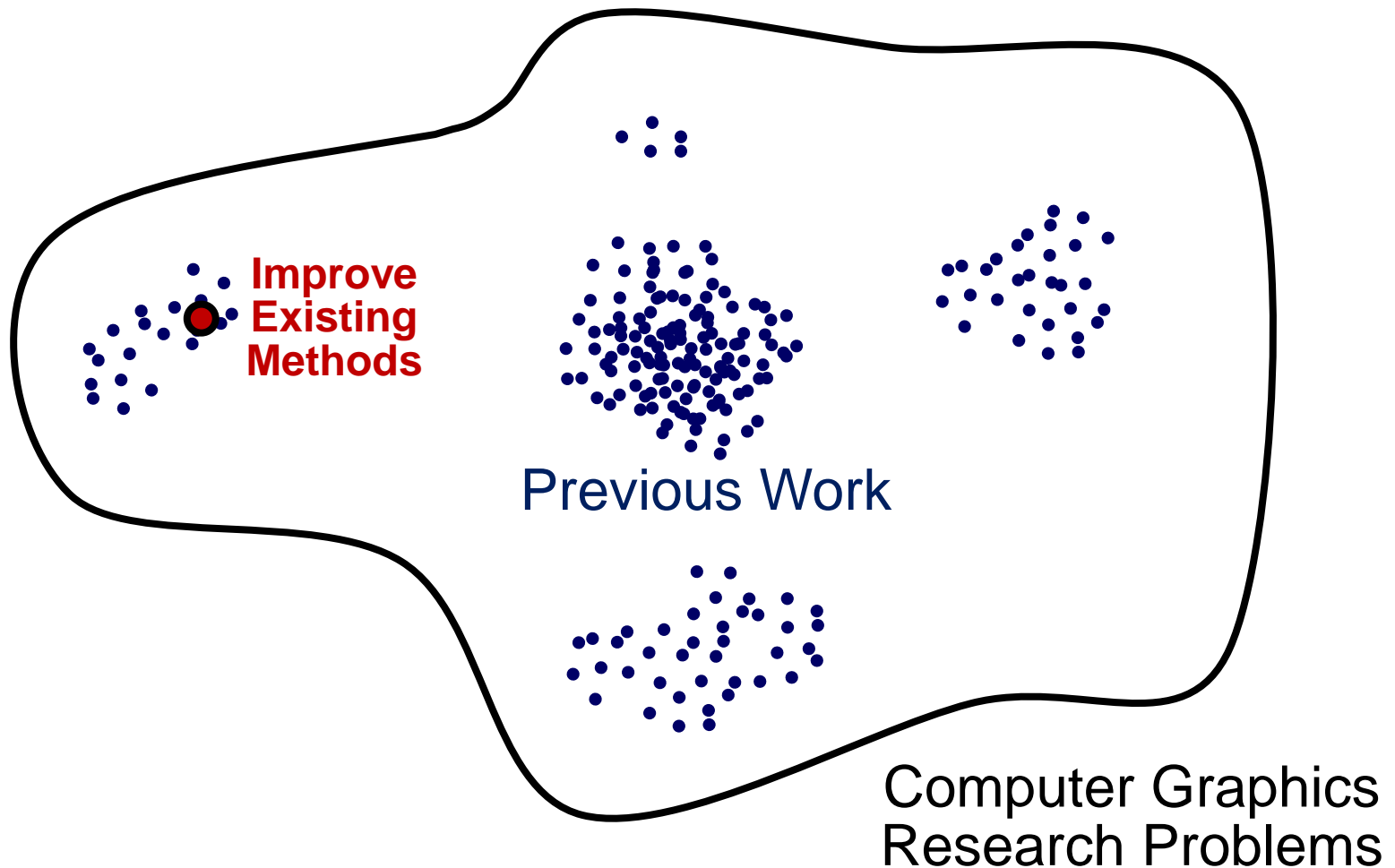


Computer Graphics
Research Problems

1. Consider Non-Traditional Problems



1. Consider Non-Traditional Problems

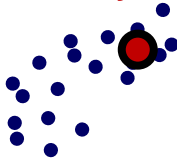


1. Consider Non-Traditional Problems



Parallel Radiosity

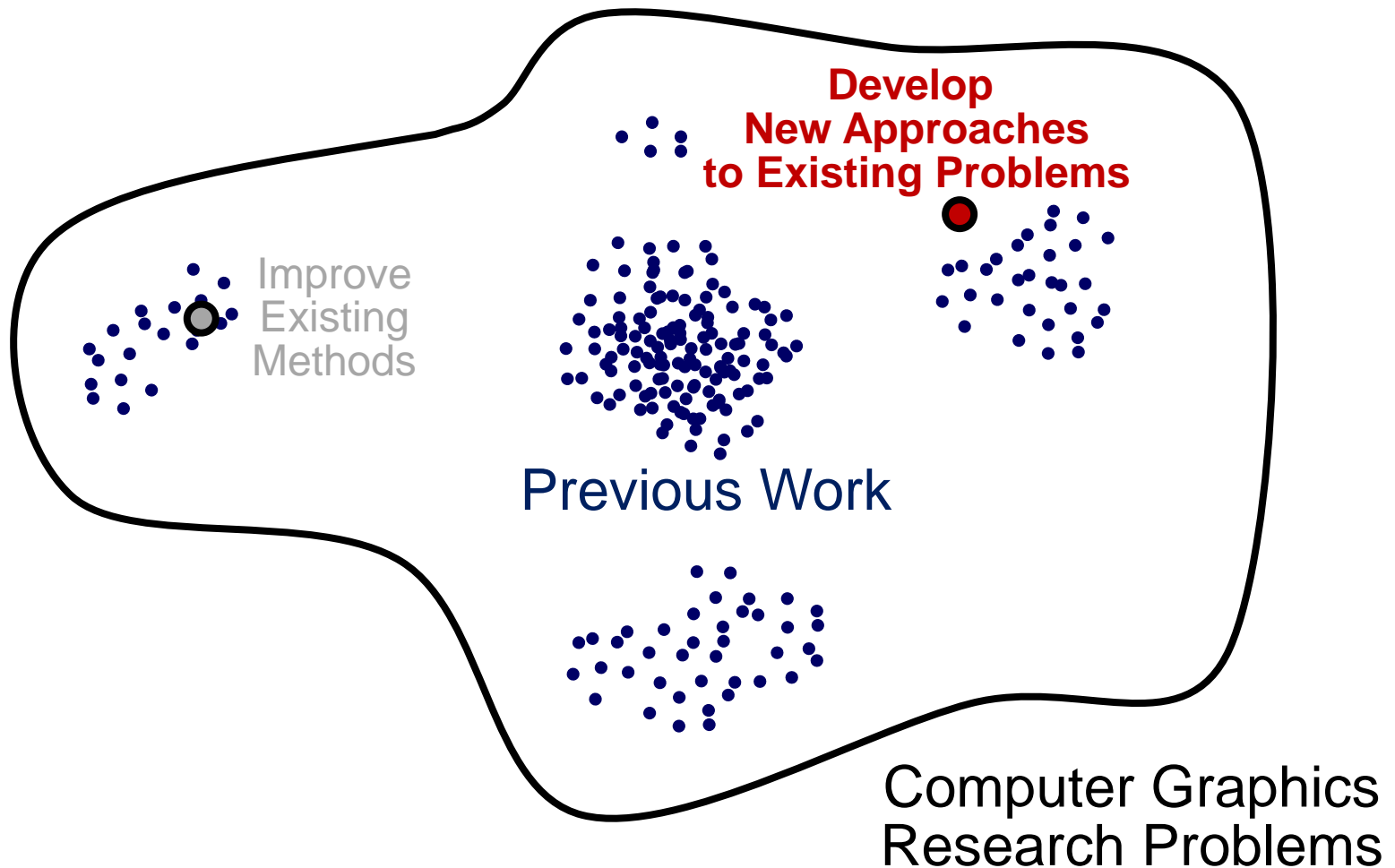
Improve
Existing
Methods



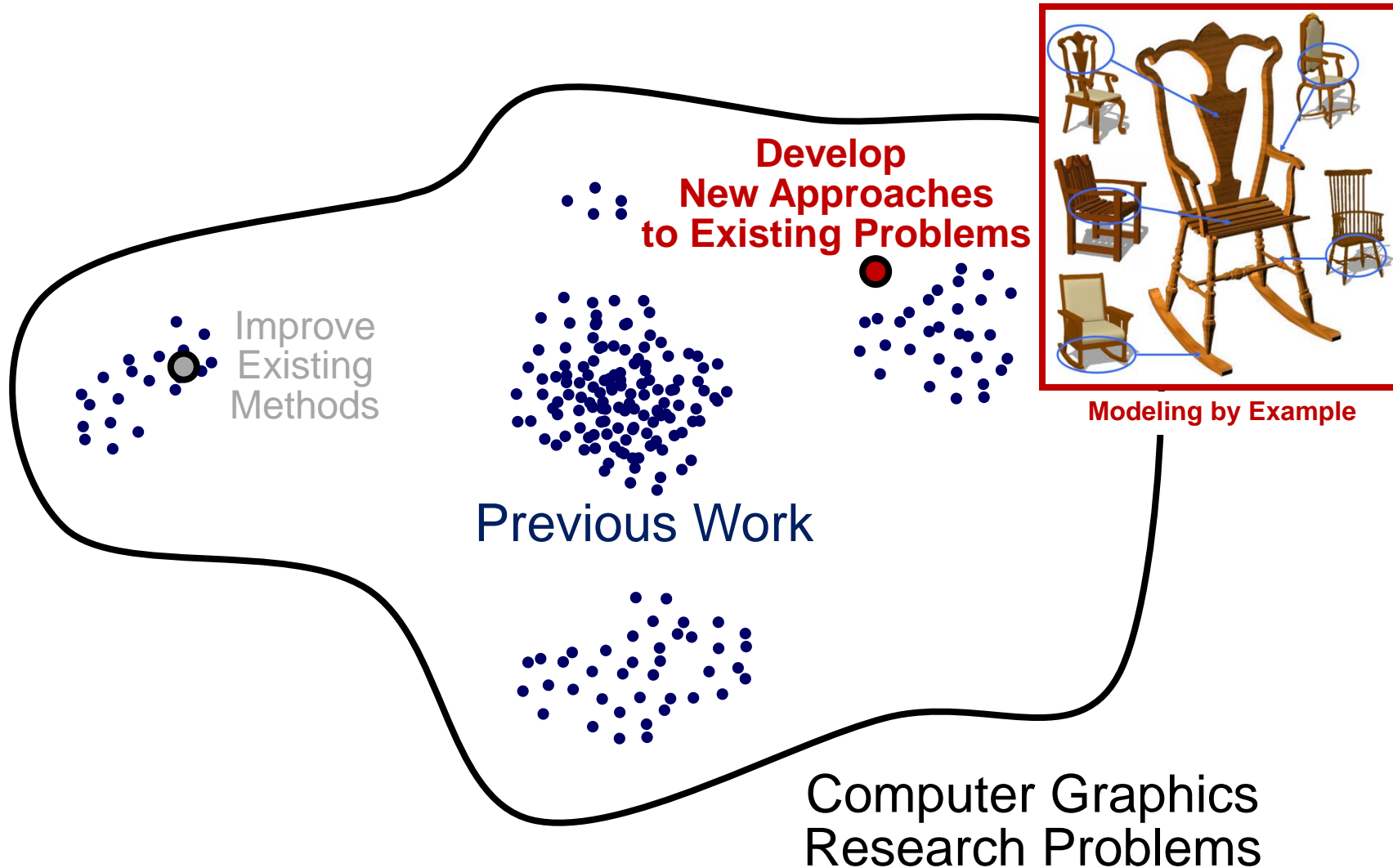
Previous Work

Computer Graphics
Research Problems

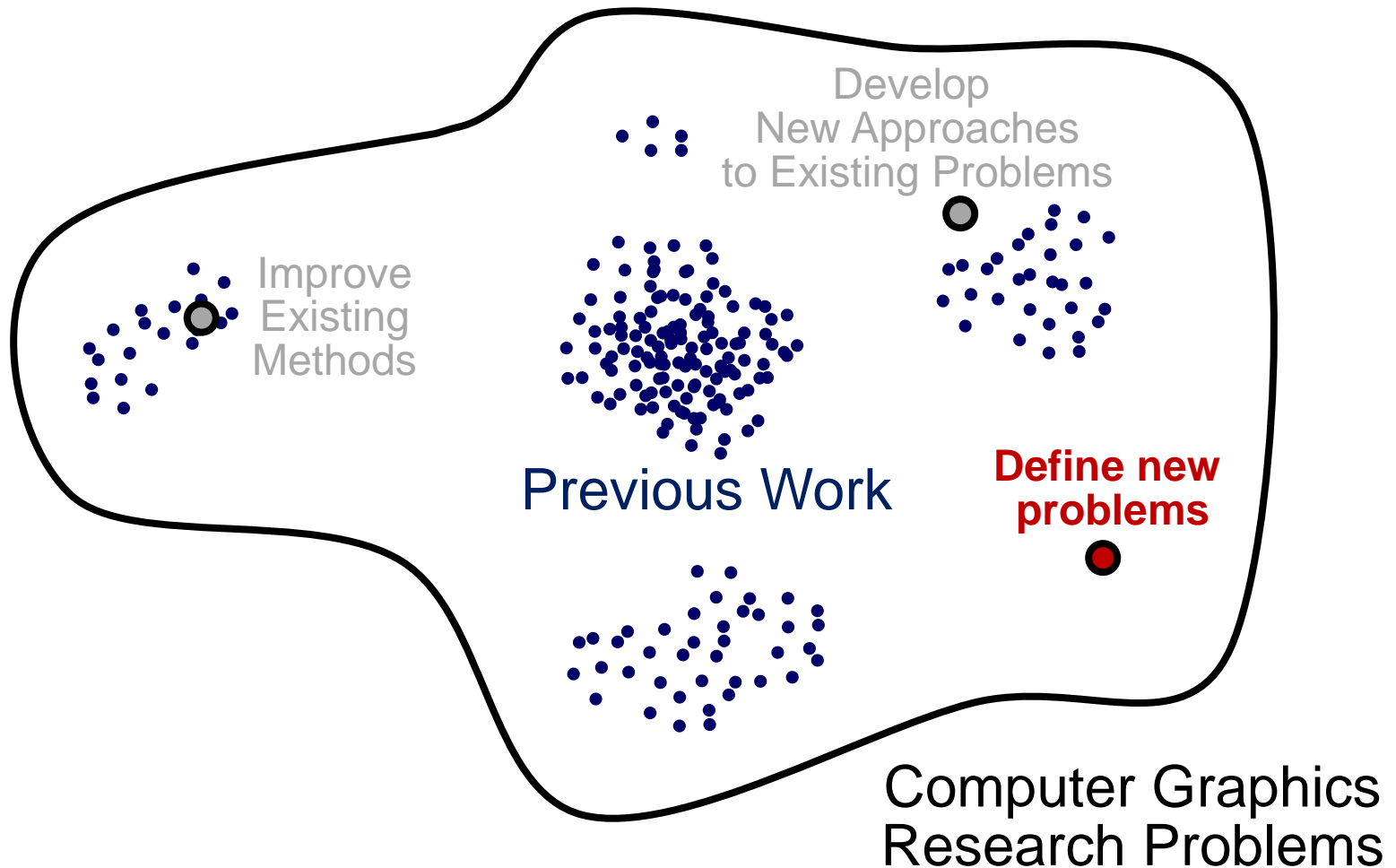
1. Consider Non-Traditional Problems



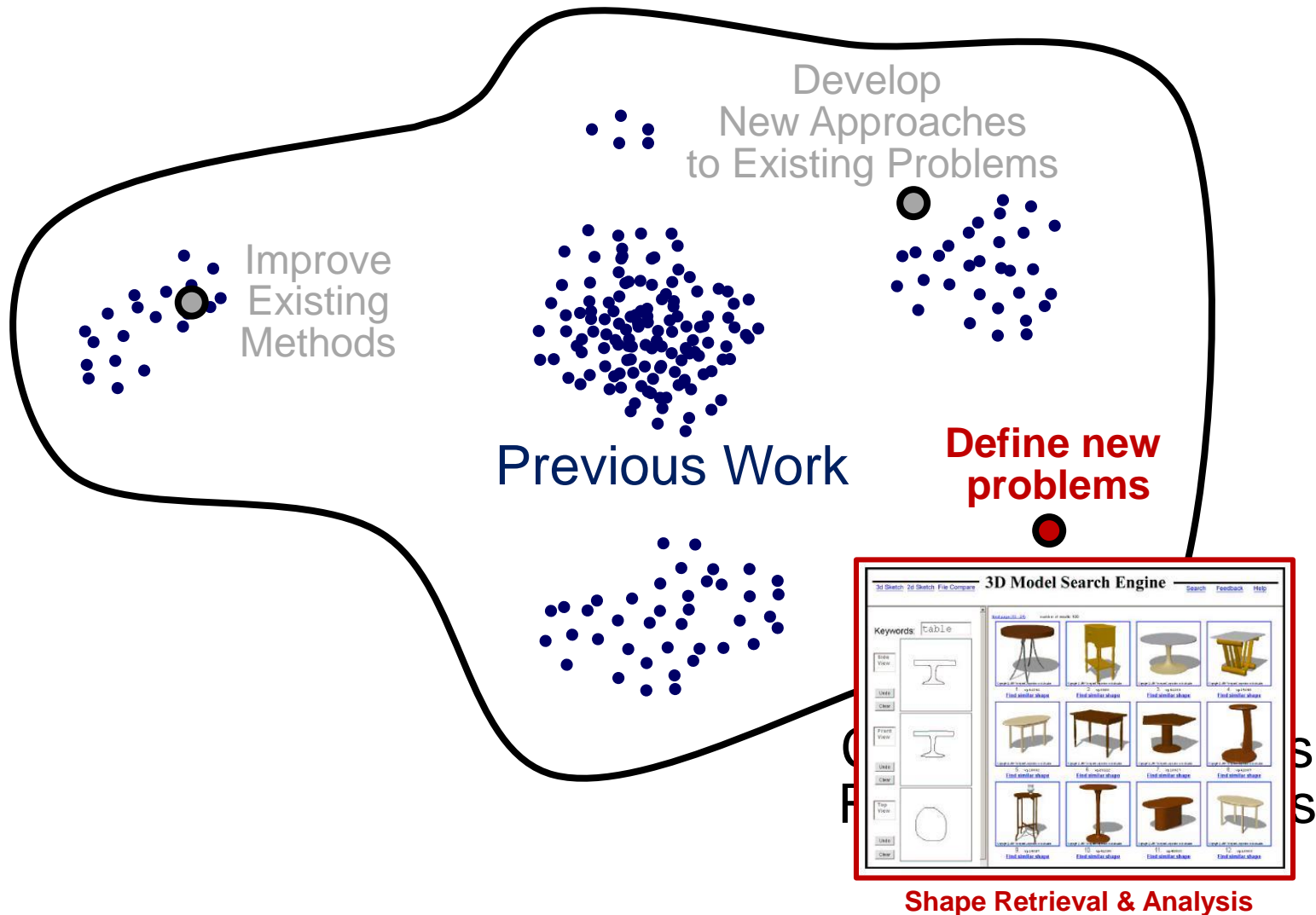
1. Consider Non-Traditional Problems



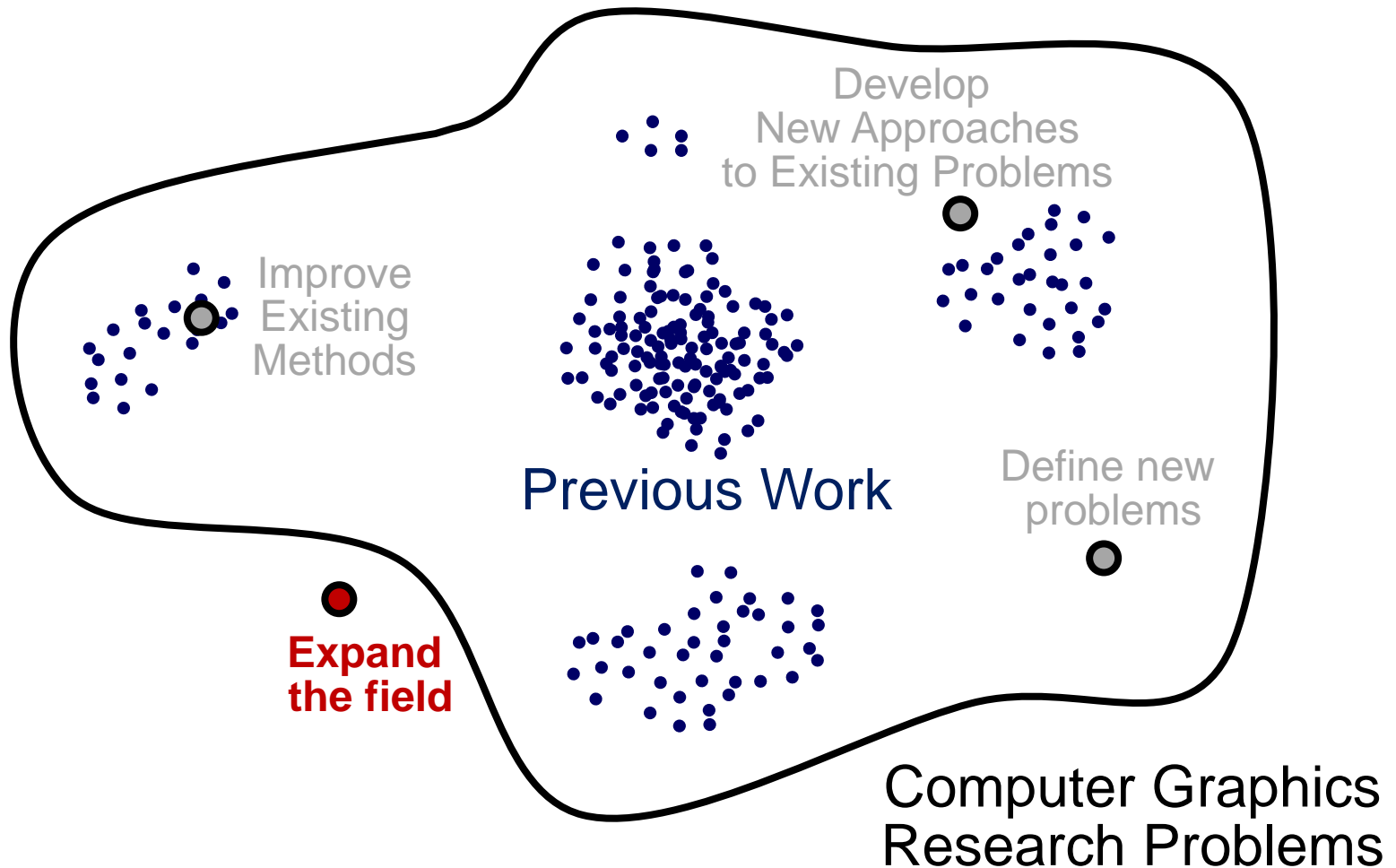
1. Consider Non-Traditional Problems



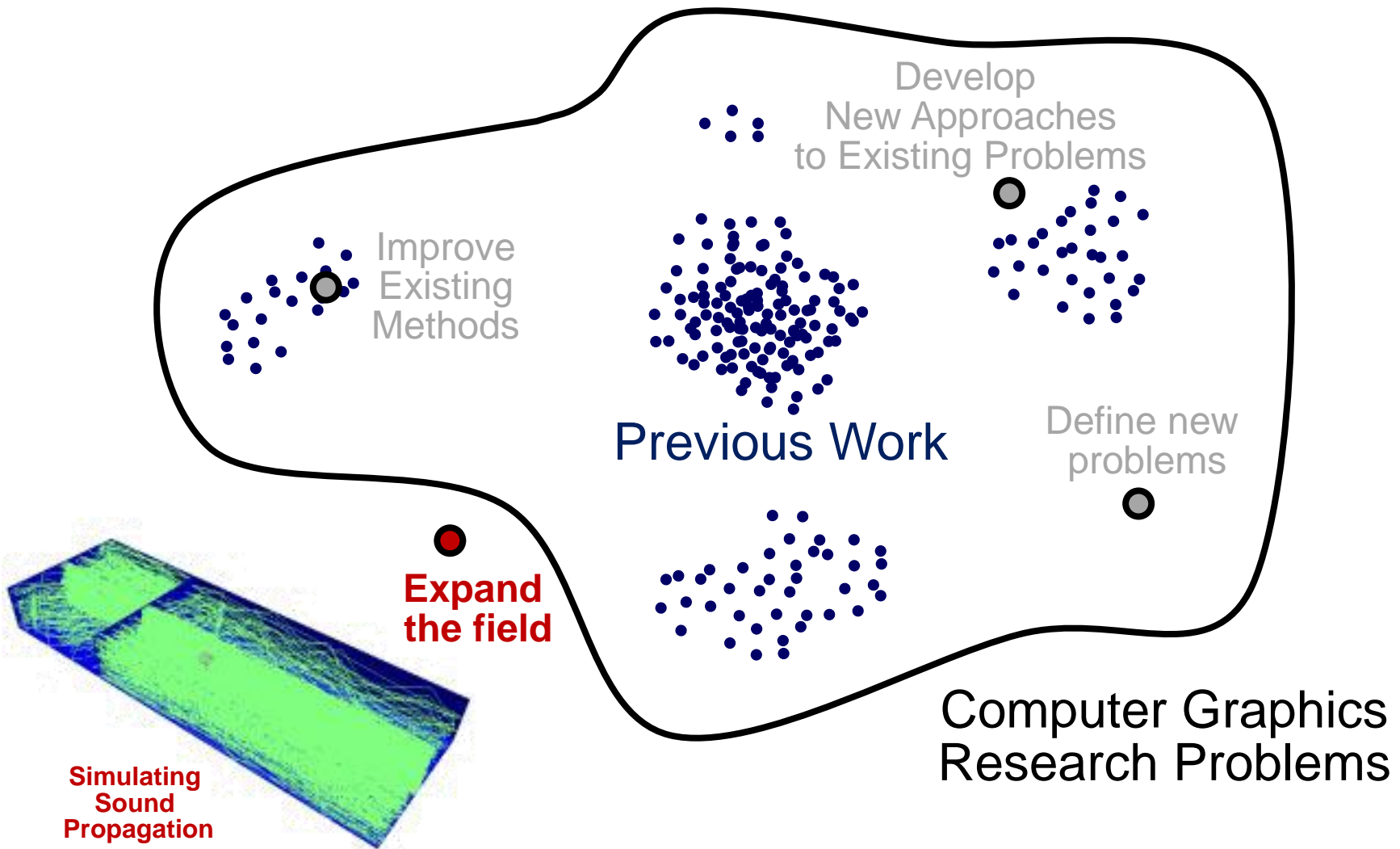
1. Consider Non-Traditional Problems



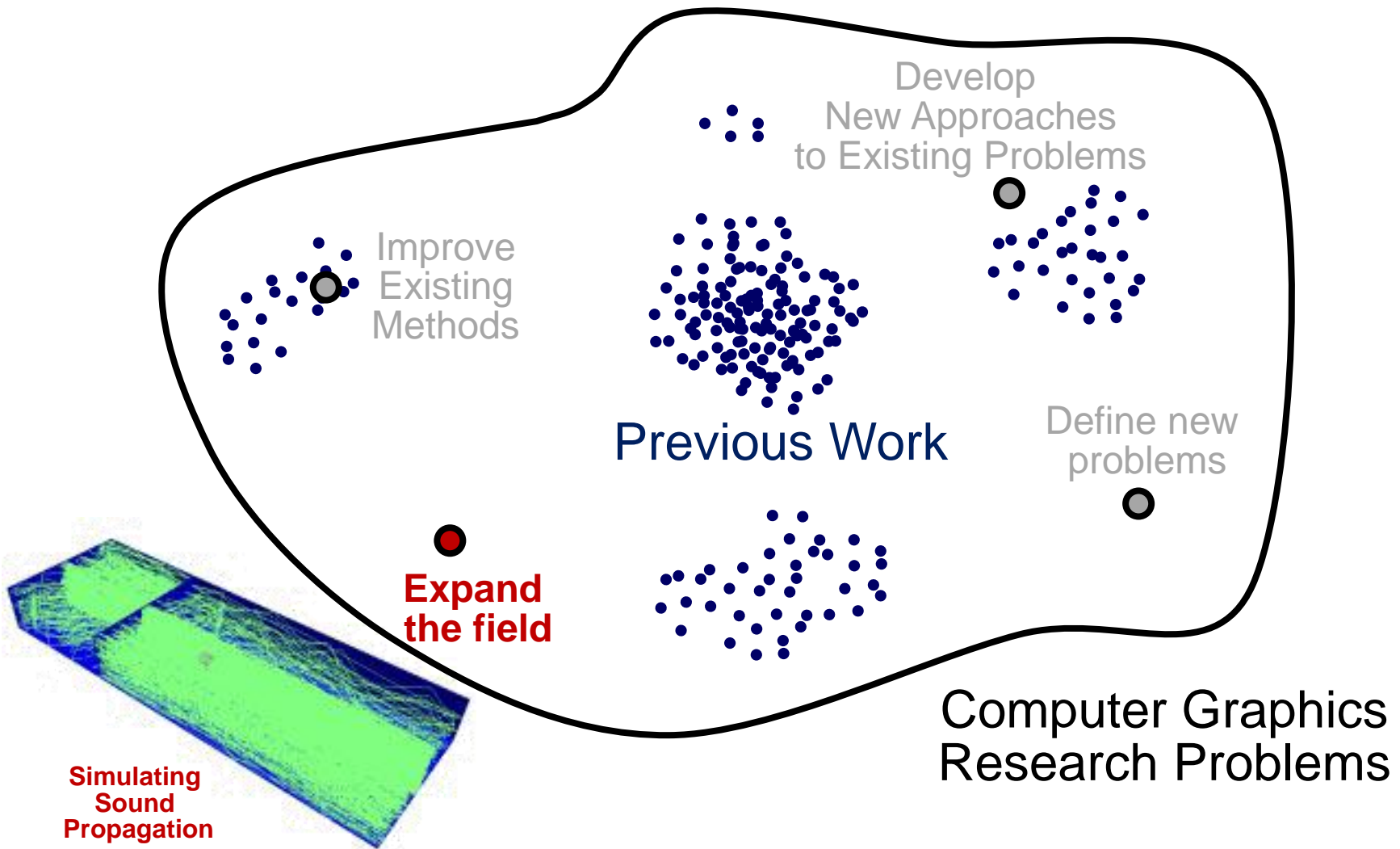
1. Consider Non-Traditional Problems



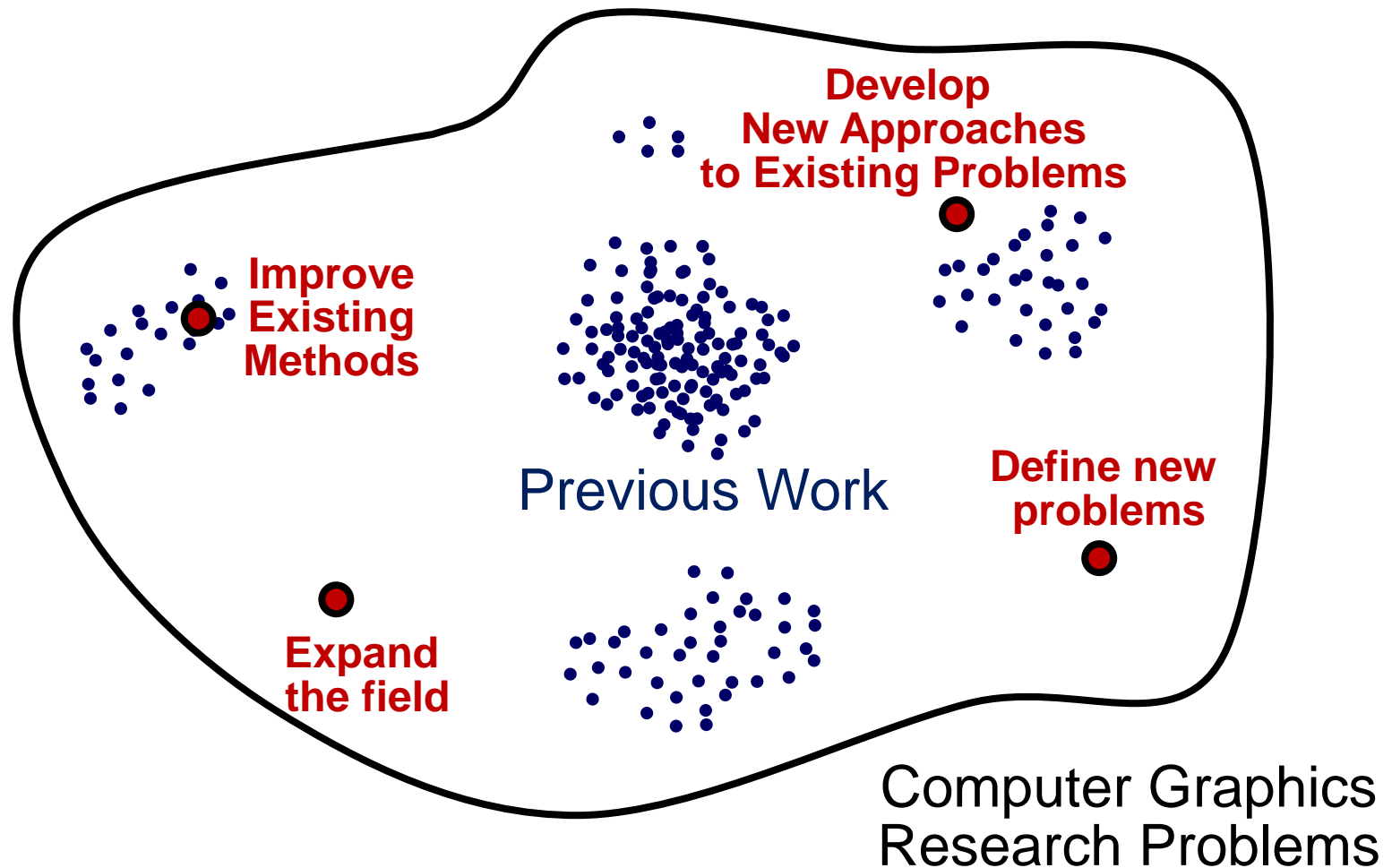
1. Consider Non-Traditional Problems



1. Consider Non-Traditional Problems

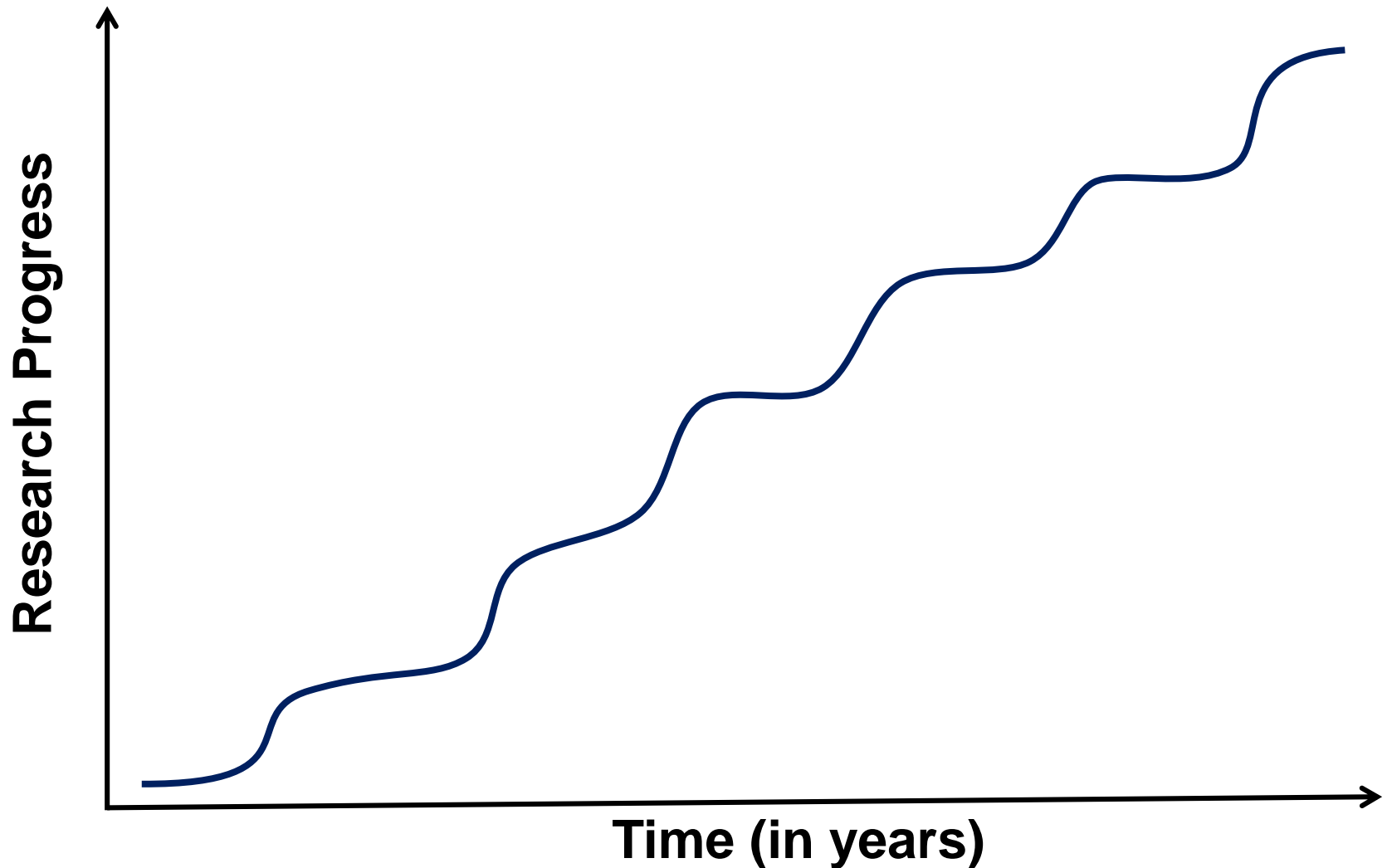


1. Consider Non-Traditional Problems

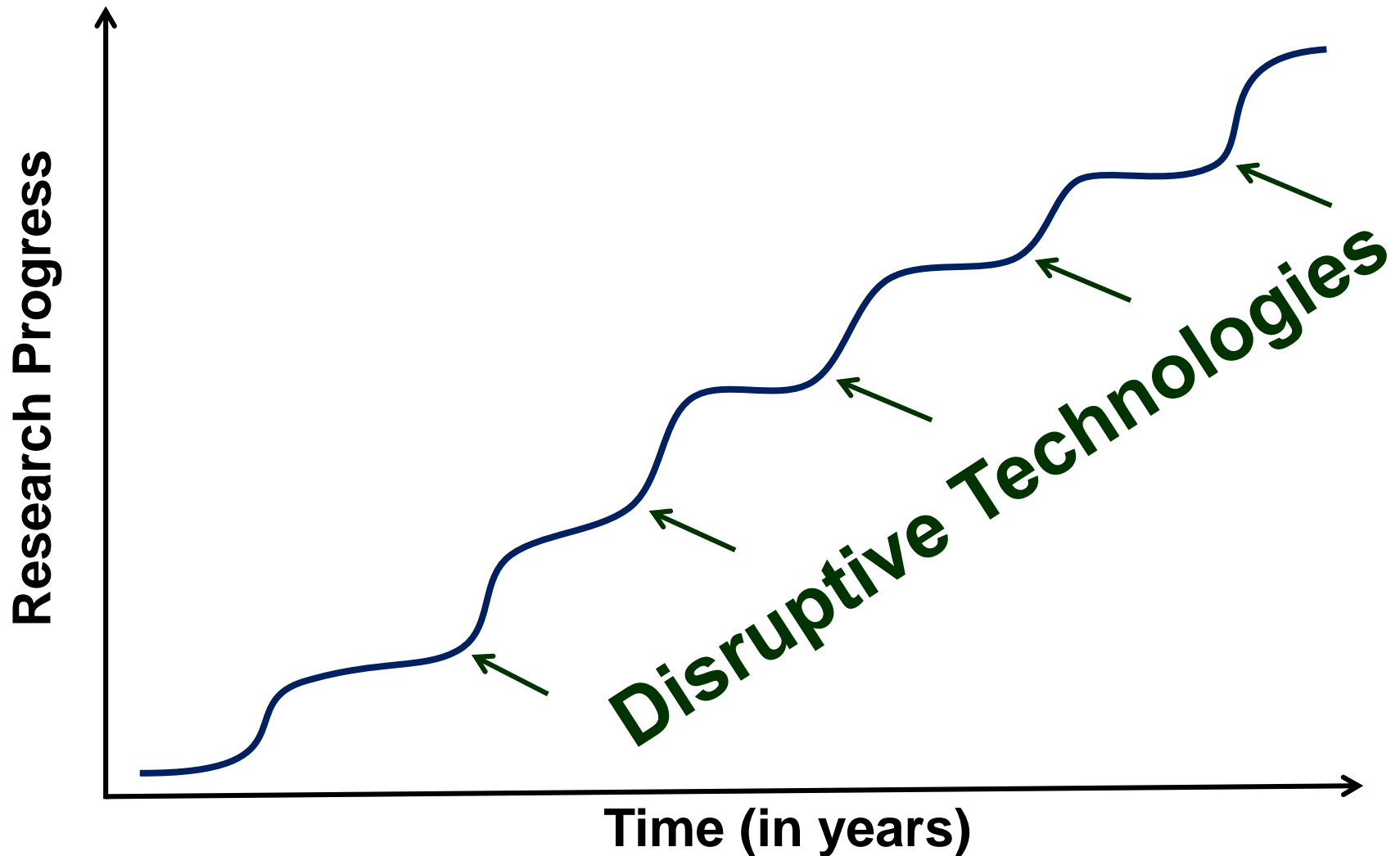


2. Anticipate Disruptive Technologies

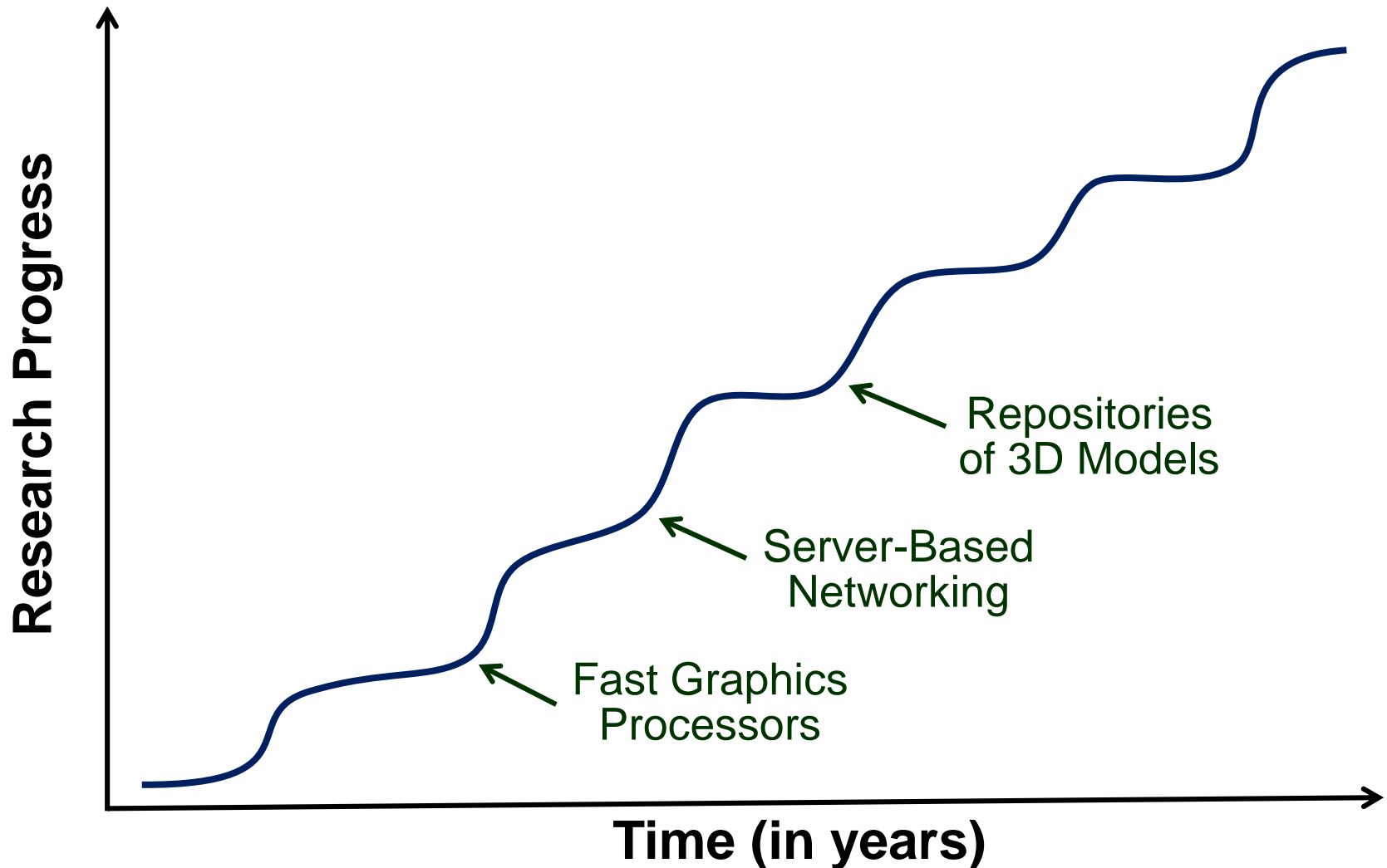
2. Anticipate Disruptive Technologies



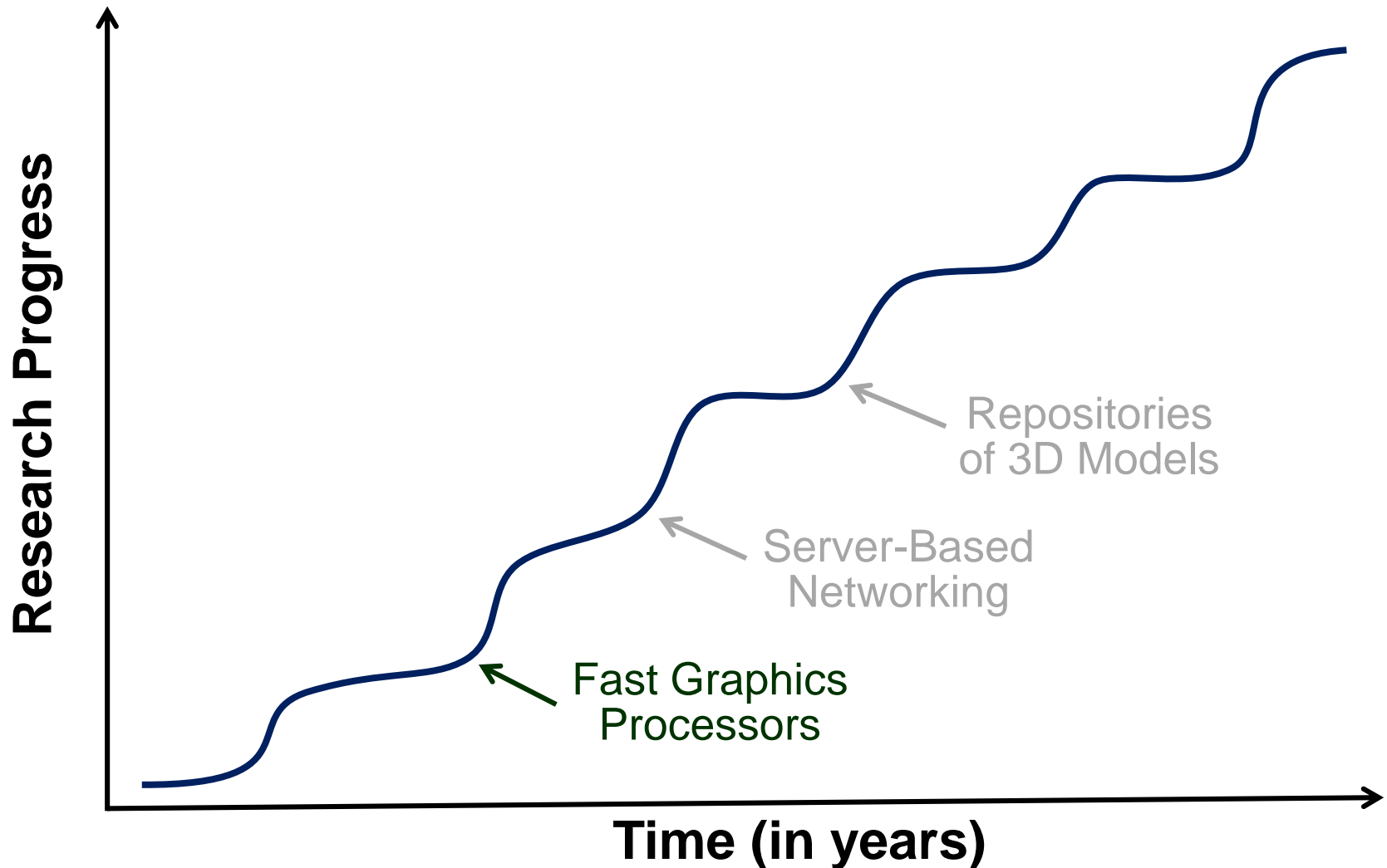
2. Anticipate Disruptive Technologies



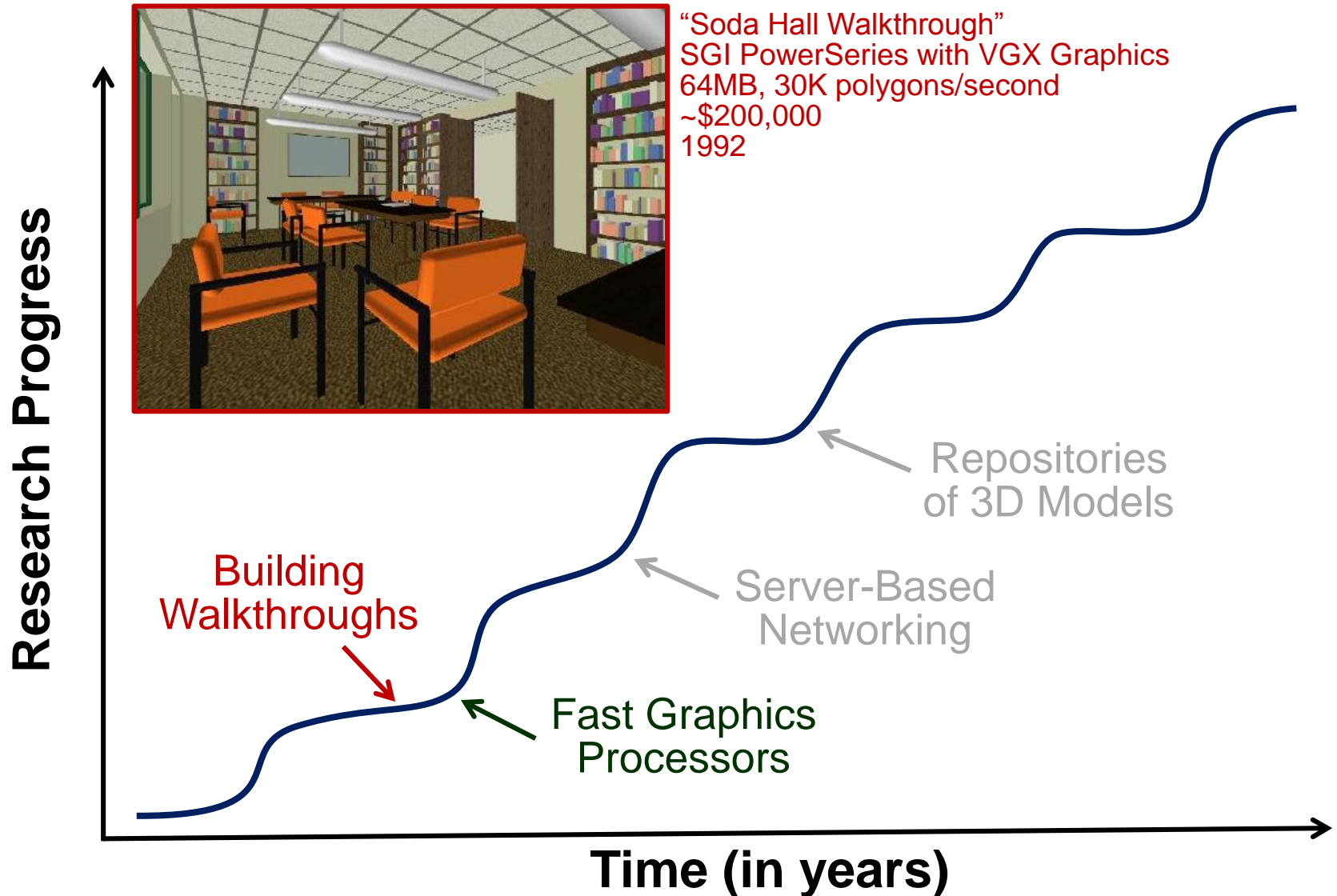
2. Anticipate Disruptive Technologies



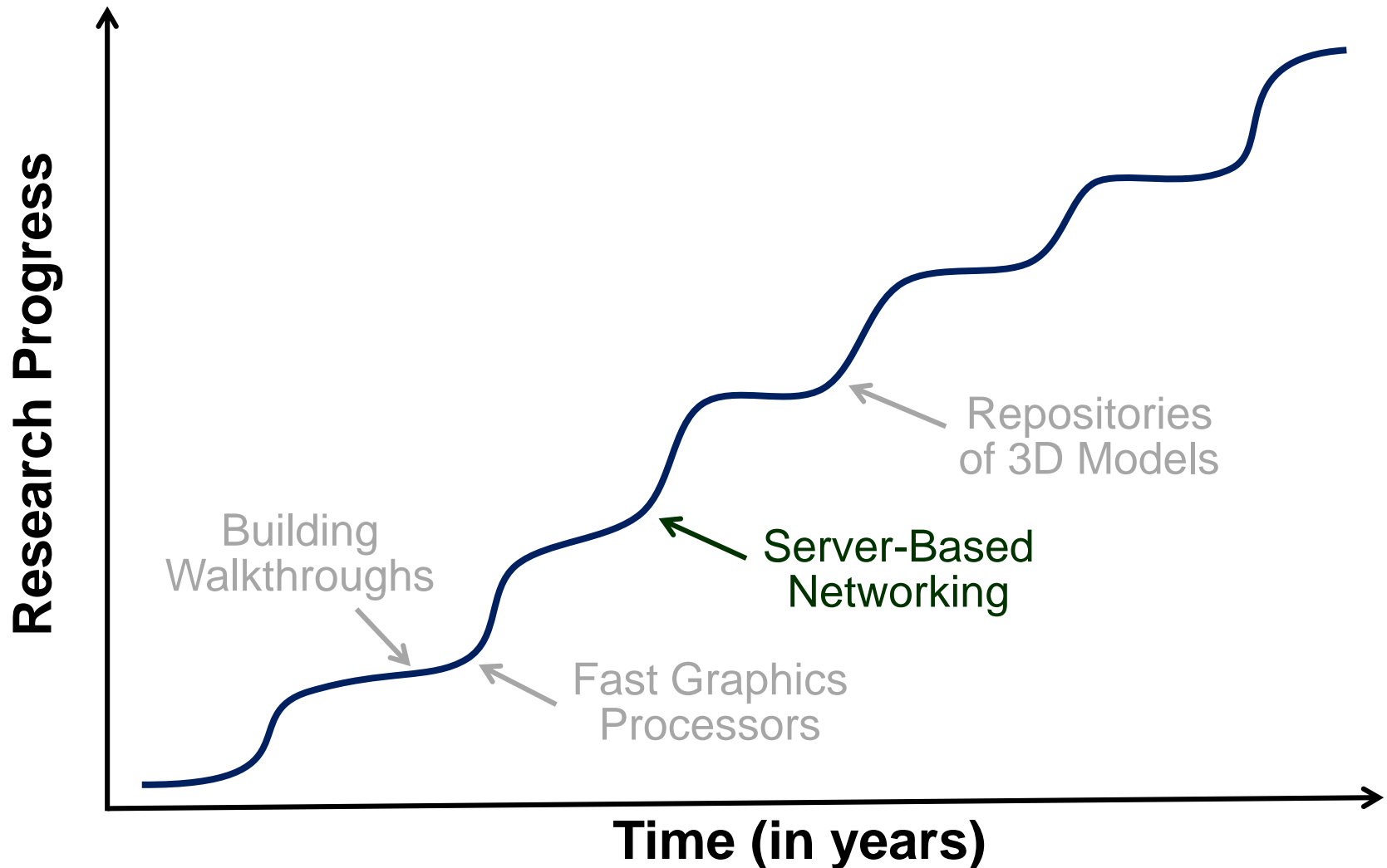
2. Anticipate Disruptive Technologies



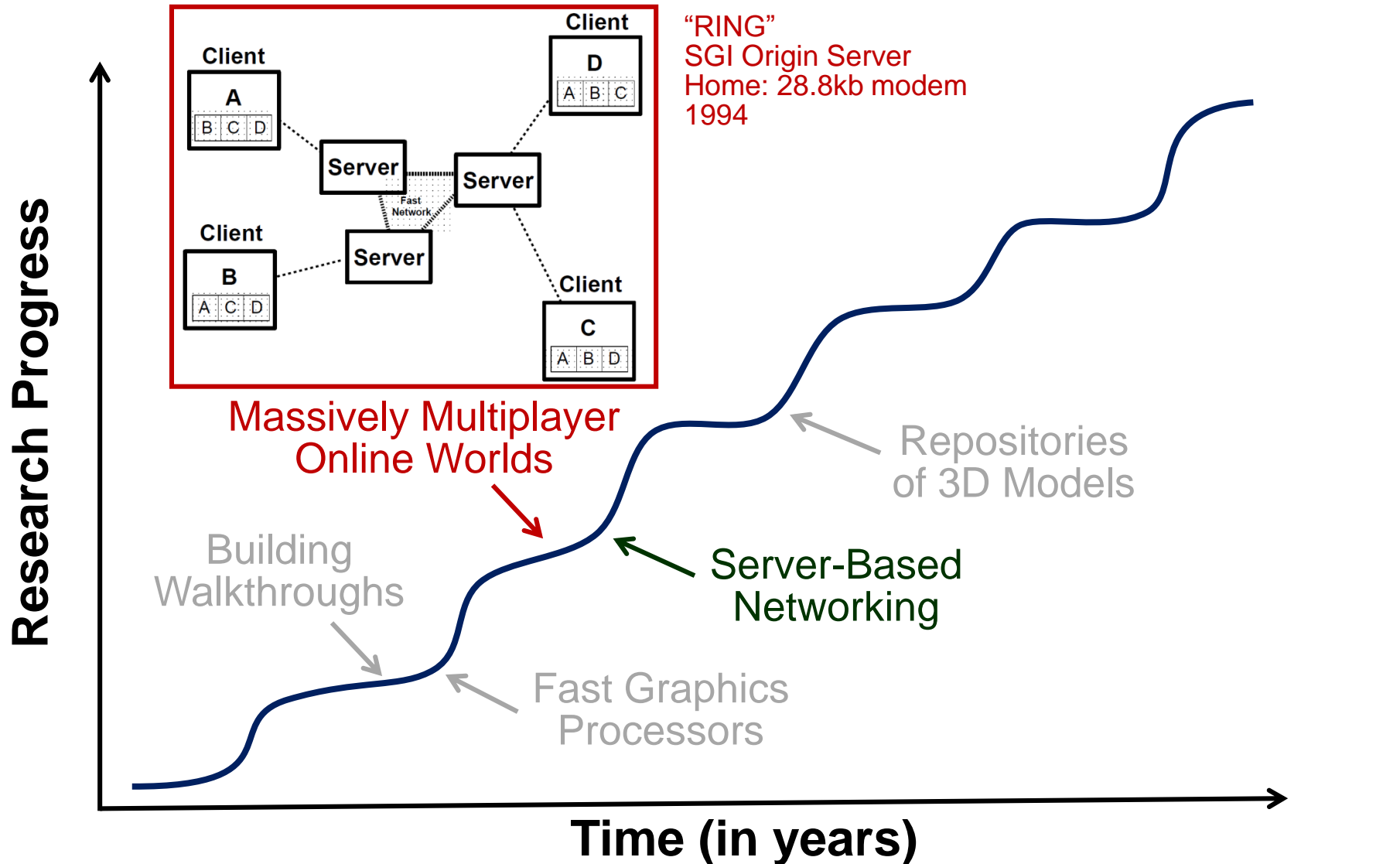
2. Anticipate Disruptive Technologies



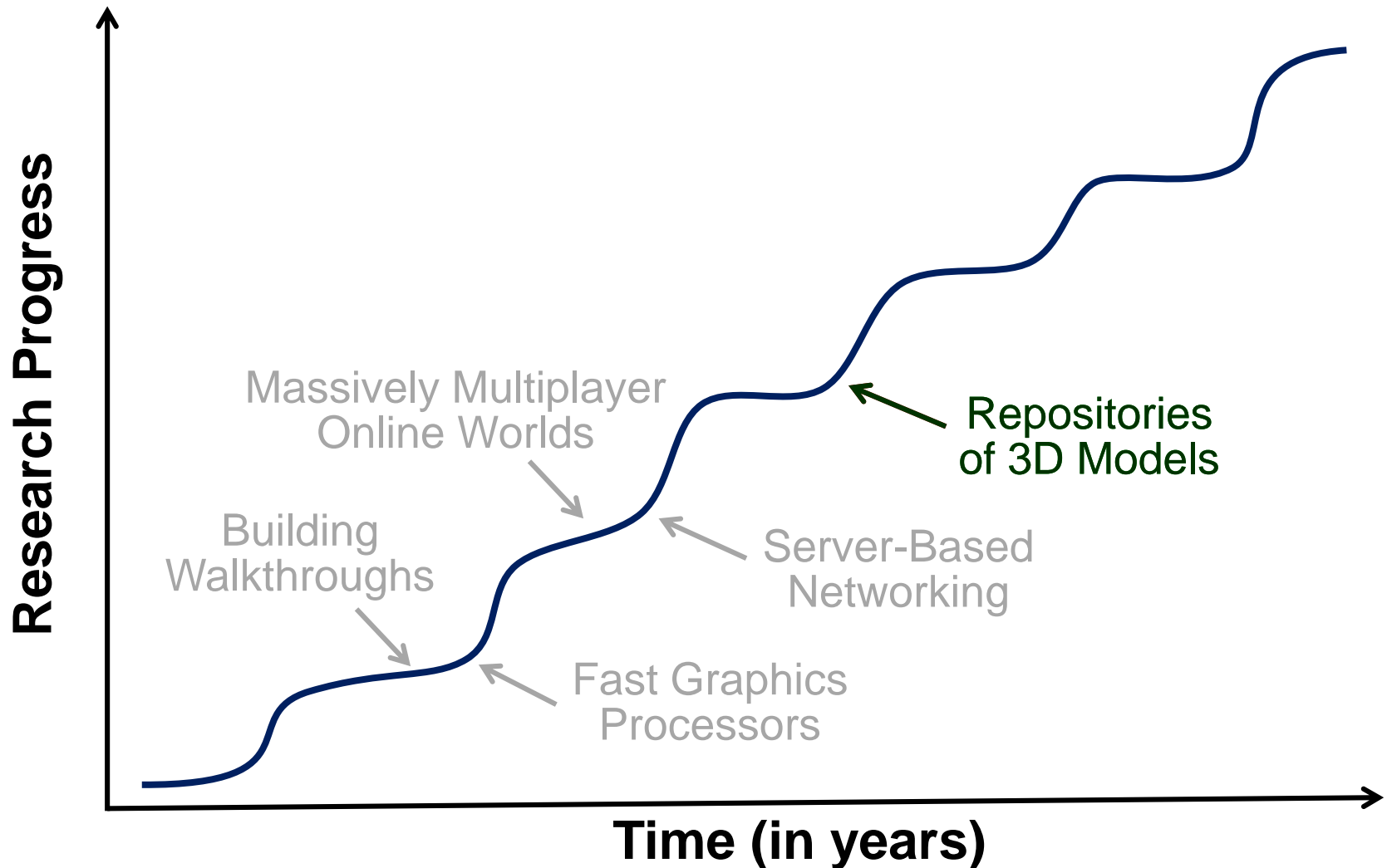
2. Anticipate Disruptive Technologies



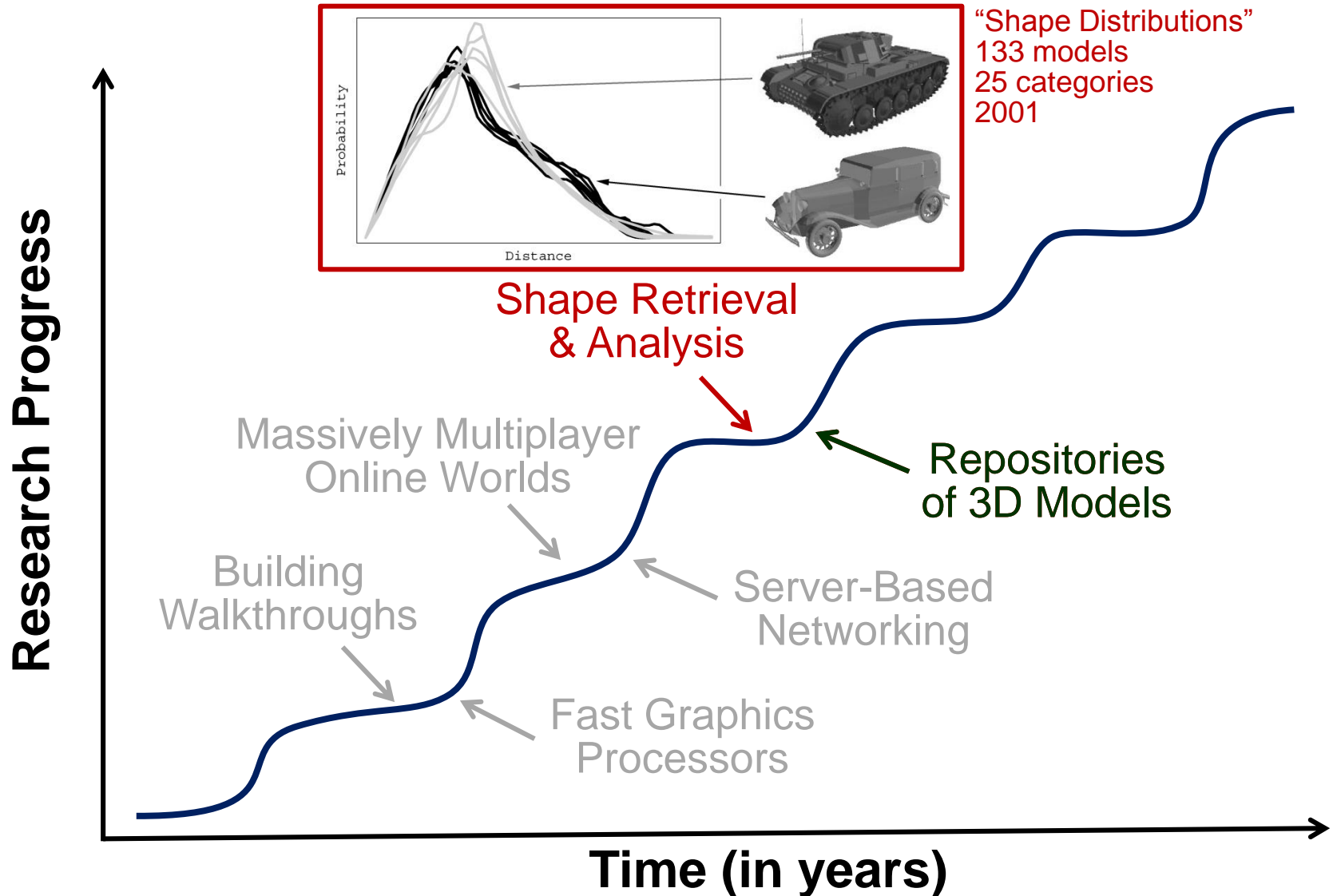
2. Anticipate Disruptive Technologies



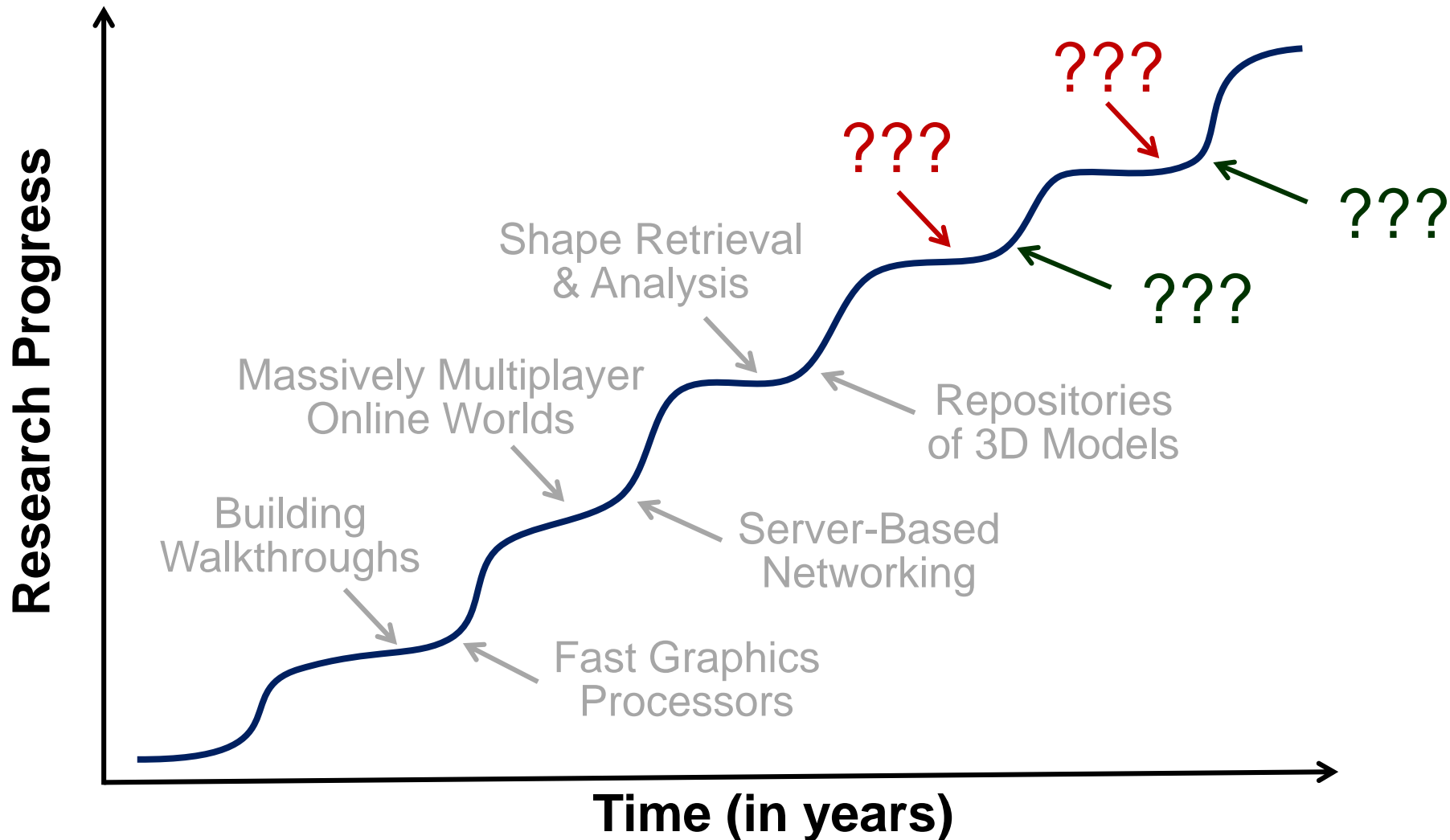
2. Anticipate Disruptive Technologies



2. Anticipate Disruptive Technologies



2. Anticipate Disruptive Technologies



3. Think Beyond Algorithms

3. Think Beyond Algorithms

There are many ways to contribute to research:

- Develop algorithms
- Design systems
- Collect data sets
- Develop benchmarks
- Formulate problems
- Prove theorems
- Write surveys
- etc.

3. Think Beyond Algorithms

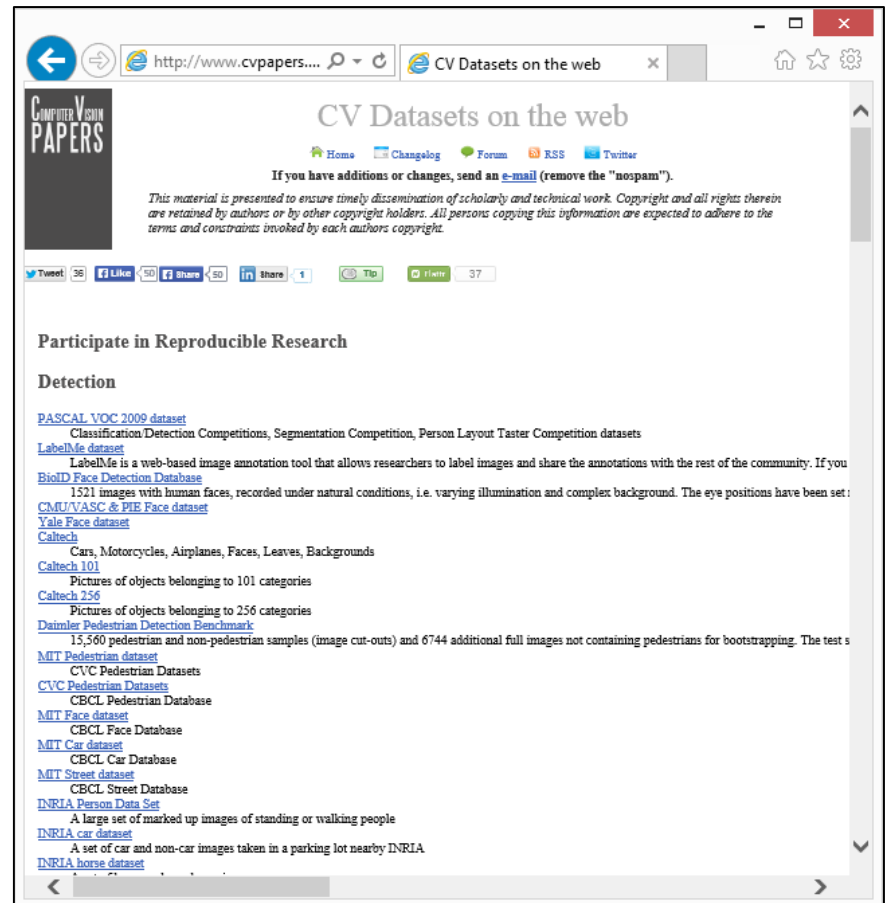
There are many ways to contribute to research:

- Develop algorithms
- Design systems
- **Collect data sets**
- Develop benchmarks
- Formulate problems
- Prove theorems
- Write surveys
- etc.

3. Think Beyond Algorithms

There are many ways to contribute to research:

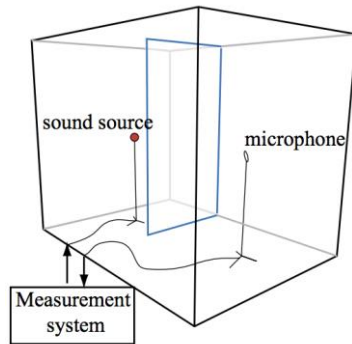
- Develop algorithms
- Design systems
- **Collect data sets**
- Develop benchmarks
- Formulate problems
- Prove theorems
- Write surveys
- etc.



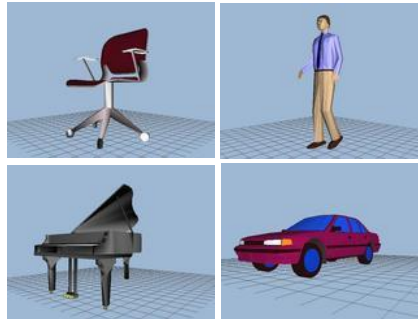
www.cvpapers.com/datasets.html

3. Think Beyond Algorithms

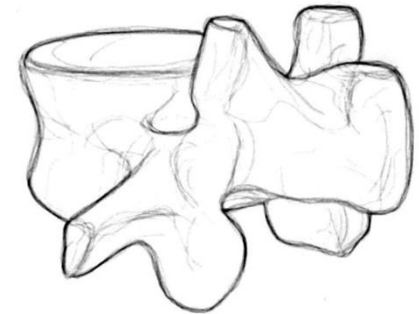
Some of my projects focused on collecting data sets:



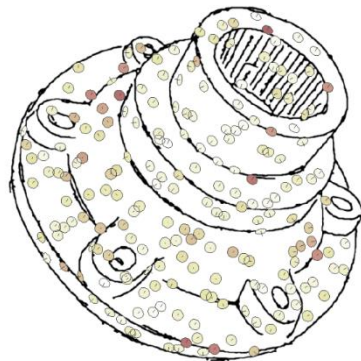
Sound Propagation
[Tsingos02]



Shape Retrieval
[Shilane04]



Line Drawing
[Cole08]



Shape Perception
[Cole09]



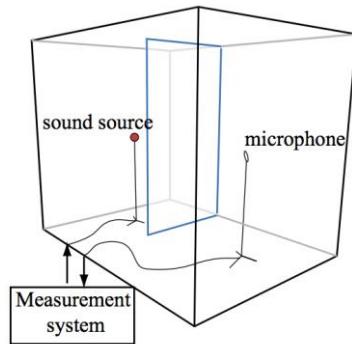
Mesh Segmentation
[Chen09]



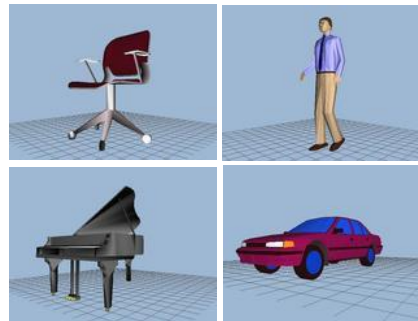
Schelling Points
[Chen12]

3. Think Beyond Algorithms

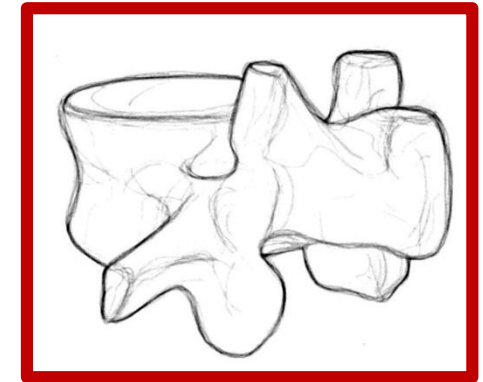
Some projects focused on collecting data sets:



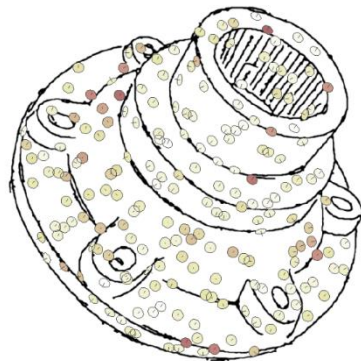
Sound Propagation
[Tsingos2]



Shape Retrieval
[Shilane04]



Line Drawing
[Cole08]



Shape Perception
[Cole09]



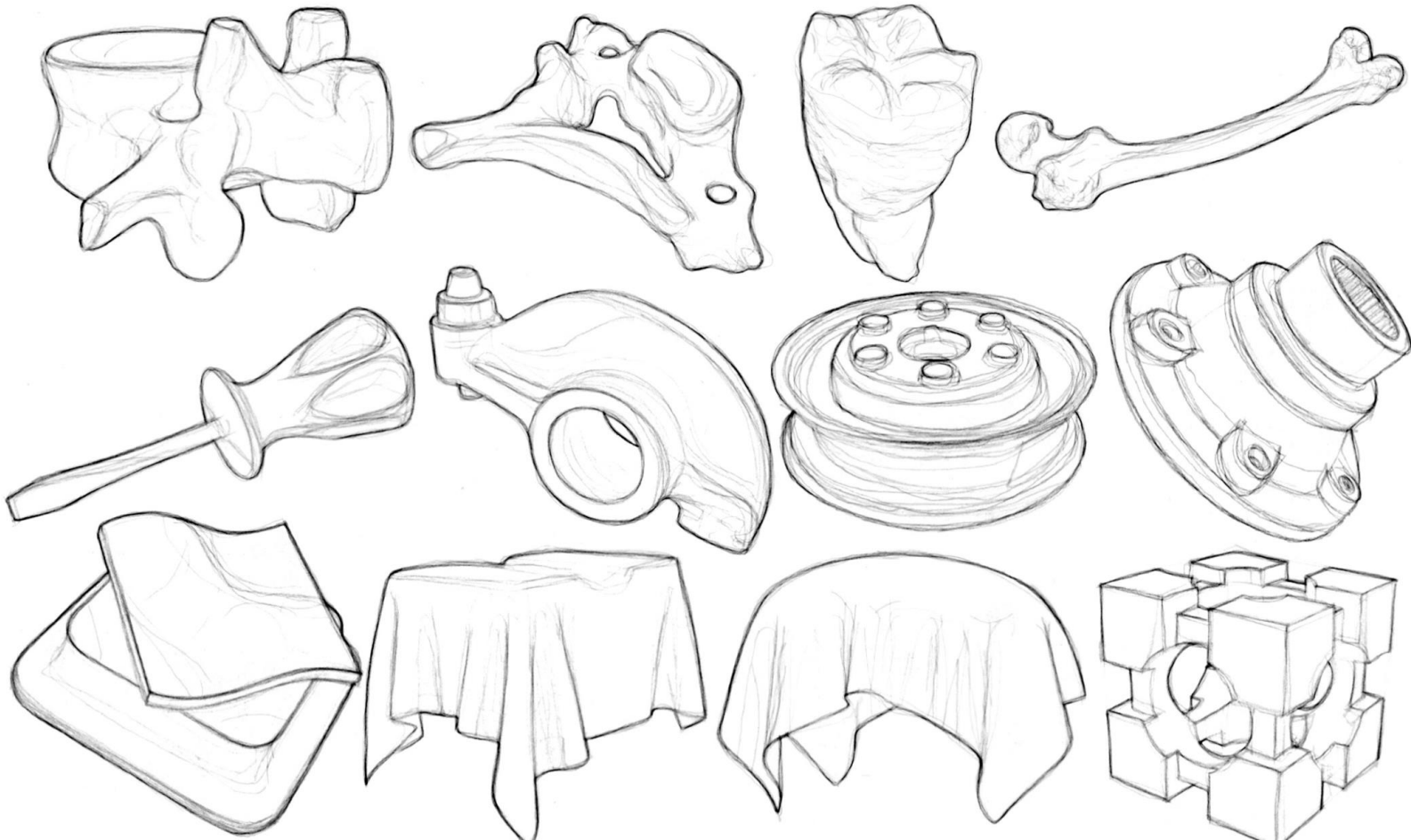
Mesh Segmentation
[Chen09]



Surface Saliency
[Chen12]

3. Think Beyond Algorithms

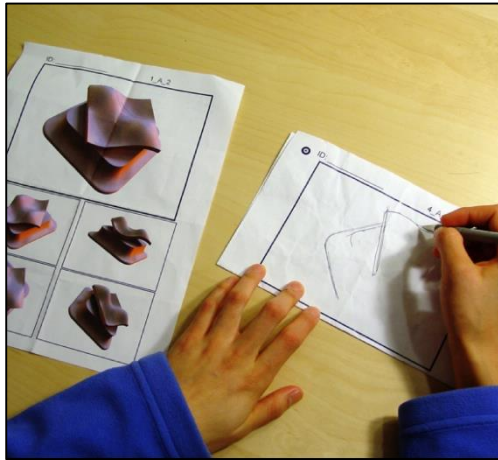
Example: “Where Do People Draw Lines?”



3. Think Beyond Algorithms

Example: “Where Do People Draw Lines?”

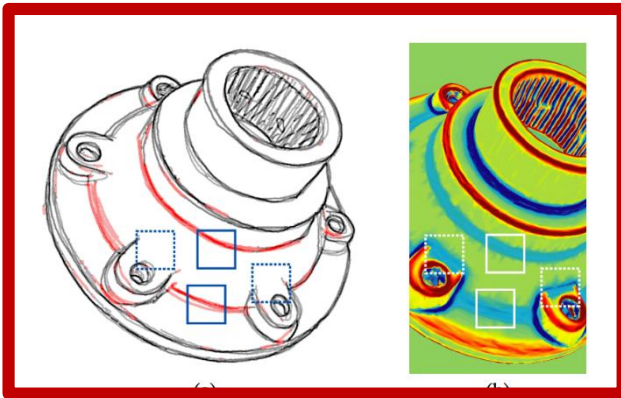
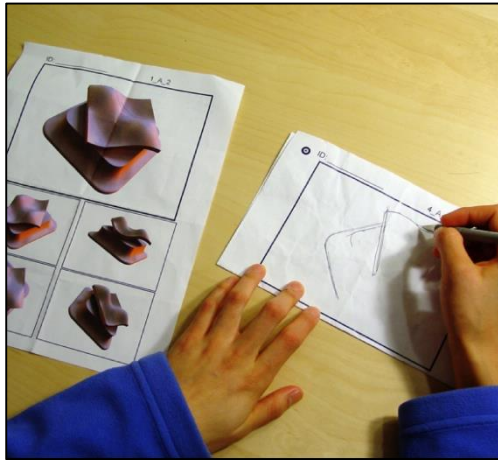
Collect data
while people
perform a task



3. Think Beyond Algorithms

Example: “Where Do People Draw Lines?”

Collect data
while people
perform a task

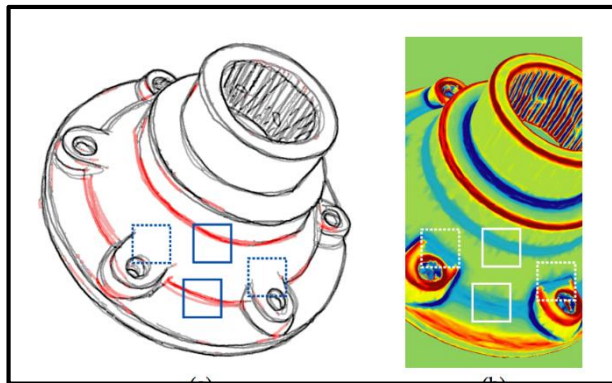
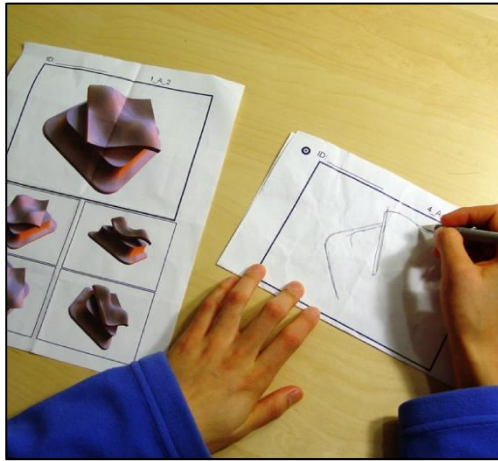


Analyze data

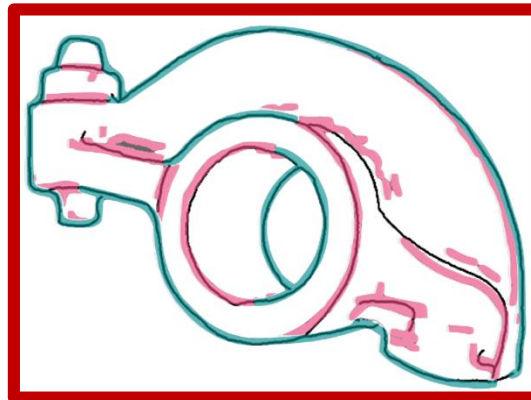
3. Think Beyond Algorithms

Example: “Where Do People Draw Lines?”

Collect data
while people
perform a task



Analyze data

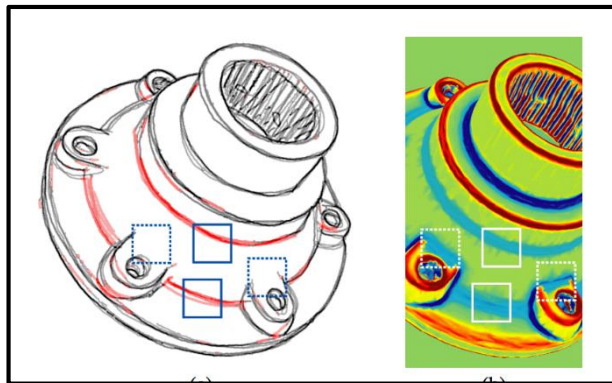
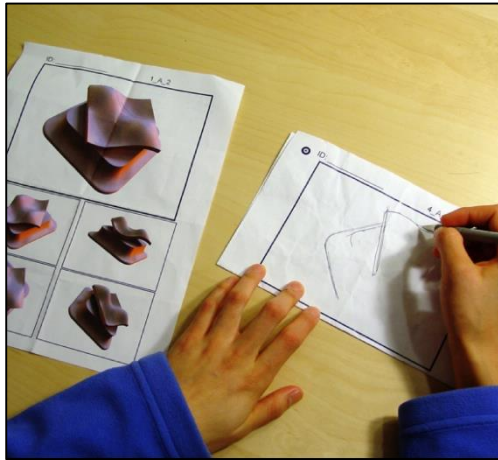


Evaluate existing algorithms

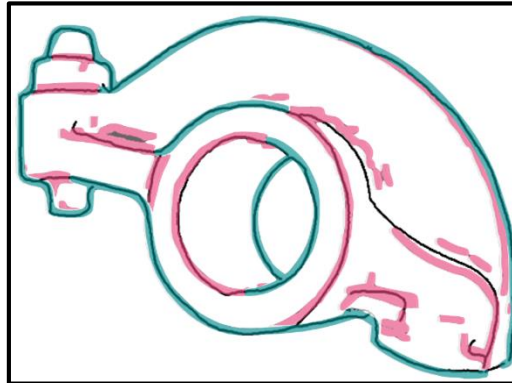
3. Think Beyond Algorithms

Example: “Where Do People Draw Lines?”

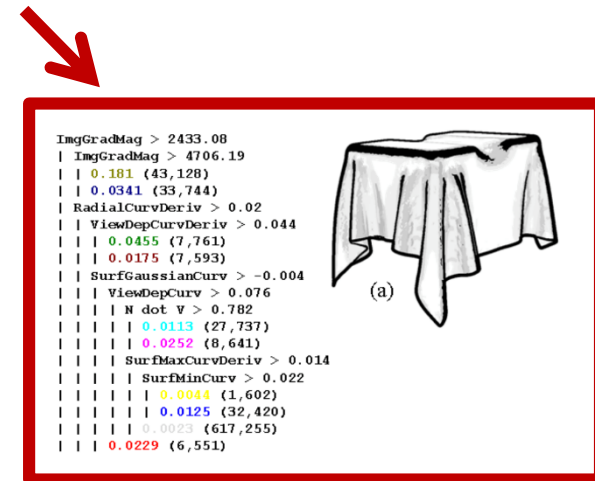
Collect data
while people
perform a task



Analyze data



Evaluate existing algorithms

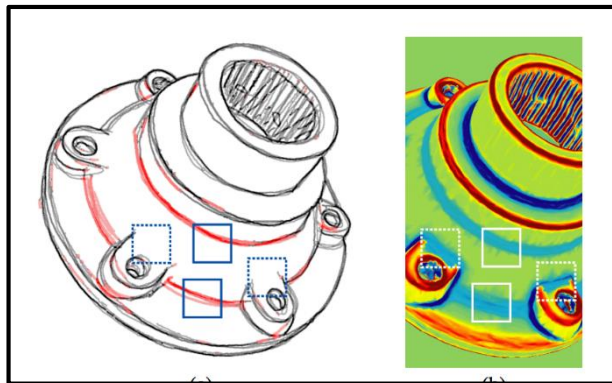
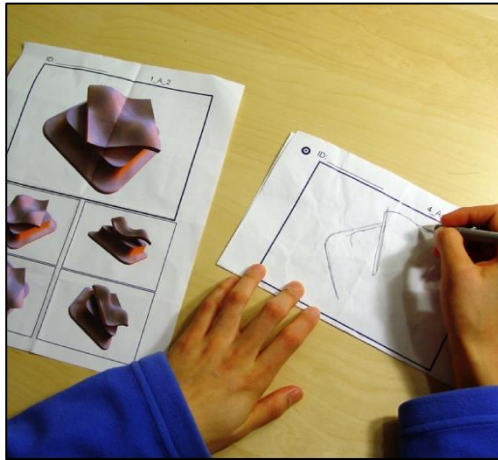


Learn to perform task

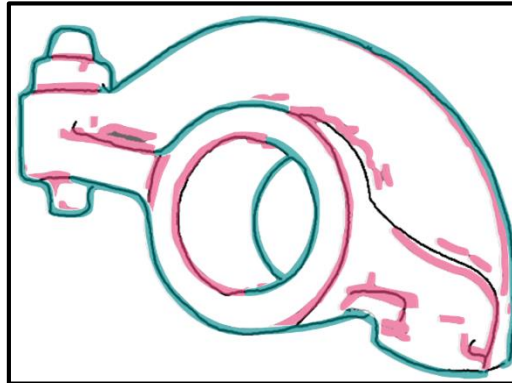
3. Think Beyond Algorithms

Example: “Where Do People Draw Lines?”

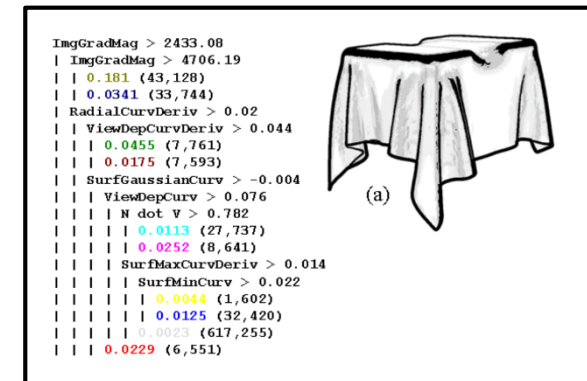
Collect data
while people
perform a task



Analyze data



Evaluate existing algorithms



Learn to perform task

4. Work on Real Applications

4. Work on Real Applications

Applications

Core Computer Graphics

Technologies

4. Work on Real Applications

Core Computer Graphics

Cameras

Processors

Sensors

Printers

Displays

Scanners

Trackers

4. Work on Real Applications

Paleontology?

Neuroscience?

Biology?

Geology?

Product Design?

Education?

Medicine?

Archaeology?

Civil Engineering?

Psychology?

Core Computer Graphics

Cameras

Processors

Sensors

Printers

Displays

Scanners

Trackers

4. Work on Real Applications

Paleontology?

Neuroscience?

Biology?

Geology?

Product Design?

Education?

Medicine?

Archaeology?

Civil Engineering?

Psychology?

*“The Computer Scientist as a Toolsmith”
Frederick P. Brooks, Jr.
ACM Allen Newell Award Presentation
SIGGRAPH 1994*

Cameras

Processors

Sensors

Printers

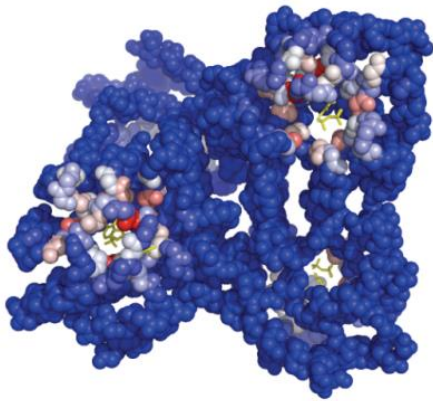
Displays

Scanners

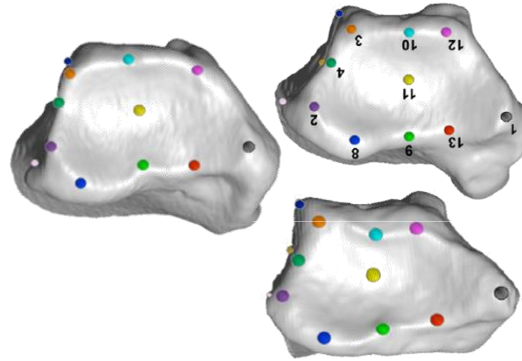
Trackers

4. Work on Real Applications

Some projects focused on applications:



Molecular Biology
[Capra09]



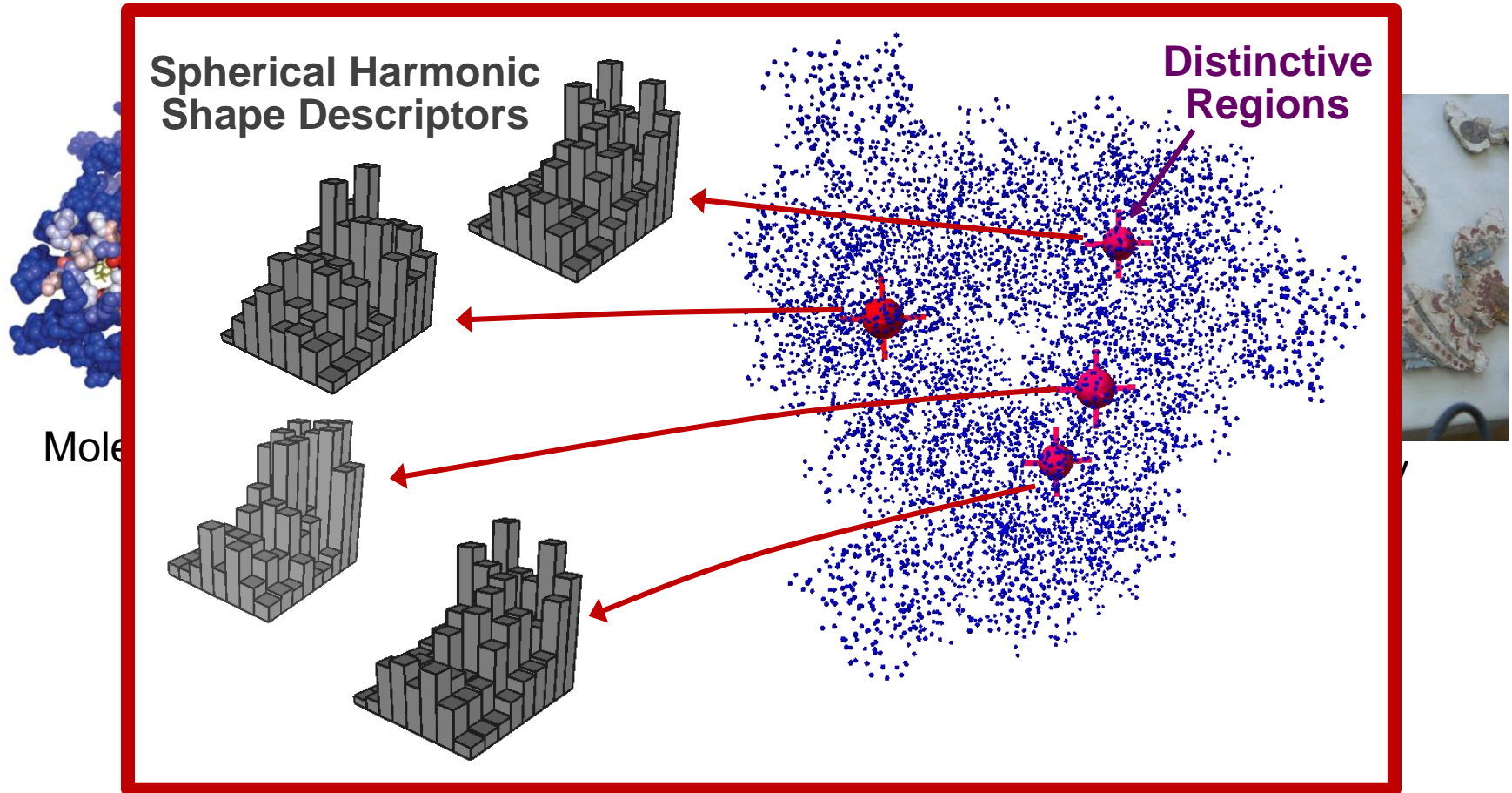
Paleontology
[Boyer11]



Archaeology
[Shin12]

4. Work on Real Applications

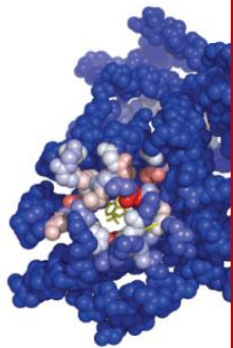
Some projects focused on applications:



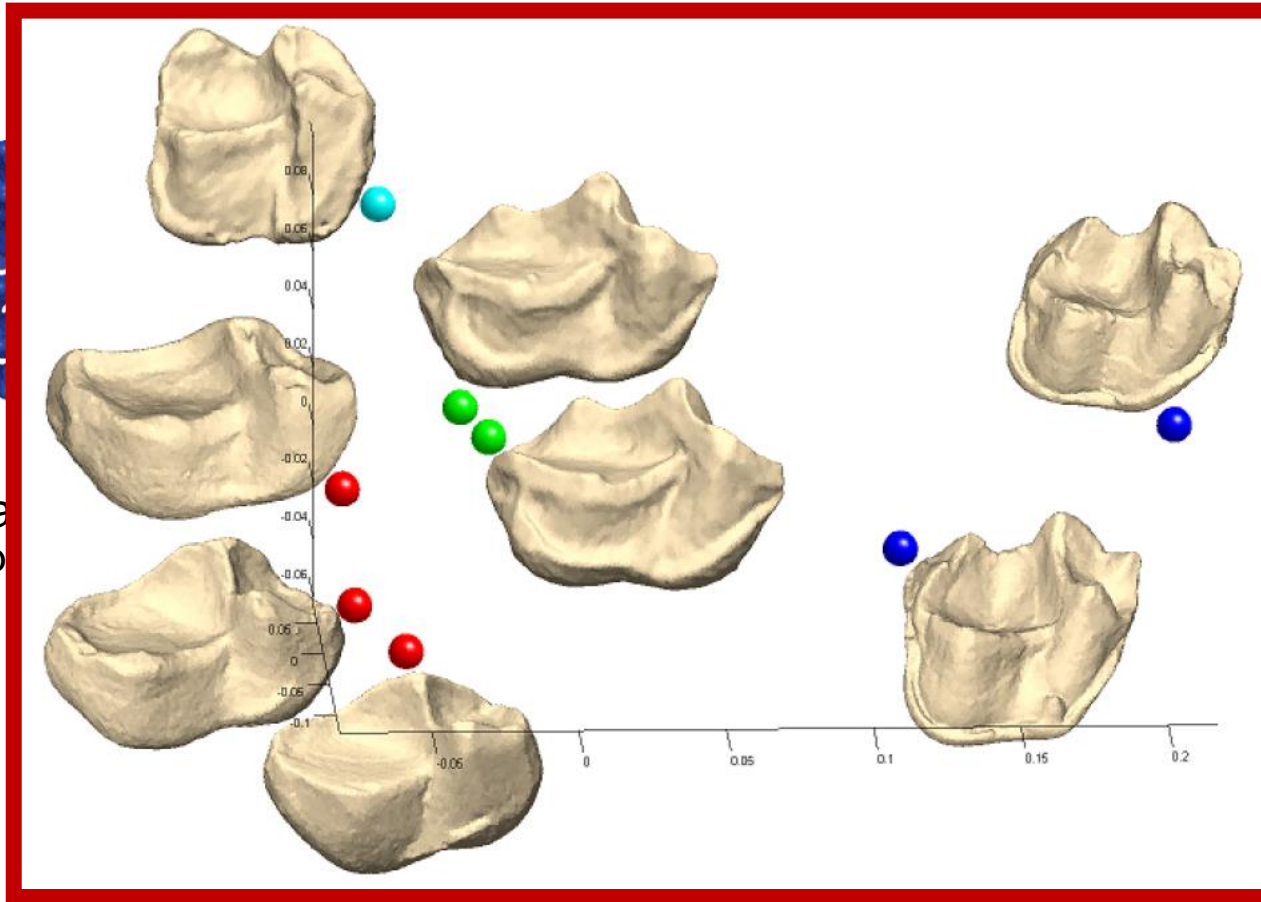
Using partial shape matching to help find proteins with similar functions

4. Work on Real Applications

Some projects focused on applications:



Molecular
[Cap

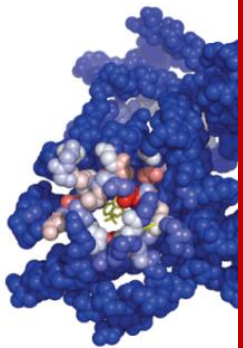


ology
12]

Using a surface dissimilarity metric to help classify scans of fossils

4. Work on Real Applications

Some projects focused on applications:



Molecular
[Capr]

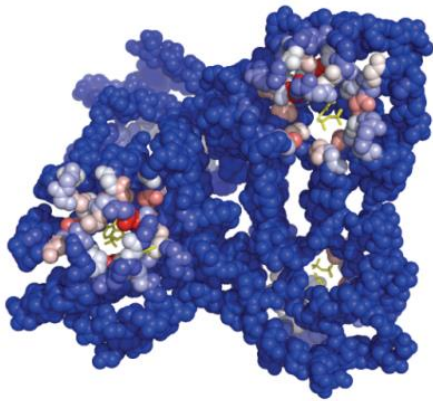


ology
[12]

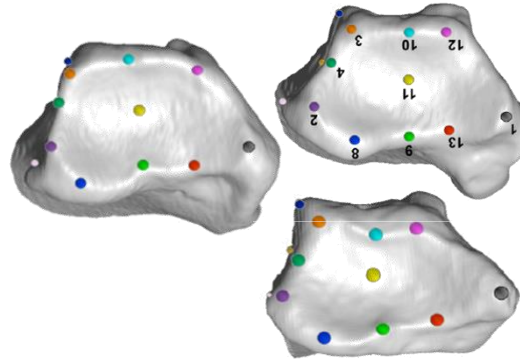
Using shape matching to help reconstruct fractured wall paintings

4. Work on Real Applications

Some projects focused on applications:



Molecular Biology
[Capra09]



Paleontology
[Boyer11]



Archaeology
[Shin12]

5. Work With Good Collaborators

5. Work With Good Collaborators

Postdocs:

- Daniel Aliaga
- Jian Sun
- Sid Chaudhuri
- Yaron Lipman

Ph.D. students:

- Aleksey Boyko
- Aleksey Golovinskiy
- Elena Sizikova
- Fisher Yu
- Maciej Halber
- Michael Kazhdan
- Patrick Min
- Paul Calamia
- Philip Shilane
- Rudrajit Samanta
- Tianqiang Liu
- Vladimir Kim
- Xiaobai Chen

Undergrad students:

- Abulhair Saparov
- Addy Ngan
- Alex Halderman
- Alex Limpaecher
- Angela Dai
- Bill Pang
- Carolyn Chen
- Celeste Fowler
- Hijung Shin
- Jeehyung Lee
- Joyce Chen
- William Kiefer
- Wilmot Li

5. Work With Good Collaborators



Adam
Finkelstein



Szymon
Rusinkiewicz



David
Dobkin

Postdocs:

- Pierre B nard
- David Bourguignon
- Martin Fuchs
- Lee Markosian
- Tim Weyrich

Ph.D. Students:

- Allison Klein
- Benedict Brown
- Chris DeCoro
- Connelly Barnes
- Corey Toler-Franklin

- Diego Nehab
- Emil Praun
- Forrester Cole
- Huiwen Chang
- Jason Lawrence
- Jingwan Lu
- Joshua Podolak
- Linjie Liu
- Ohad Fried
- Michael Burns
- Sema Berkiten
- Thiago Pereira
- Wagner Correa
- Xinyi Fan
- Yiming Liu
- Zhiyan Liu

5. Work With Good Collaborators

UC Berkeley:

- Carlo Séquin
- Seth Teller

Bell Labs:

- Ingrid Carlbom
- Alex Biliris
- Gopal Pingali
- Nicolas Tsingos
- T.M. Murali

Stanford:

- Daniel Ritchie
- Manolis Savva
- Matthew Fisher
- Pat Hanrahan
- Qixing Huang

Other Institutions:

- Aaron Hertzmann
- Ayellet Tal
- Dan Goldman
- David Jacobs
- Doug DeCarlo
- Eli Schechtman
- Evangelos Kalogerakis
- Hanspeter Pfister
- Jim McCann
- Leonidas Guibas
- Niloy Mitra
- Raif Rustamov
- Stephen DiVerdi
- Wilmot Li
- Wojciech Matusik

Other Disciplines:

- Andreas Vlachopoulos
- Ben Shedd
- Christos Doumas
- Doug Boyer
- Gary Elko
- Heather Barros
- James West
- Janet Thornton
- Jukka Jernvall
- Manish Singh
- Mohan Sondhi
- Otto J Anshus
- Peter Svensson
- Roman Laskowski

5. Work With Good Collaborators

UC Berkeley:

➤ Carlo Séquin



- Daniel Ritchie
- Manolis Savva
- Matthew Fisher
- Pat Hanrahan
- Qixing Huang

Other Institutions:

- Aaron Hertzmann
- Ayellet Tal
- Dan Goldman
- David Jacobs
- Doug DeCarlo
- Eli Schechtman
- Evangelos Kalogerakis
- Hanspeter Pfister
- Jim McCann
- Leonidas Guibas
- Niloy Mitra
- Raif Rustamov
- Stephen DiVerdi
- Wilmot Li
- Wojciech Matusik

Other Disciplines:

- Andreas Vlachopoulos
- Ben Shedd
- Christos Doumas
- Doug Boyer
- Gary Elko
- Heather Barros
- James West
- Janet Thornton
- Jukka Jernvall
- Manish Singh
- Mohan Sondhi
- Otto J Anshus
- Peter Svensson
- Roman Laskowski

5. Work With Good Collaborators

UC Berkeley:

- Carlo Séquin
- Seth Teller



Stanford:

- Daniel Ritchie
- Manolis Savva
- Matthew Fisher
- Pat Hanrahan
- Qixing Huang

Other Institutions:

- Aaron Hertzmann
- Ayellet Tal
- Dan Goldman
- David Jacobs
- Doug DeCarlo
- Eli Schechtman
- Evangelos Kalogerakis
- Hanspeter Pfister
- Jim McCann
- Leonidas Guibas
- Niloy Mitra
- Raif Rustamov
- Stephen DiVerdi
- Wilmot Li
- Wojciech Matusik

Other Disciplines:

- Andreas Vlachopoulos
- Ben Shedd
- Christos Doumas
- Doug Boyer
- Gary Elko
- Heather Barros
- James West
- Janet Thornton
- Jukka Jernvall
- Manish Singh
- Mohan Sondhi
- Otto J Anshus
- Peter Svensson
- Roman Laskowski

5. Work With Good Collaborators

UC Berkeley:

- Carlo Séquin
- Seth Teller

Bell Labs:

➤ Ingrid Carlbom



- Matthew Fisher
- Pat Hanrahan
- Qixing Huang

Other Institutions:

- Aaron Hertzmann
- Ayellet Tal
- Dan Goldman
- David Jacobs
- Doug DeCarlo
- Eli Schechtman
- Evangelos Kalogerakis
- Hanspeter Pfister
- Jim McCann
- Leonidas Guibas
- Niloy Mitra
- Raif Rustamov
- Stephen DiVerdi
- Wilmot Li
- Wojciech Matusik

Other Disciplines:

- Andreas Vlachopoulos
- Ben Shedd
- Christos Doumas
- Doug Boyer
- Gary Elko
- Heather Barros
- James West
- Janet Thornton
- Jukka Jernvall
- Manish Singh
- Mohan Sondhi
- Otto J Anshus
- Peter Svensson
- Roman Laskowski

5. Work With Good Collaborators

UC Berkeley:

- Carlo Séquin
- Seth Teller

Bell Labs:

Ingrid Isenhardt



- Pat Hanrahan
- Qixing Huang

Other Institutions:

- Aaron Hertzmann
- Ayellet Tal
- Dan Goldman
- David Jacobs
- Doug DeCarlo
- Eli Schechtman
- Evangelos Kalogerakis
- Hanspeter Pfister
- Jim McCann
- Leonidas Guibas
- Niloy Mitra
- Raif Rustamov
- Stephen DiVerdi
- Wilmot Li
- Wojciech Matusik

Other Disciplines:

- Andreas Vlachopoulos
- Ben Shedd
- Christos Doumas
- Doug Boyer
- Gary Elko
- Heather Barros
- James West
- Janet Thornton
- Jukka Jernvall
- Manish Singh
- Mohan Sondhi
- Otto J Anshus
- Peter Svensson
- Roman Laskowski

5. Work With Good Collaborators

Family:



5. Work With Good Collaborators

Thank You!