

Welcome to Introduction to Robotics

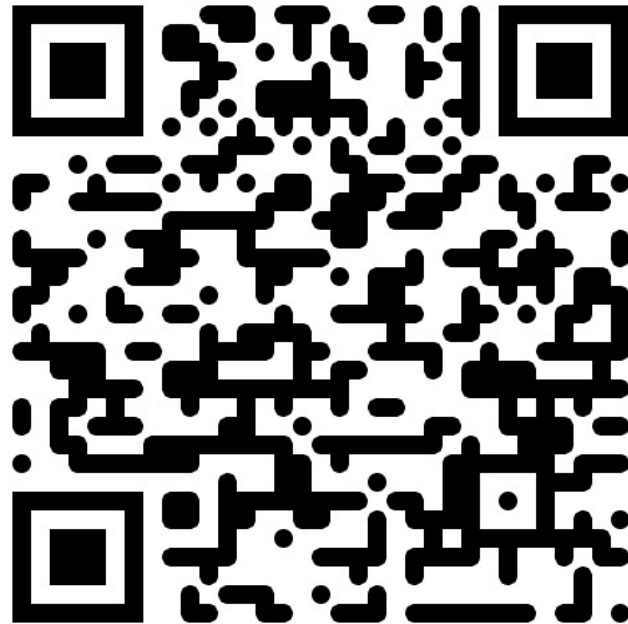
Prof. Katie Driggs-Campbell

January 20, 2026

Introductions: course staff and lab info

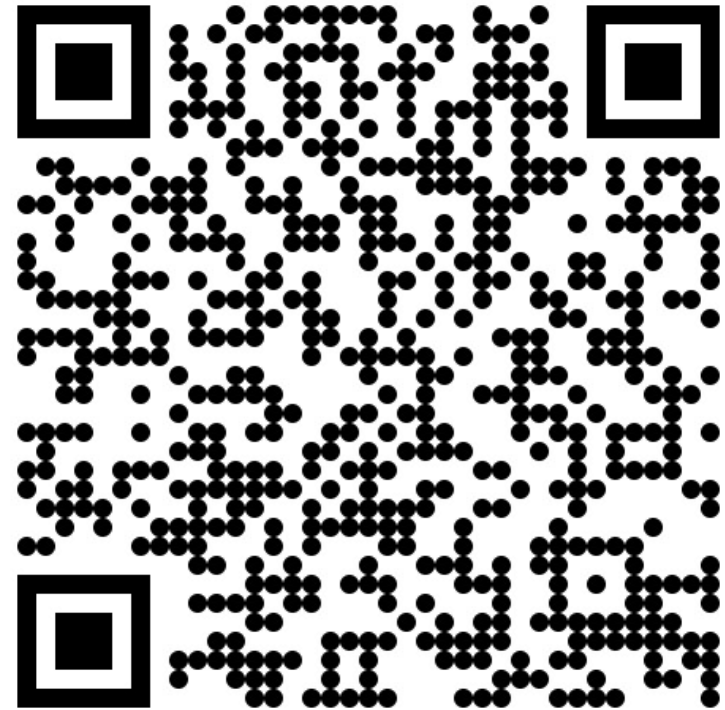
lab website:

<http://coecsl.ece.illinois.edu/ece470/>



Course Communication and Assistance

- Website:
<https://publish.illinois.edu/ece470-intro-robotics/>
- Link to CampusWire on website
- Office Hours on website
 - Changes will be posted on CampusWire
- Homework Parties on Fridays TBD
 - Remember to be kind to your TAs





SCHEDULE – SPRING 2026

[Updated 1/12/26 – subject to change]

Important Information:

Subscribe to MediaSpace

Join PrairieLearn

Homework due Fridays at midnight

Week	Tues	Topic 1	Thurs	Topic 2	Side Notes
1	01.20	Intro + Review slides-empty slides-annotated	01.22	Mechanism Design Mod. Rob. Ch 2	Suggested Material: Matrix Cookbook Linear Algebra Done Right Gilbert Strang Lectures Spring 2023 Lectures: Linear Algebra Diff Eq
2	01.27	Rigid body motion	01.29	Transformations	
3	02.03	Screw Motions	02.05	Exponential Coordinates	
4	02.10	Review I	02.12	Exam I in CBTF	

Course Components

- 20% Homework
 - 50% Exams (15-20% each)
 - 20% Laboratory
 - 10% Final Project
- + Extra Credit

Suggested:

ROBOTIC MANIPULATION

Richard M. Murray
Zexiang Li
S. Shankar Sastry

Required:

MODERN ROBOTICS

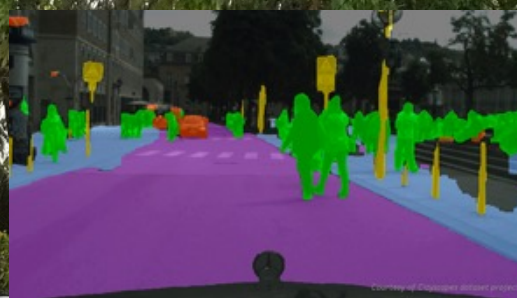
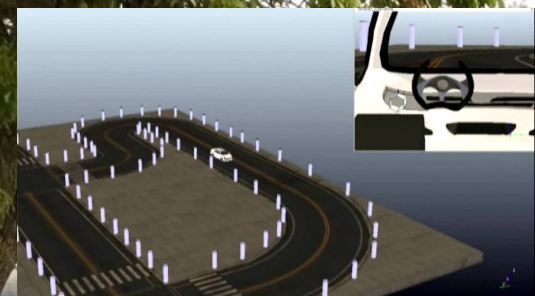
MECHANICS, PLANNING,
AND CONTROL

KEVIN M. LYNCH
FRANK C. PARK

Course Components

- Almost weekly homework on PrairieLearn
 - Try logging on now!
 - HW1 is due next Friday!
 - No dropped assignments. Late assignments can be submitted for **up to** 50% credit one week late.
- Exams will be administered at the CBTF using PrairieLearn
 - Check out the CBTF orientation quiz





Simulation & Validation

Sensors

Perception

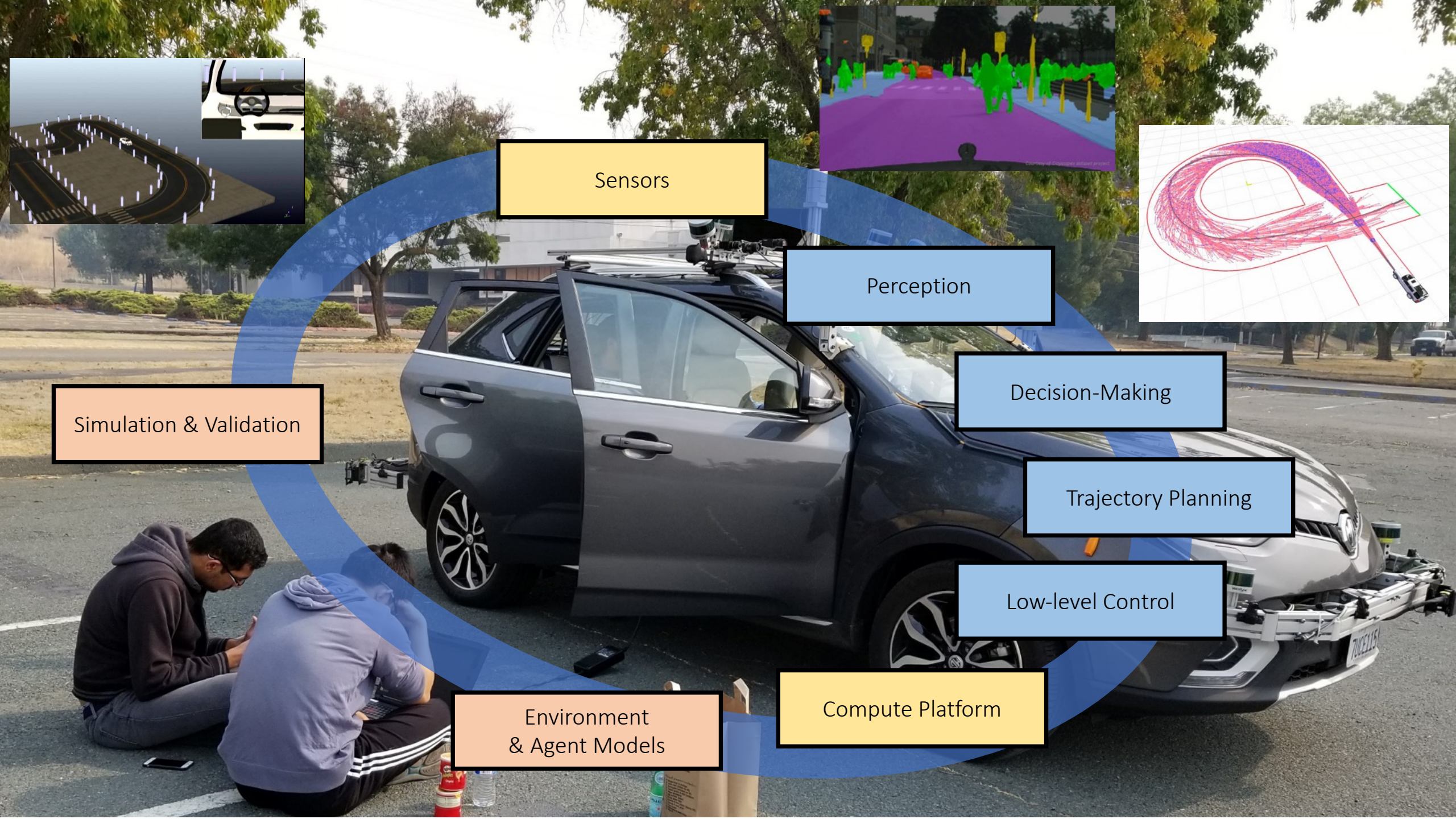
Decision-Making

Trajectory Planning

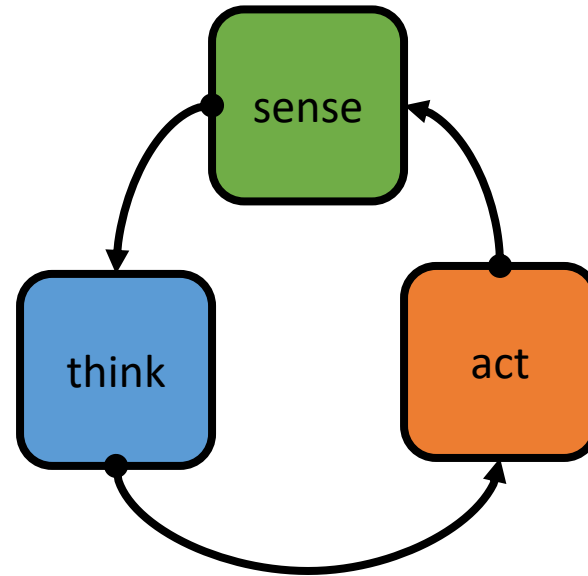
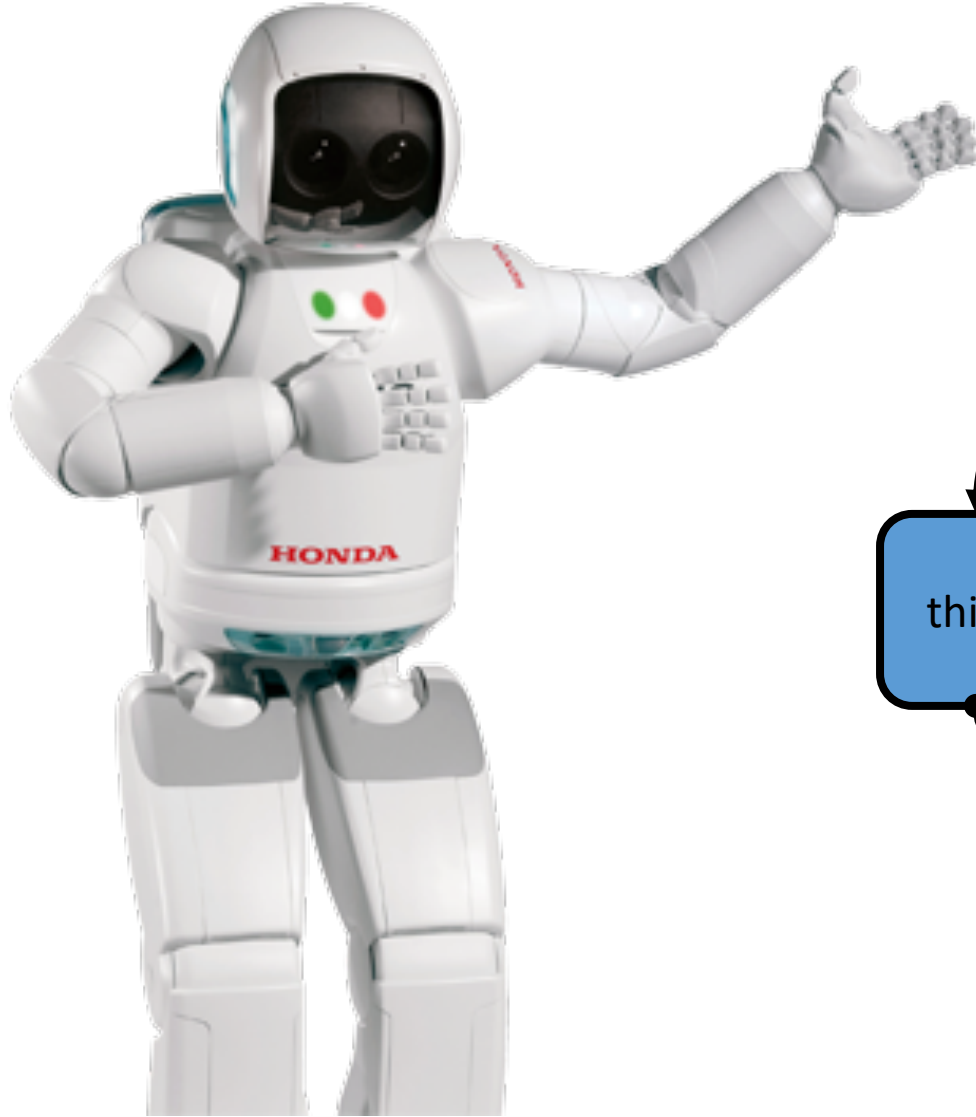
Low-level Control

Compute Platform

Environment
& Agent Models



Topics in Intro to Robotics



1. Mechanism design
2. Rigid body motion & transformations
3. Screw theory
4. Forward Kinematics
5. Velocity Kinematics
6. Inverse Kinematics
7. Manipulation
8. Motion Planning
9. Fun topics!

Pick and Place



Video Credit: Keenan Wyrbek, Personal Robotics Lab, Stanford

Quick Math Review

Inspiration from Lukas Luft, Wolfram Burgard, and Roy Dong

Vectors

Matrices 1

Matrices 1

Matrices 2

Extra!

Matrix Operations and Rank

Common Matrix Operations

- Multiplication by a scalar
- Sum (commutative, associative)
- Multiplication by a vector
- Product (not commutative)
- Transposition
- Inversion (if square, full rank)

Matrix Rank

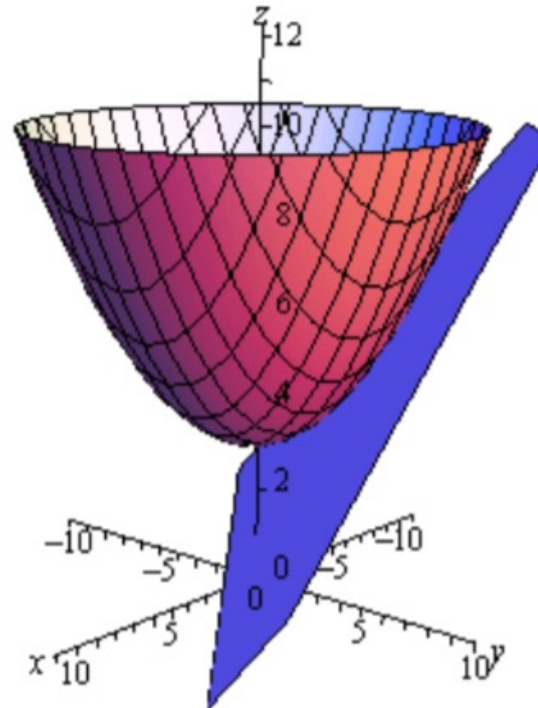
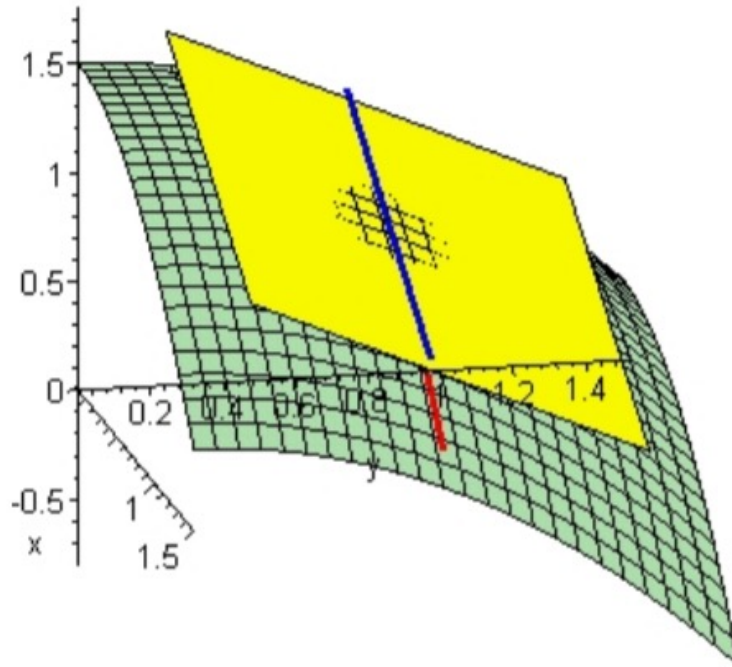
- Rank is determined by the maximum number of linearly independent rows (columns)
- If A is $m \times n$, then
 - $\text{rank}(A) \geq 0$
 - $\text{rank}(A) \leq \min(m, n)$
- $\text{rank}(A)$ can be computed by finding the rows that are linearly dependent, Gaussian elimination, and/or by counting the number of non-zero rows

Matrix Example

Jacobian Matrices

Jacobian Matrix

Gives the orientation of the **tangent plane** to the vector-valued function at a given point



Motions as Differential Equations

Exponentials 1

Exponentials 2

Extra!

review materials
for linear algebra



The Matrix Cookbook



Linear Algebra Done Right



Textbooks on Linear Algebra
by Gilbert Strang

Summary

- Introduced course content
- Reviewed Vector and Matrix representations and operations
- The **Jacobian** contains the partial derivatives for a vector valued function
- Quick refresher on differential equations
 - Matrix exponentials will be very useful matrix operations!