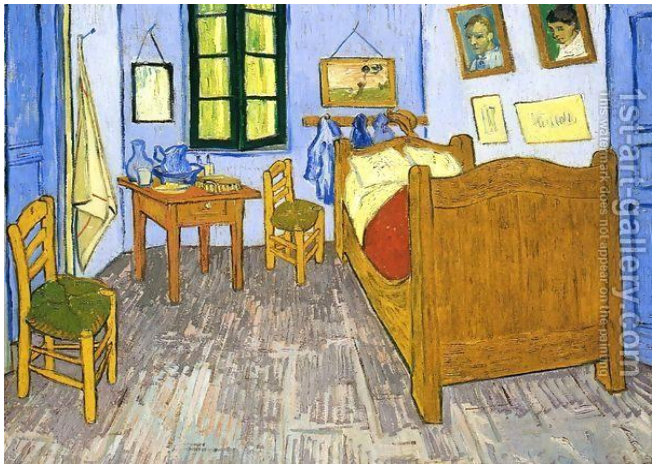
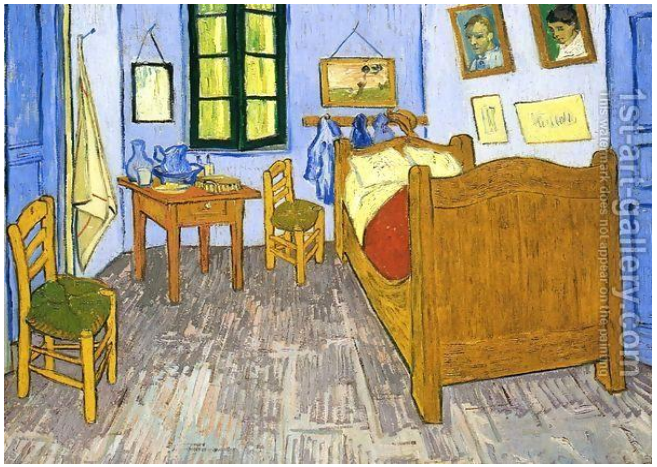


CS331B (3 units)

3dRR: Representation and Recognition

Lecture 3

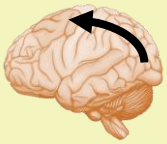


CS331B (3 units)

3dRR: Representation and Recognition

Announcements:

- Project proposal deadline coming up in 10 days!
- Look at the syllabus for updates



WHERE

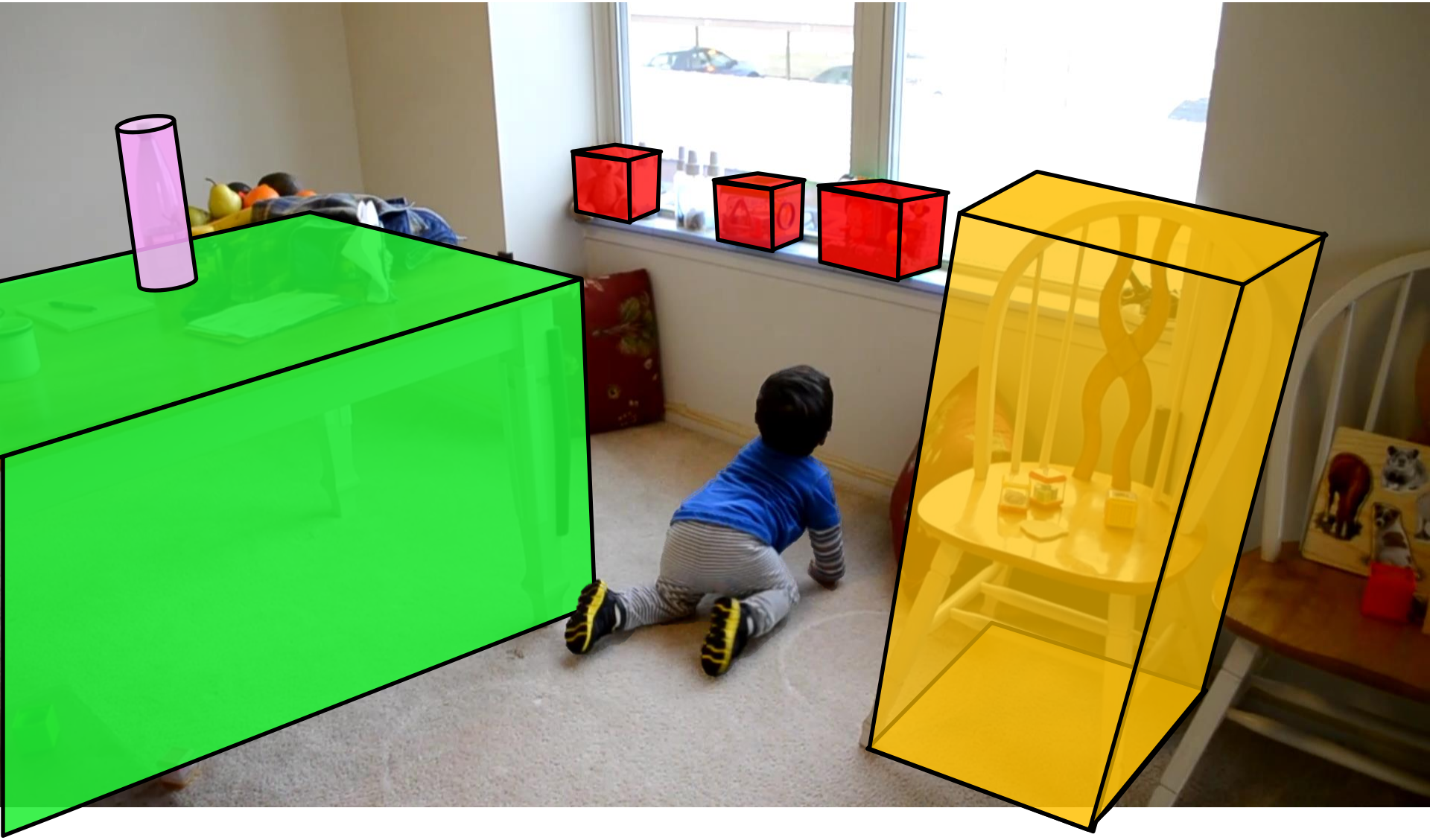
- 3D shape modeling
- 3D scene reconstruction
- Camera localization

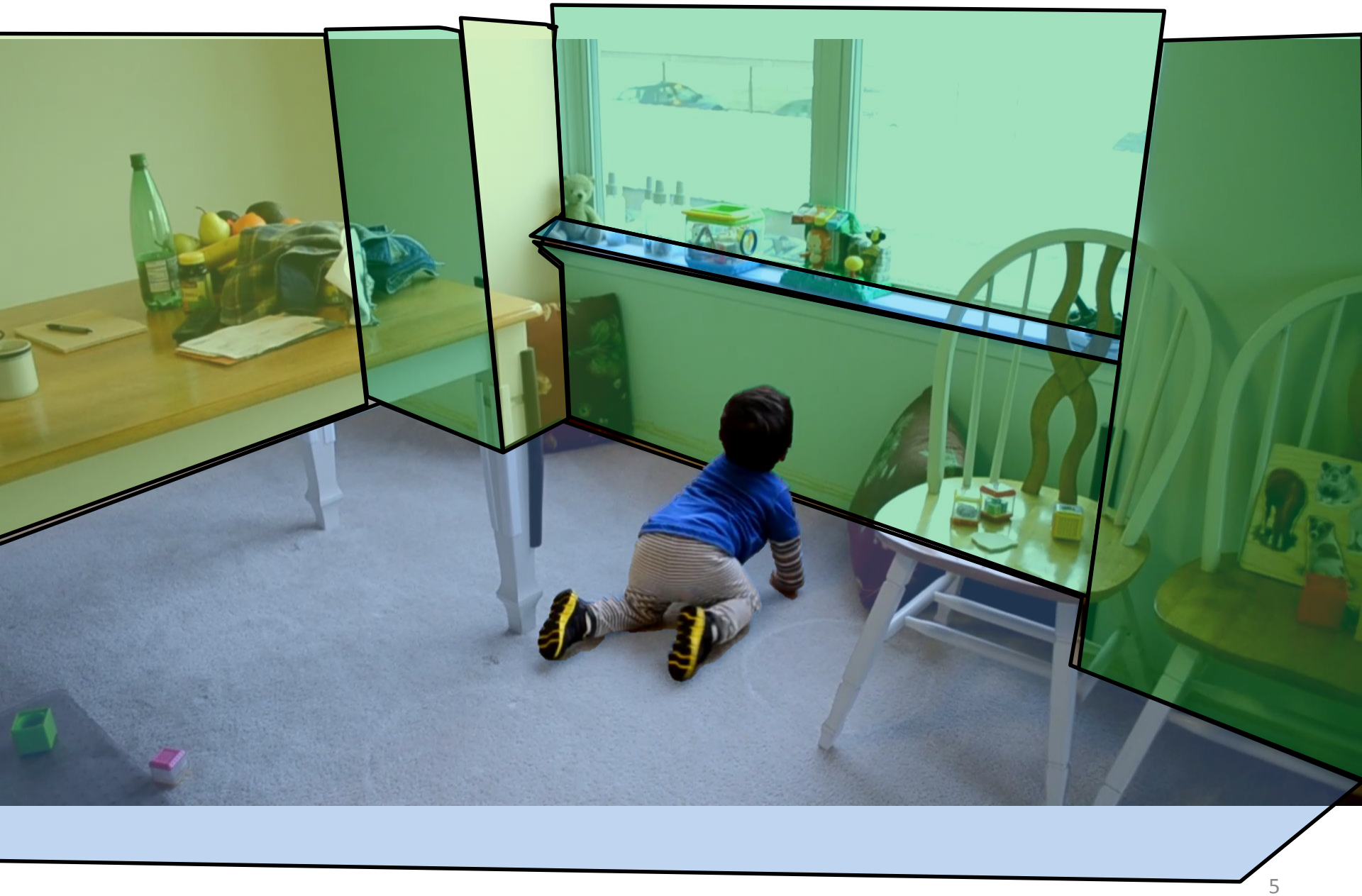
WHAT

- Material classification
- Object recognition
- Scene classification
- Target tracking
- Activity recognition

Understanding the 3D world

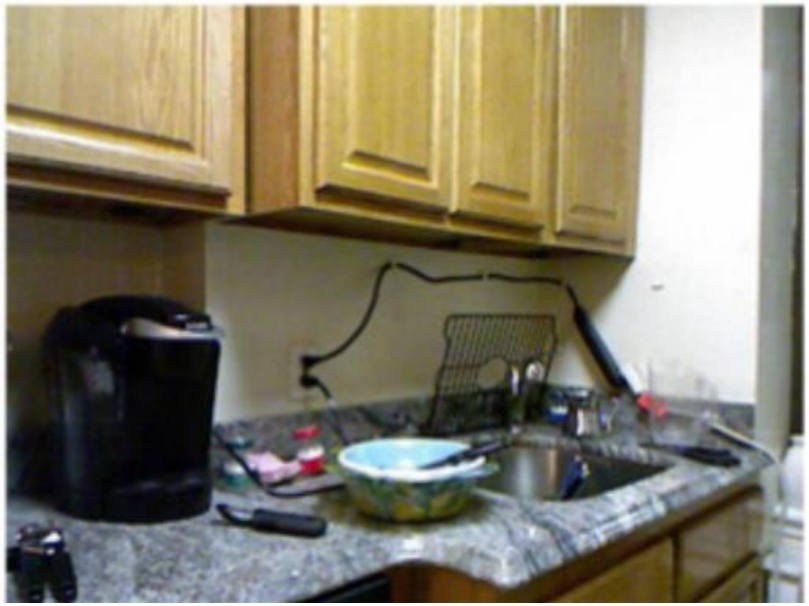
- 3D Object detection
- 3D scene understanding
- Activity understanding

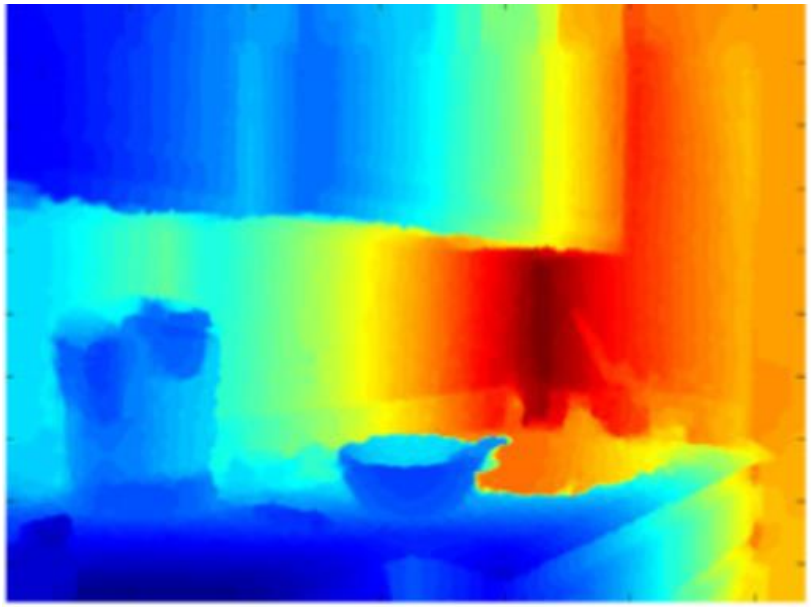




Representing the 3D space

- Retinotopics (each 2D pixel is associated to a depth value)
  - Depth maps (from Stereo, D-RGB, etc….)

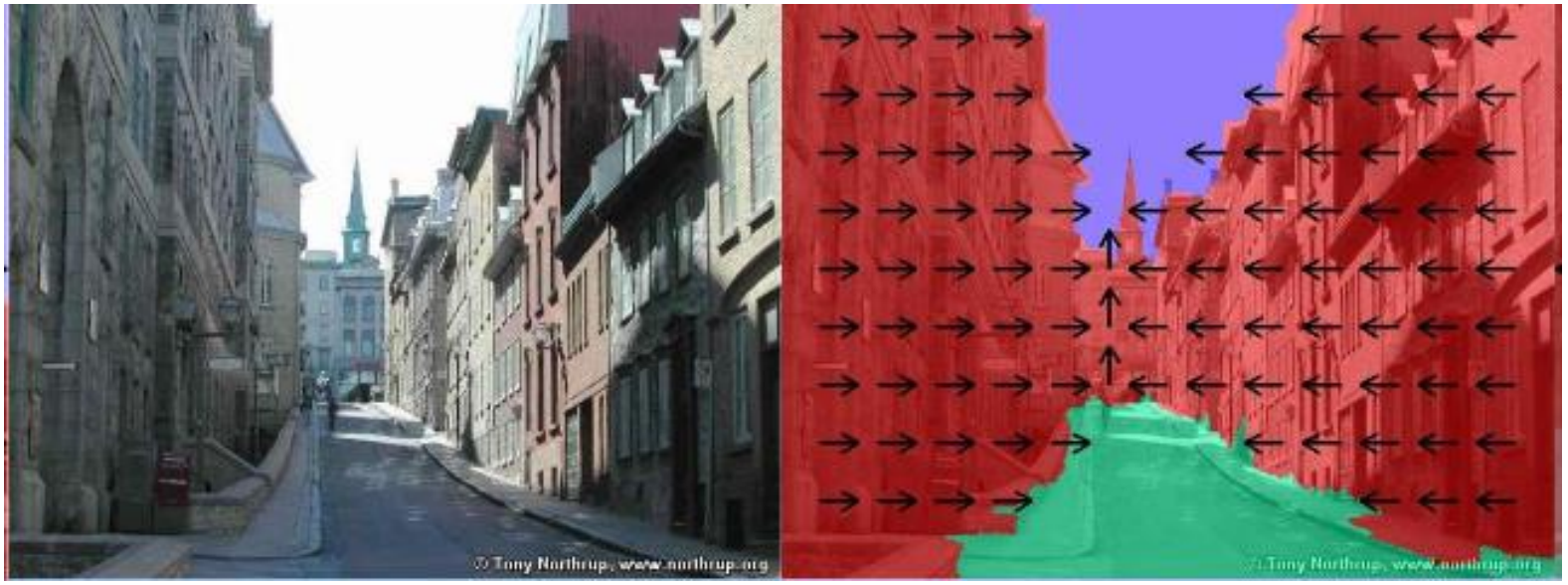




From X. Ren et al., CVPR 11, UW-dataset

Representing the 3D space

- Retinotopics (each 2D pixel is associated to a depth value)
  - Depth maps (from Stereo, D-RGB, etc….)
  - Orientation maps (from single view)



Hoiem et al. 05

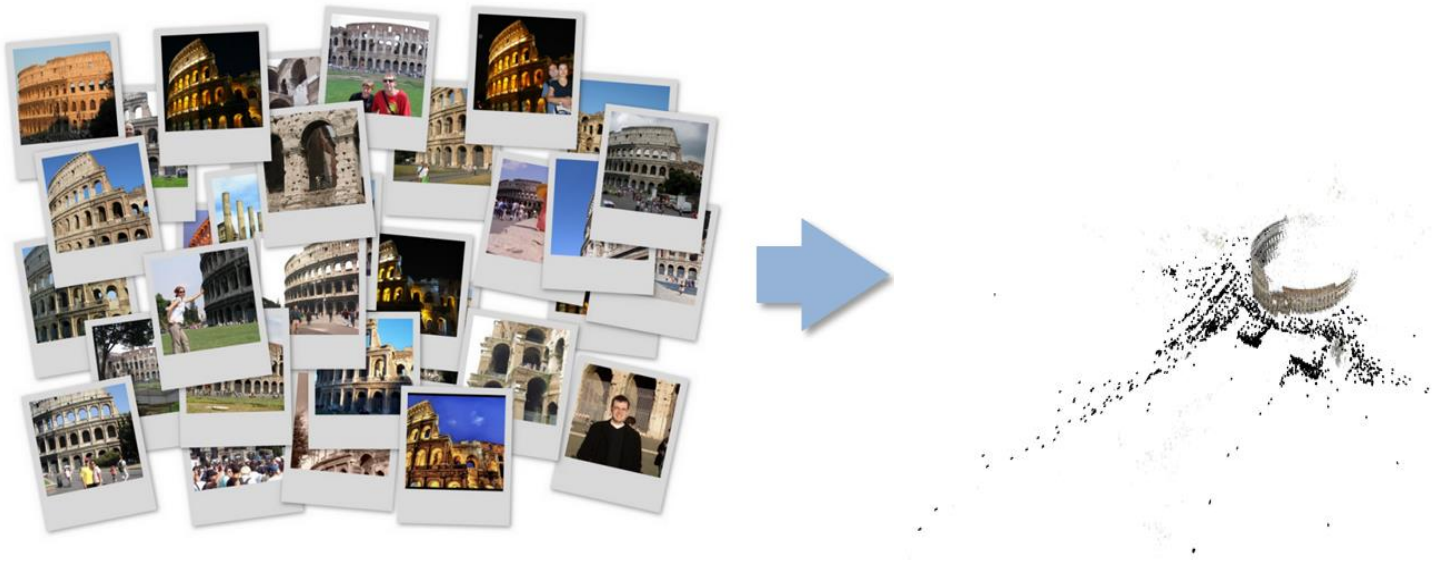
Representing the 3D space

- Retinotopics (each 2D pixel is associated to a depth value)
  - Depth maps (from Stereo, D-RGB, etc….)
  - Orientation maps (from single view)

Hoiem et al. 05

Representing the 3D space

- 3D point clouds (2D features are associated to 3D points)



From sparse images (SFM)

Fitzgibbon & Zisserman, 98
Triggs et al., 99
Pollefeys et al., 99
Kutulakos & Seitz, 99

Lucas & Kanade, 81
Chen & Medioni, 92
Debevec et al., 96
Levoy & Hanrahan, 96

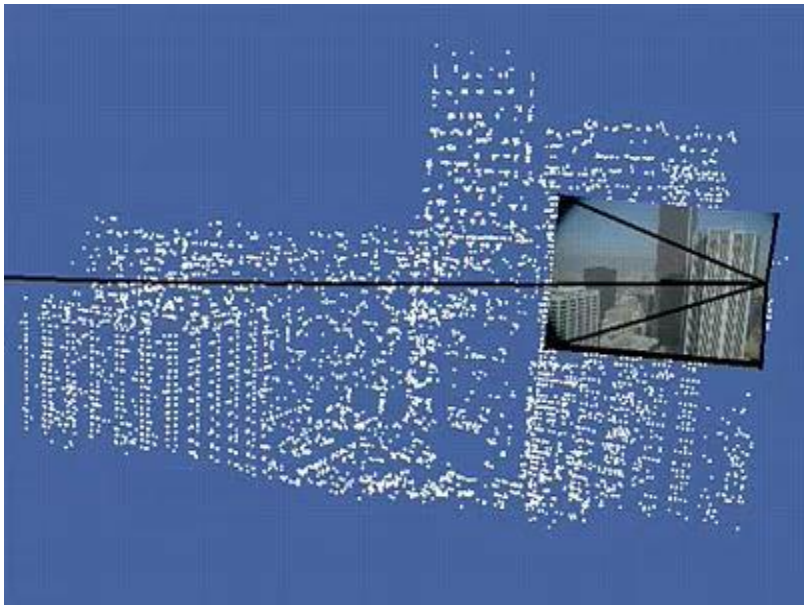
Levoy et al., 00
Hartley & Zisserman, 00
Dellaert et al., 00
Rusinkiewic et al., 02
Nistér, 04
Brown & Lowe, 04

Schindler et al., 04
Lourakis & Argyros, 04
Colombo et al., 05
Savarese et al., IJCV 05
Savarese et al., IJCV 06
Saxena et al., 07-09

Snavely et al., 06-08
Schindler et al., 08
Agarwal et al., 09
Frahm et al., 10
Golparvar-Fard, et al. JAEI 10
Pandey et al. IFAC , 2010
Pandey et al. ICRA 2011

Representing the 3D space

- 3D point clouds (2D features are associated to 3D points)



Courtesy of Oxford Visual Geometry Group

From video frames (SLAM)

Fitzgibbon & Zisserman, 98
Triggs et al., 99
Pollefeys et al., 99
Kutulakos & Seitz, 99

Lucas & Kanade, 81
Chen & Medioni, 92
Debevec et al., 96
Levoy & Hanrahan, 96

Levoy et al., 00
Hartley & Zisserman, 00
Dellaert et al., 00
Rusinkiewic et al., 02
Nistér, 04
Brown & Lowe, 04

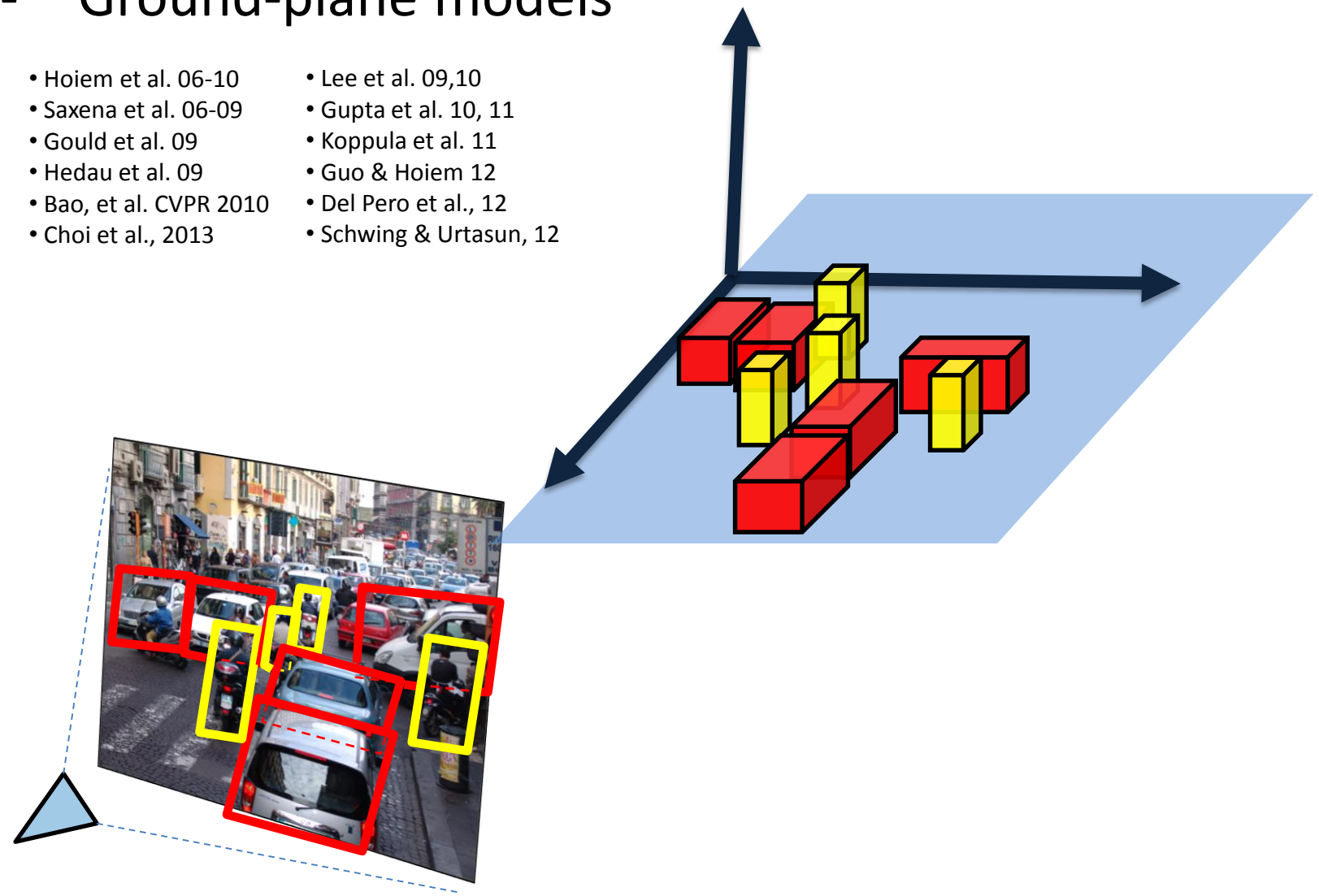
Schindler et al., 04
Lourakis & Argyros, 04
Colombo et al., 05
Savarese et al., IJCV 05
Savarese et al., IJCV 06
Saxena et al., 07-09

Snavely et al., 06-08
Schindler et al., 08
Agarwal et al., 09
Frahm et al., 10
Golparvar-Fard, et al. JAEI 10
Pandey et al. IFAC , 2010
Pandey et al. ICRA 2011

Representing the 3D space

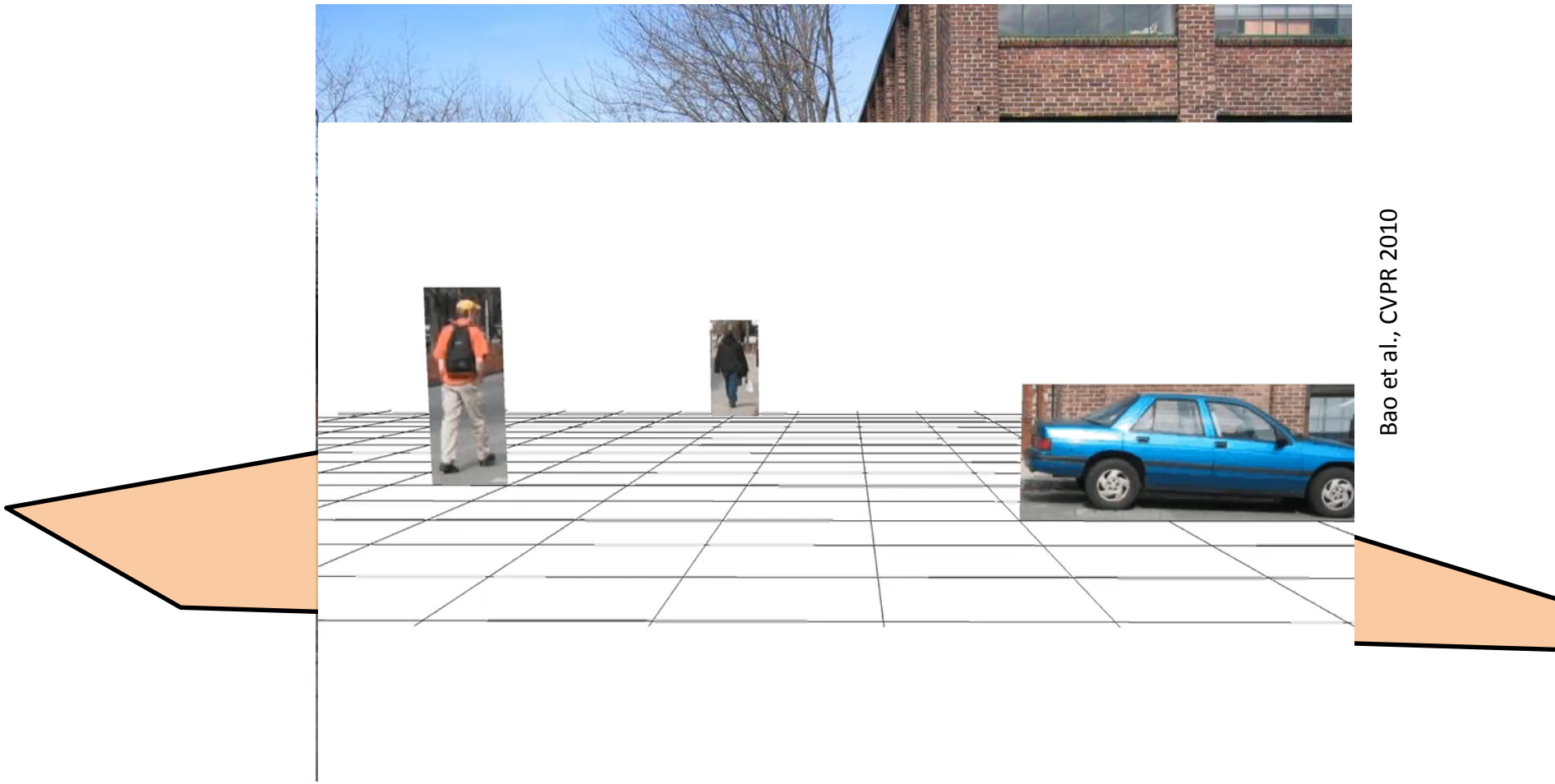
- Ground-plane models

- Hoiem et al. 06-10
- Saxena et al. 06-09
- Gould et al. 09
- Hedau et al. 09
- Bao, et al. CVPR 2010
- Choi et al., 2013
- Lee et al. 09,10
- Gupta et al. 10, 11
- Koppula et al. 11
- Guo & Hoiem 12
- Del Pero et al., 12
- Schwing & Urtasun, 12



Representing the 3D space

- Ground-plane models

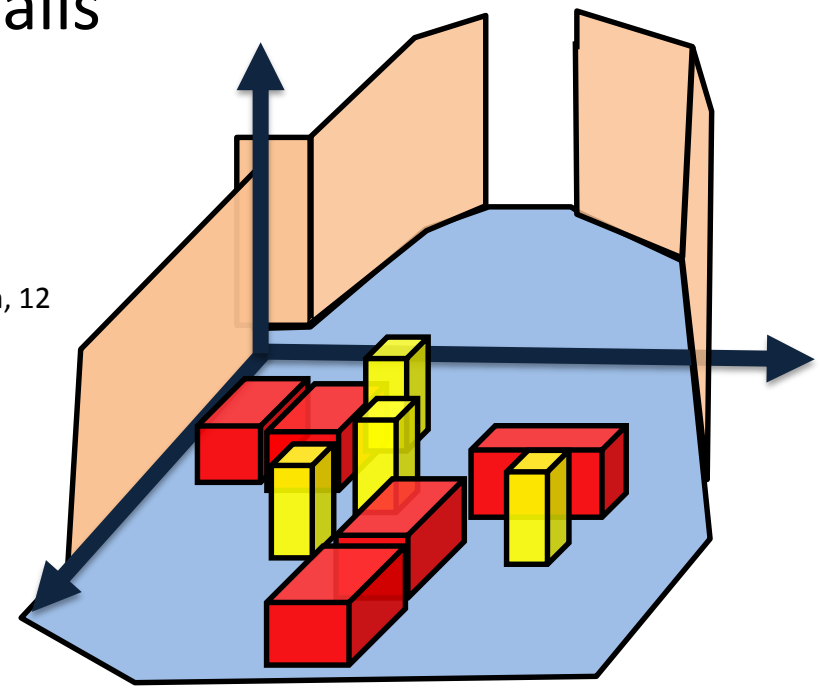


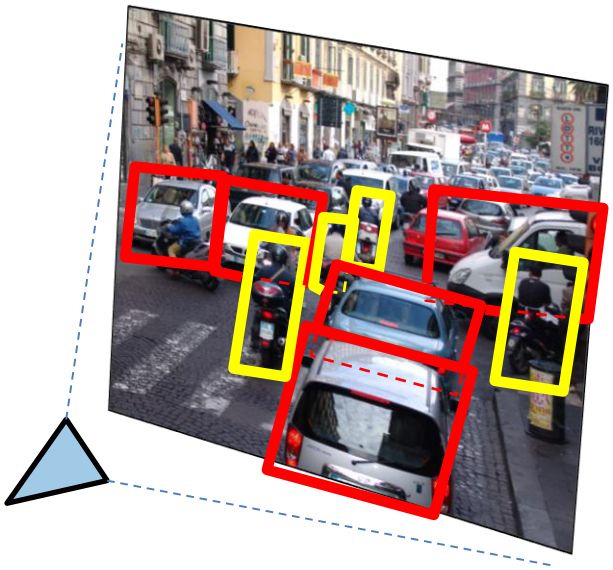
Bao et al., CVPR 2010

Representing the 3D space

- Ground-plane + walls

- Hoiem et al. 06-10
- Saxena et al. 06-09
- Gould et al. 09
- Hedau et al. 09
- Bao, et al. CVPR 2010
- Choi et al., 2013
- Lee et al. 09,10
- Gupta et al. 10, 11
- Koppula et al. 11
- Guo & Hoiem 12
- Del Pero et al., 12
- Schwing & Urtasun, 12

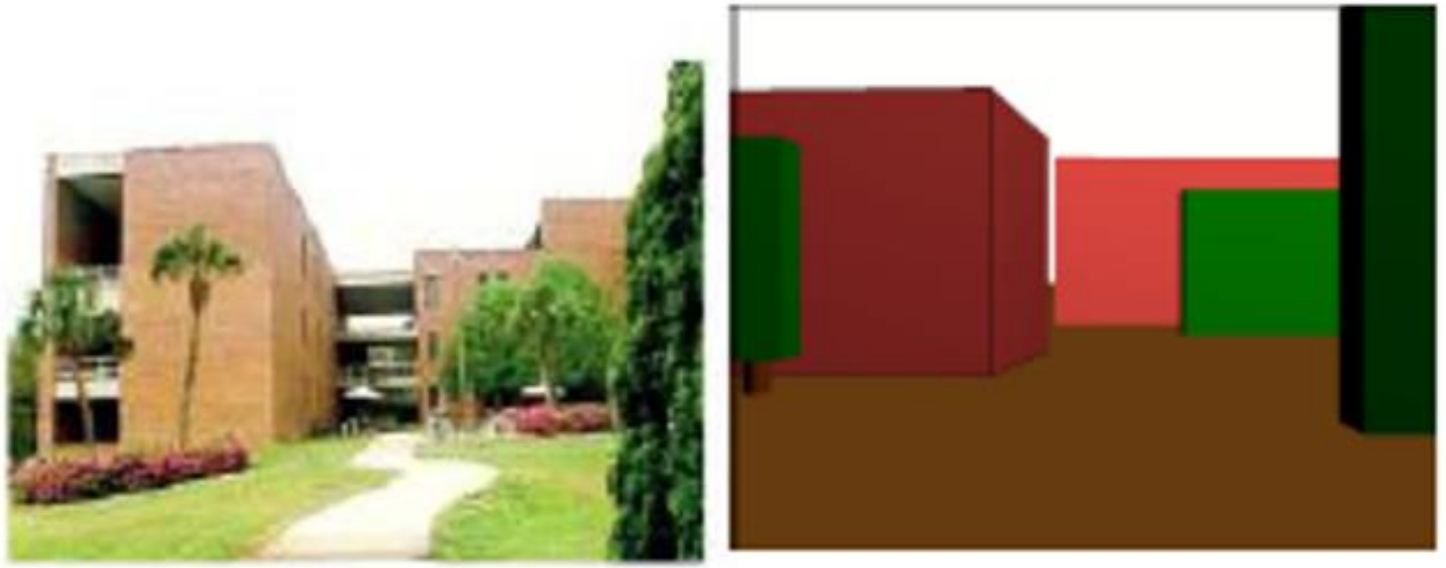




Representing the 3D space

- Block-world models

- Hoiem et al. 06-10
- Saxena et al. 06-09
- Gould et al. 09
- Hedau et al. 09
- Bao, et al. CVPR 2010
- Choi et al., 2013
- Lee et al. 09,10
- Gupta et al. 10, 11
- Koppula et al. 11
- Guo & Hoiem 12
- Del Pero et al., 12
- Schwing & Urtasun, 12

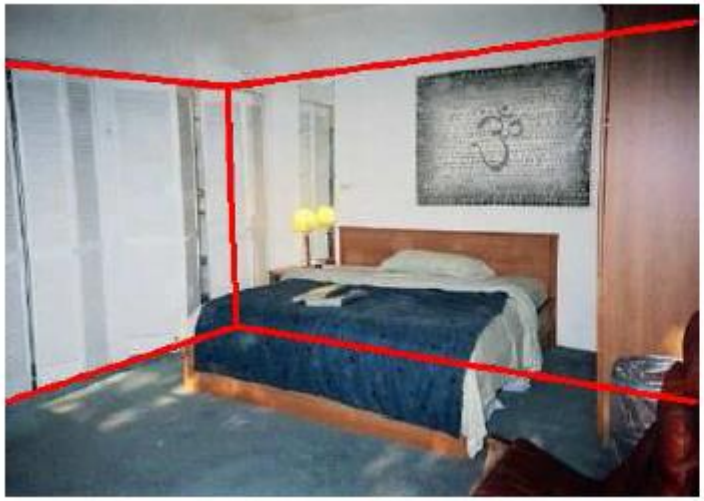


Gupta et al. 10, 11

Representing the 3D space

- Box model

- Hoiem et al. 06-10
- Saxena et al. 06-09
- Gould et al. 09
- Hedau et al. 09
- Bao, et al. CVPR 2010
- Choi et al., 2013
- Lee et al. 09,10
- Gupta et al. 10, 11
- Koppula et al. 11
- Guo & Hoiem 12
- Del Pero et al., 12
- Schwing & Urtasun, 12



Hedau et al. 09

Representing the 3D space

- Box model

- Hoiem et al. 06-10
- Saxena et al. 06-09
- Gould et al. 09
- Hedau et al. 09
- Bao, et al. CVPR 2010
- Choi et al., 2013
- Lee et al. 09,10
- Gupta et al. 10, 11
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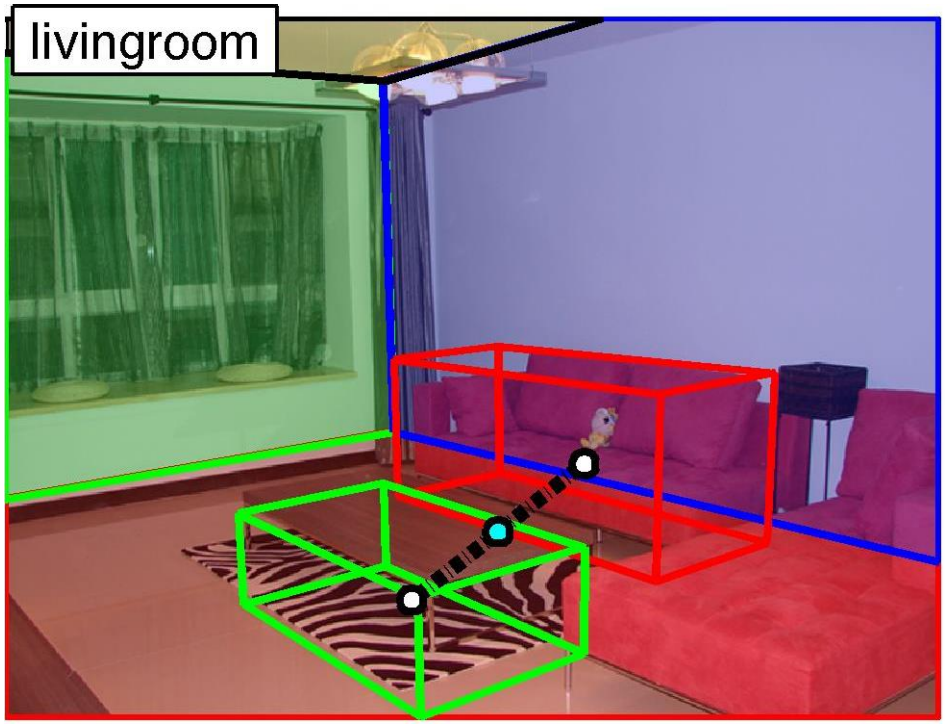
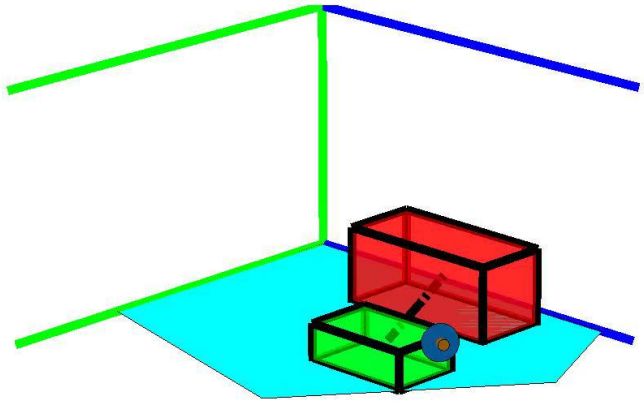


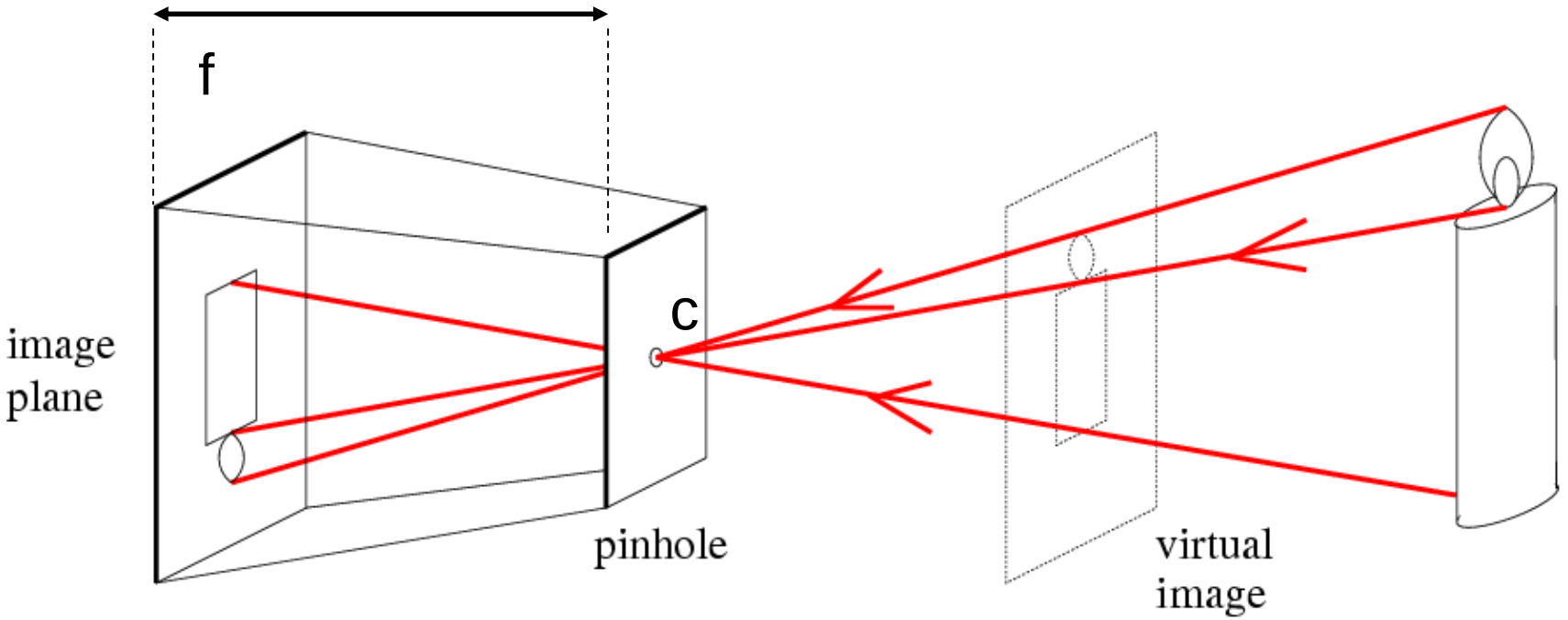


Choi et al., 2013

Representing the observer

- Perspective (pinhole) camera models

(typically used in methods for 3D reconstruction such as SFM or SLAM)



$$(x, y, z) \rightarrow (f\,\frac{x}{z}, f\,\frac{y}{z})$$

Representing the observer

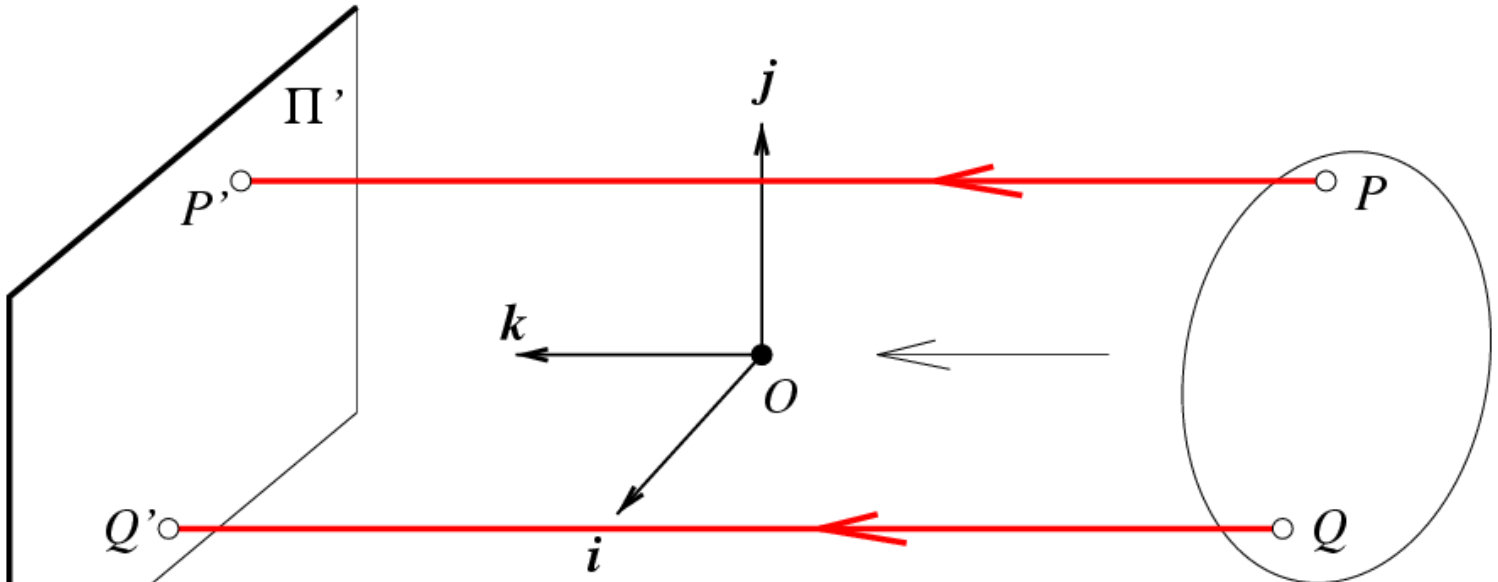
- Perspective (pinhole) camera models

(typically used in methods for 3D reconstruction such as SFM or SLAM)

Representing the observer

- Affine camera models

(typically used in simplified 3D reconstruction methods such as affine-SFM)

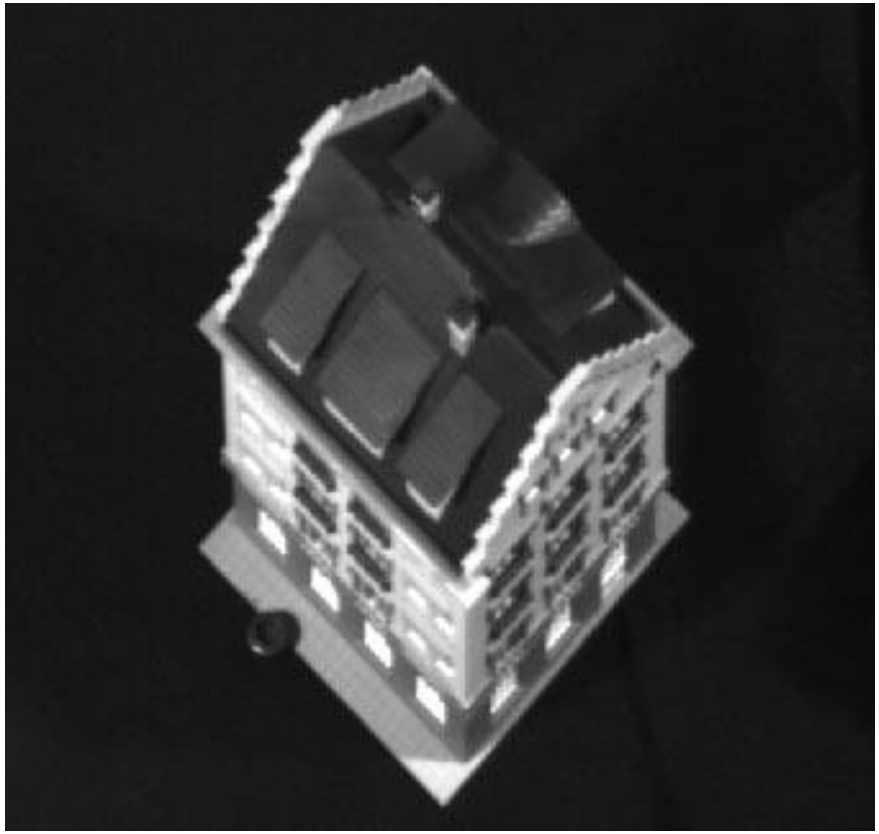


$$\begin{cases} x' = -\dfrac{f'}{z}x \\ y' = -\dfrac{f'}{z}y \end{cases} \rightarrow \begin{cases} x' = -x \\ y' = -y \end{cases}$$

Representing the observer

- Affine camera models

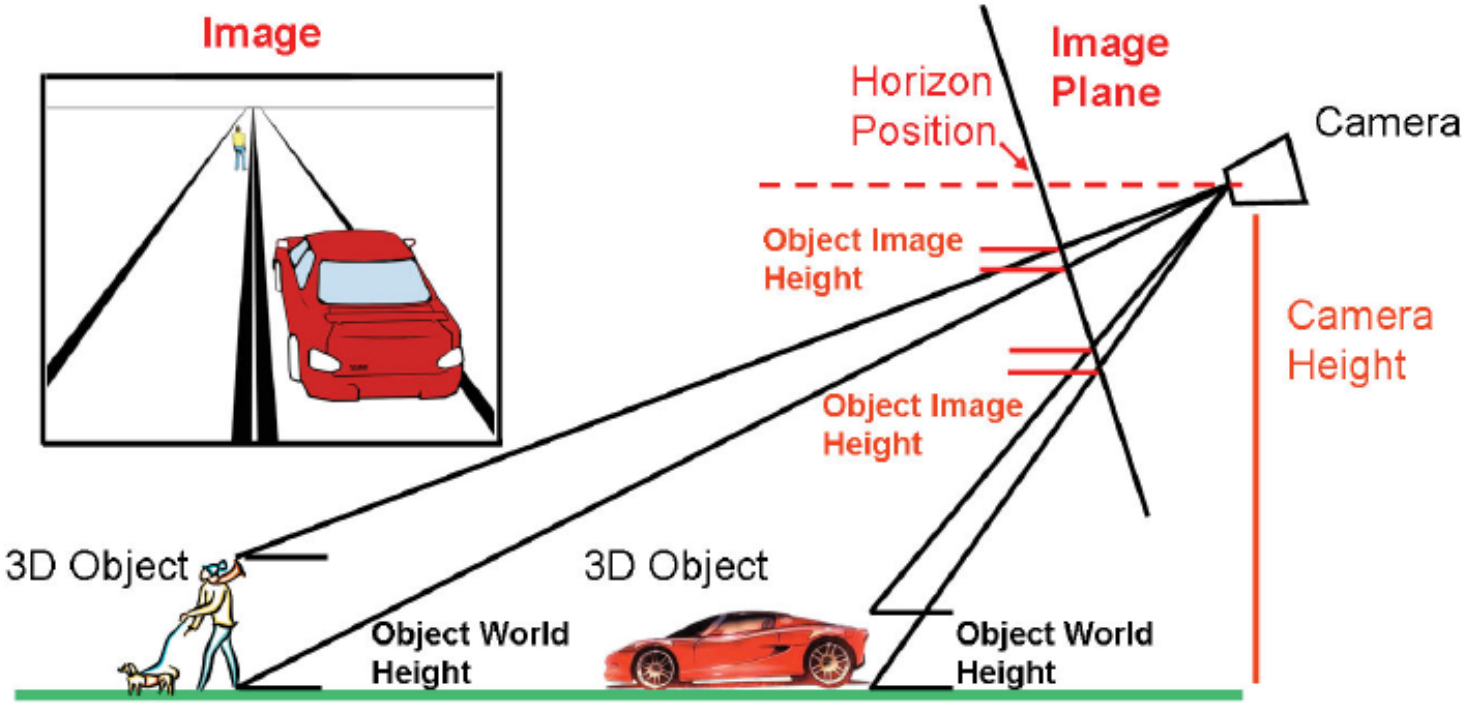
(typically used in simplified 3D reconstruction methods such as affine-SFM)



Representing the observer

- Simplified camera models

Approximated but enable simple relationships between objects, space and observer



Putting object in perspective, Hoiem et al. 2005