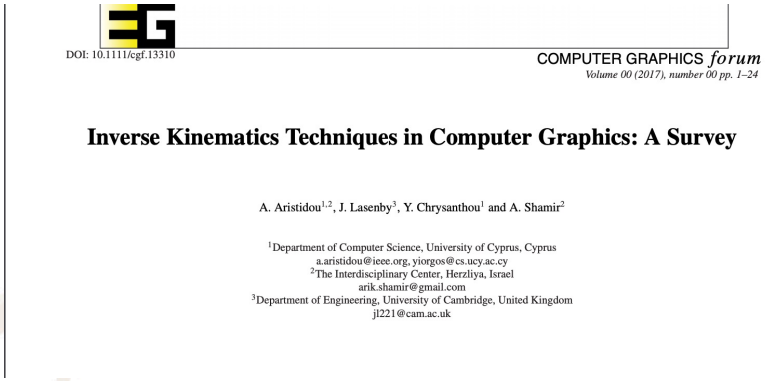

# Animation for Computer Games
# COMP 477/6311

Prof. Tiberiu Popa

## Inverse Kinematics

# Acknowledgments


- Material in this lecture based largely on:
- Aristidou, A., Lasenby, J., Chrysanthou, Y., & Shamir, A. (2018, September). Inverse kinematics techniques in computer graphics: A survey. In *Computer Graphics Forum* (Vol. 37, No. 6, pp. 35-58).
- http://www.andreasaristidou.com/publications/papers/IK_survey.pdf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**Inverse Kinematics Techniques in Computer Graphics: A Survey**


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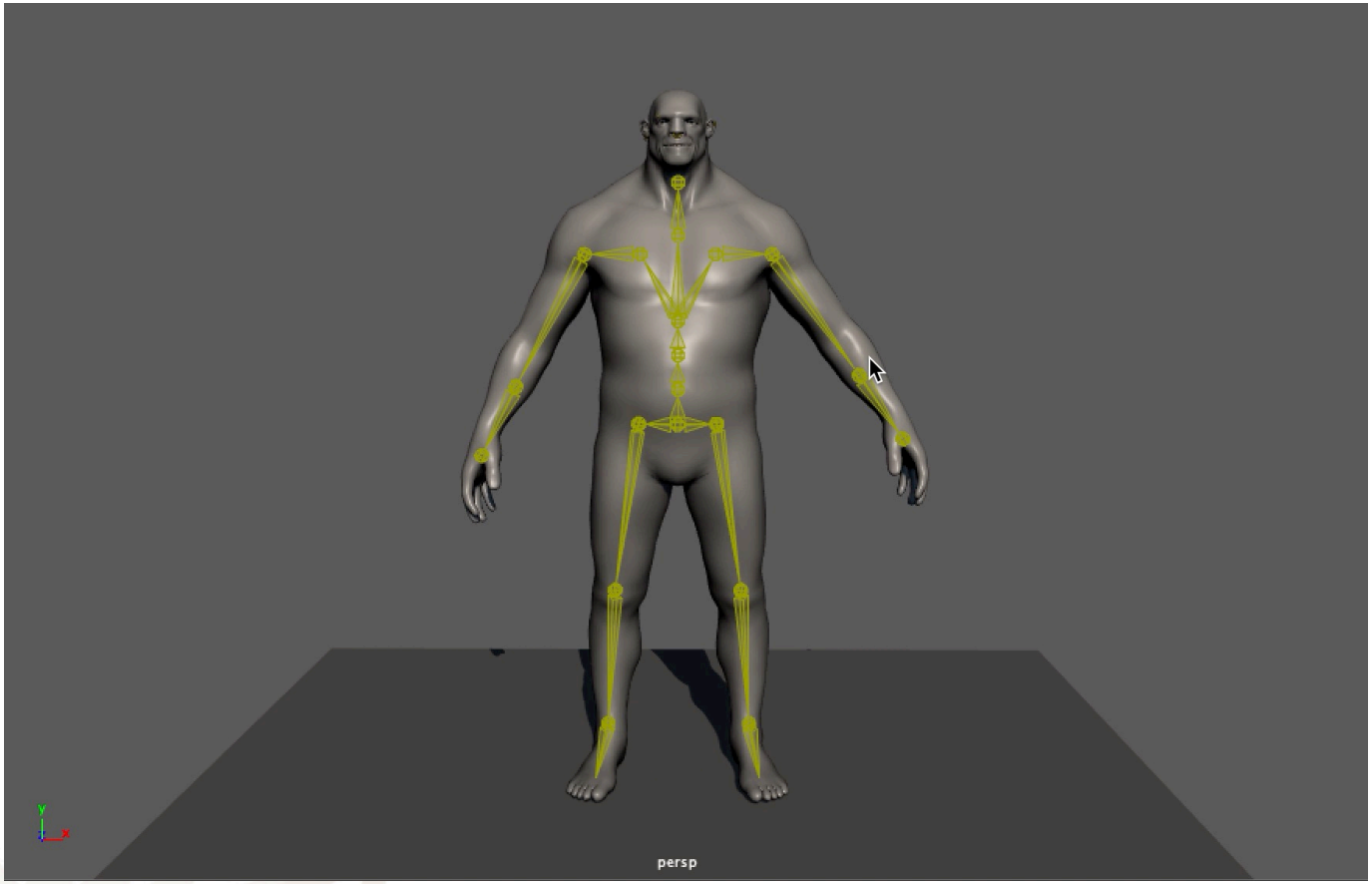
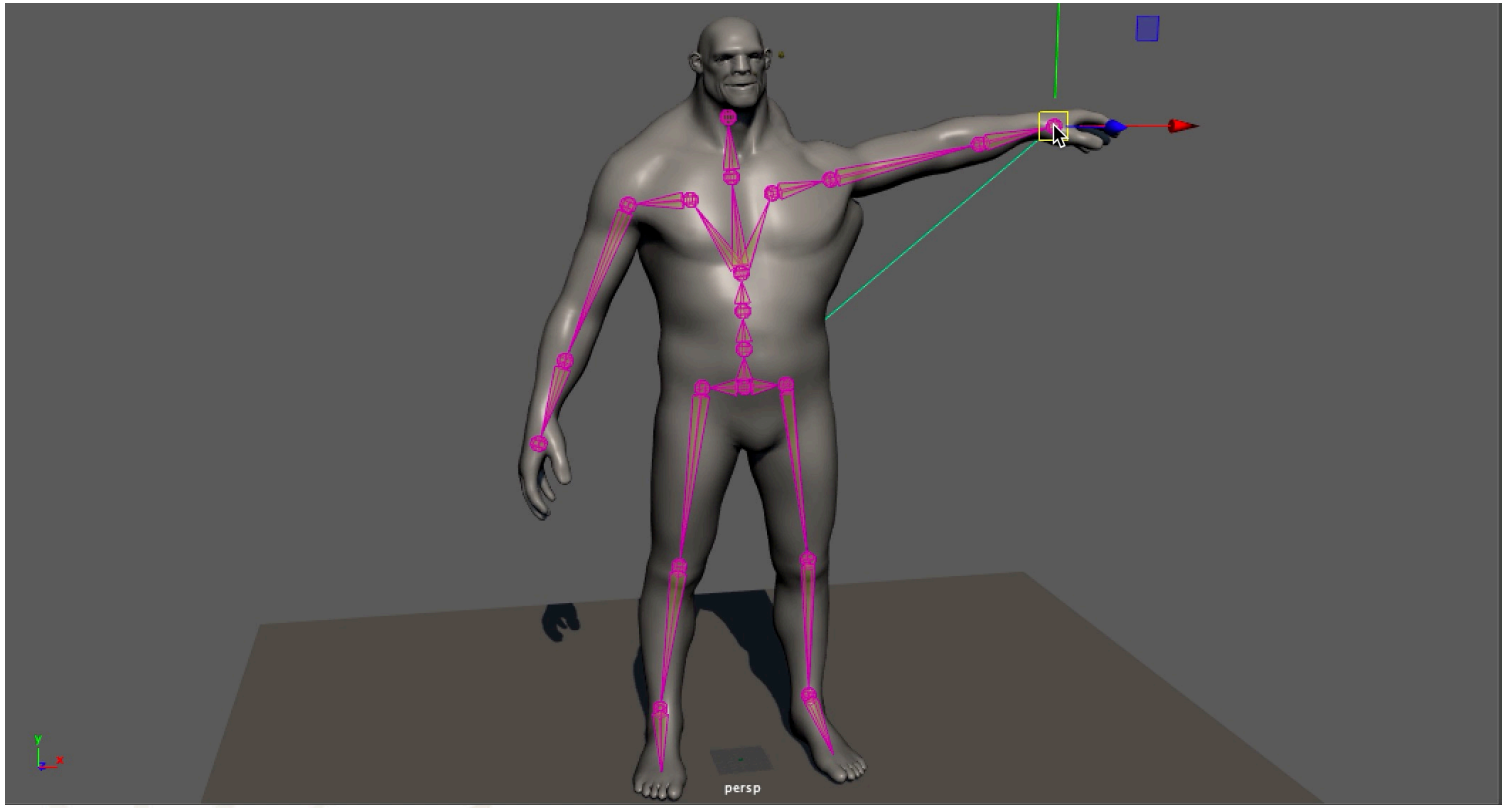
# FK vs. IK




https://www.youtube.com/watch?v=c538zkwxgTQ&t=4s

# FK vs. IK

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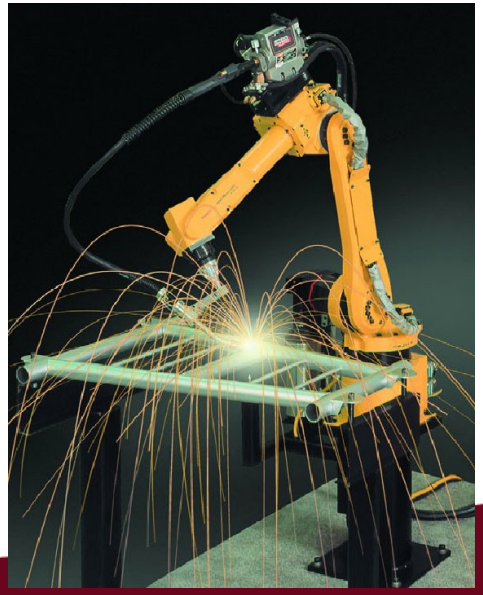
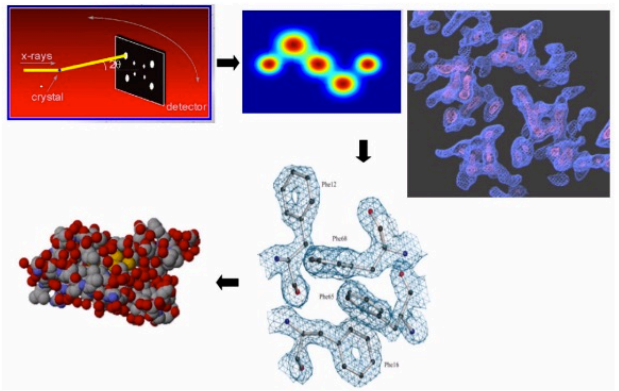
# Why IK?

- Animation
- Robotics
- Ergonomics
- Protein IK





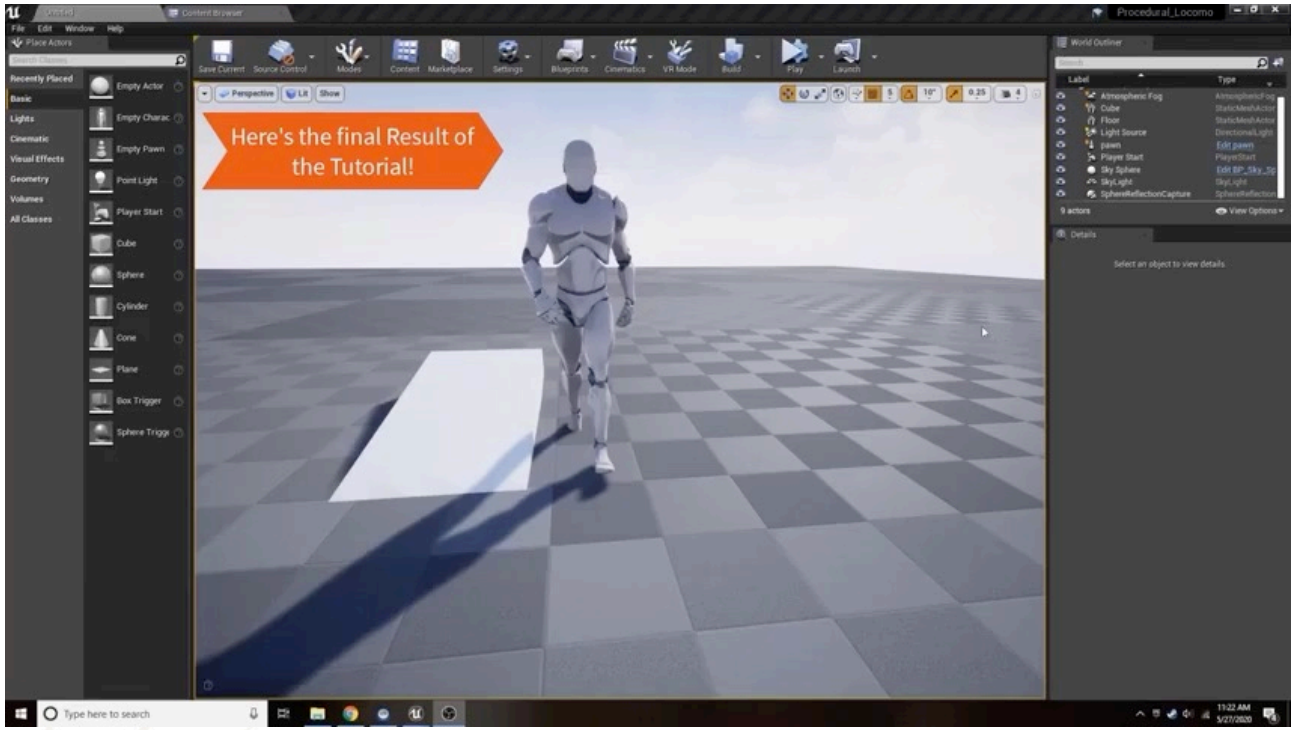
# Why IK?

- Animation control in games


Video by Daniel Holden, UBISOFT LaForge
https://www.youtube.com/watch?v=Ul0Gilv5wvY

# Why IK?

- Animation

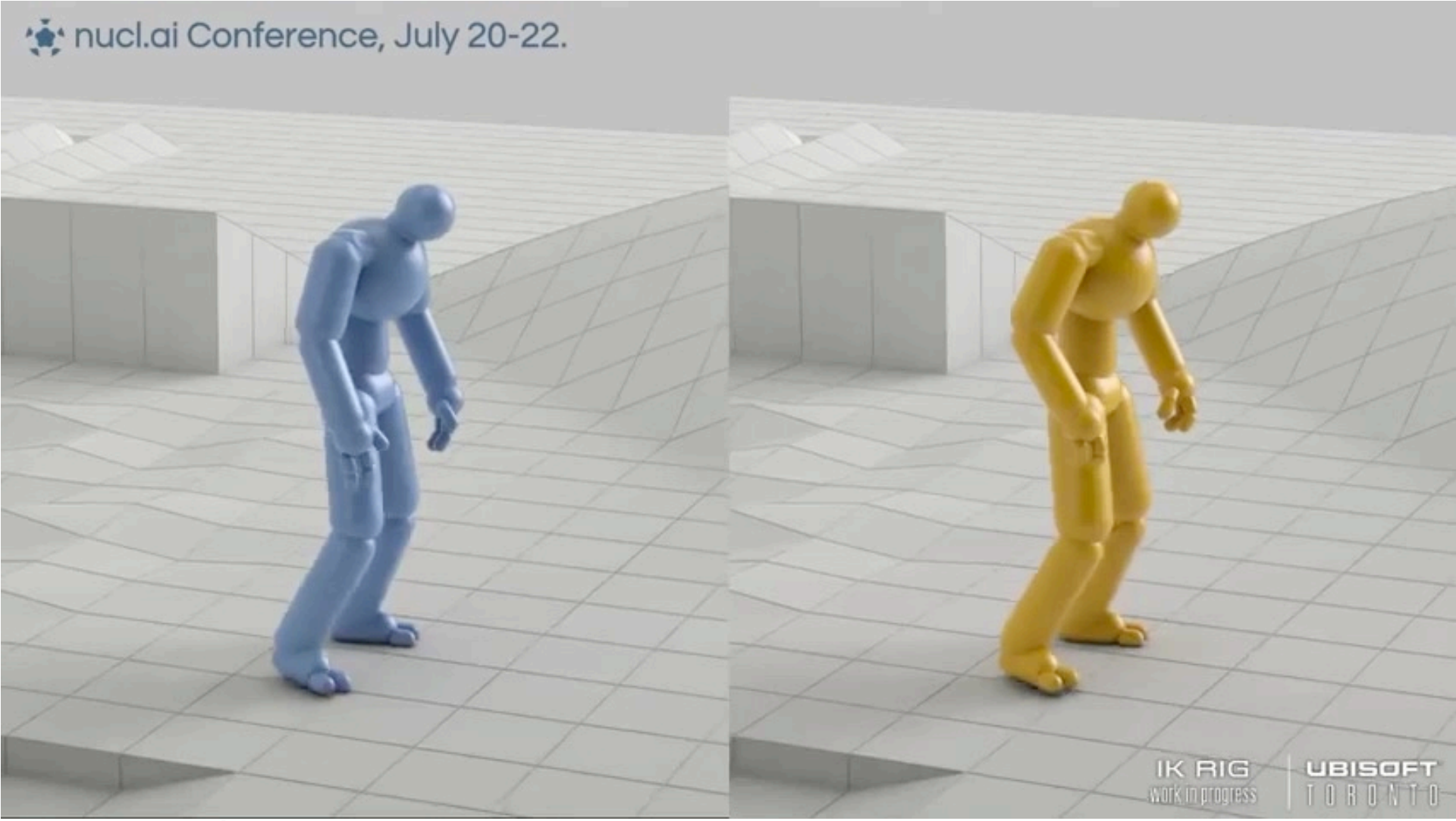



https://www.youtube.com/watch?v=c4-KYbYyxhg

# Why IK?

- Animation

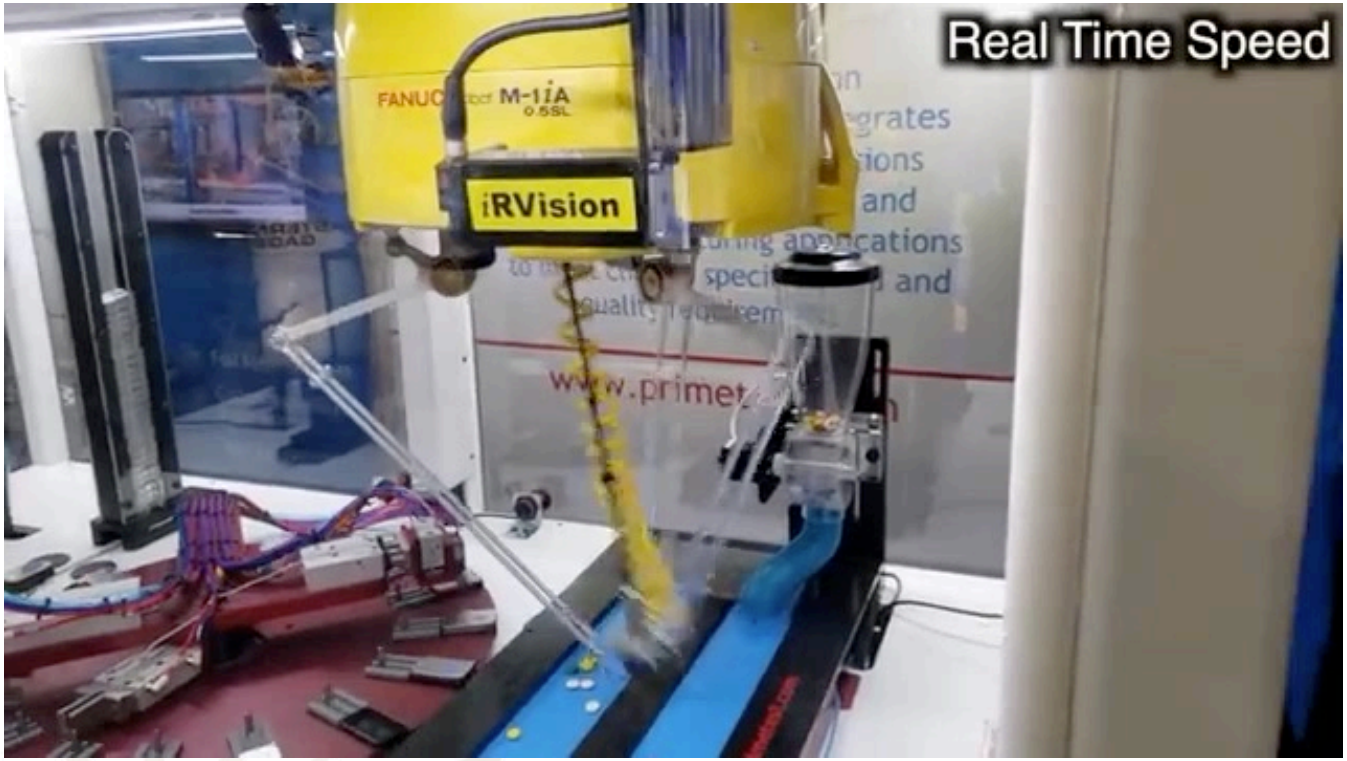
https://www.youtube.com/watch?v=kK9rQzbSzio




https://www.youtube.com/watch?v=V4TQSeUpH3Q

# Why IK

- Robotics




https://www.youtube.com/watch?v=s-yne8xTNM0

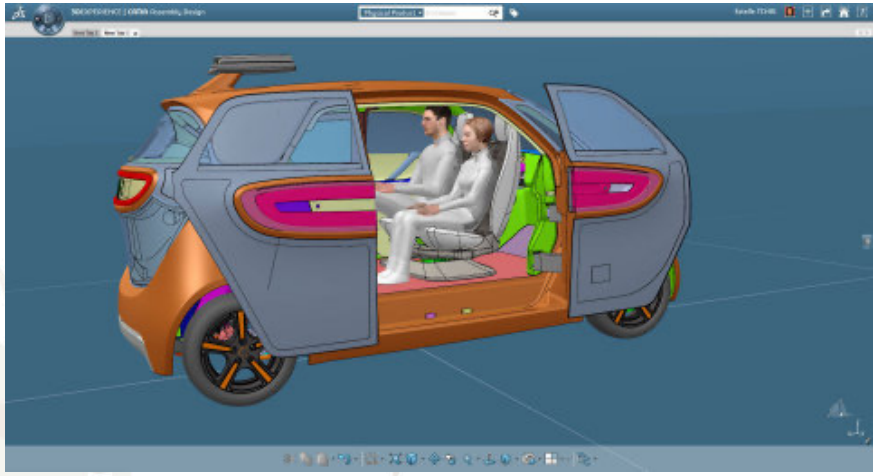
# Why IK

- Robotics


https://www.youtube.com/watch?v=bAdqazixuRY

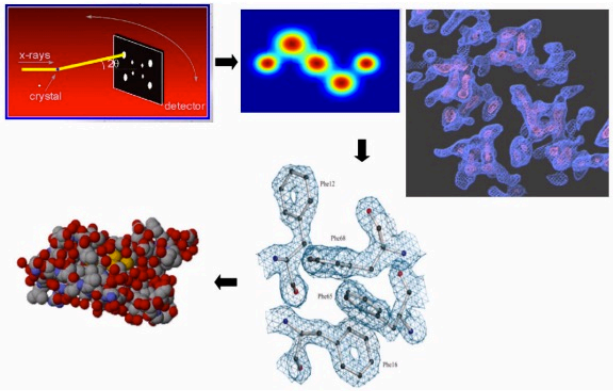
# Why IK

- Ergonomics



# Why IK?

- Protein IK



# Many flavours of IK problems
# Many Challenges

- Constraints
  - Biomechanical constrains
  - Physical obstacles
- Smooth solution path
- Often under constraint
- Efficiency/speed
- Online → moving target

# Cyclic-Coordinate Descent (CCD) Method

- Wang and Chen.
  "A Combined Optimization Method for Solving the Inverse Kinematics Problem of Mechanical Manipulators."
  *IEEE Transactions on Robotics and Automation*.
  Vol. 7, No. 4, August 1991, pp. 489-499.

# Cyclic-Coordinate Descent (CCD) Method

- Minimizing the system error by adjusting each joint angle one at a time.
- Starts at the last link in the chain and works backwards, adjusting each joint along the way.

# Cyclic-Coordinate Descent (CCD) Method

- Pros:
  - Guaranteed to converge
  - Simple to implement
  - Fast (each step is efficient)
- Cons:
  - Usually Performs poorly if starting too far from solution
  - Oscillating path
  - Impractical to add obstacles / constraints
  - Gets stuck