4/23/2024

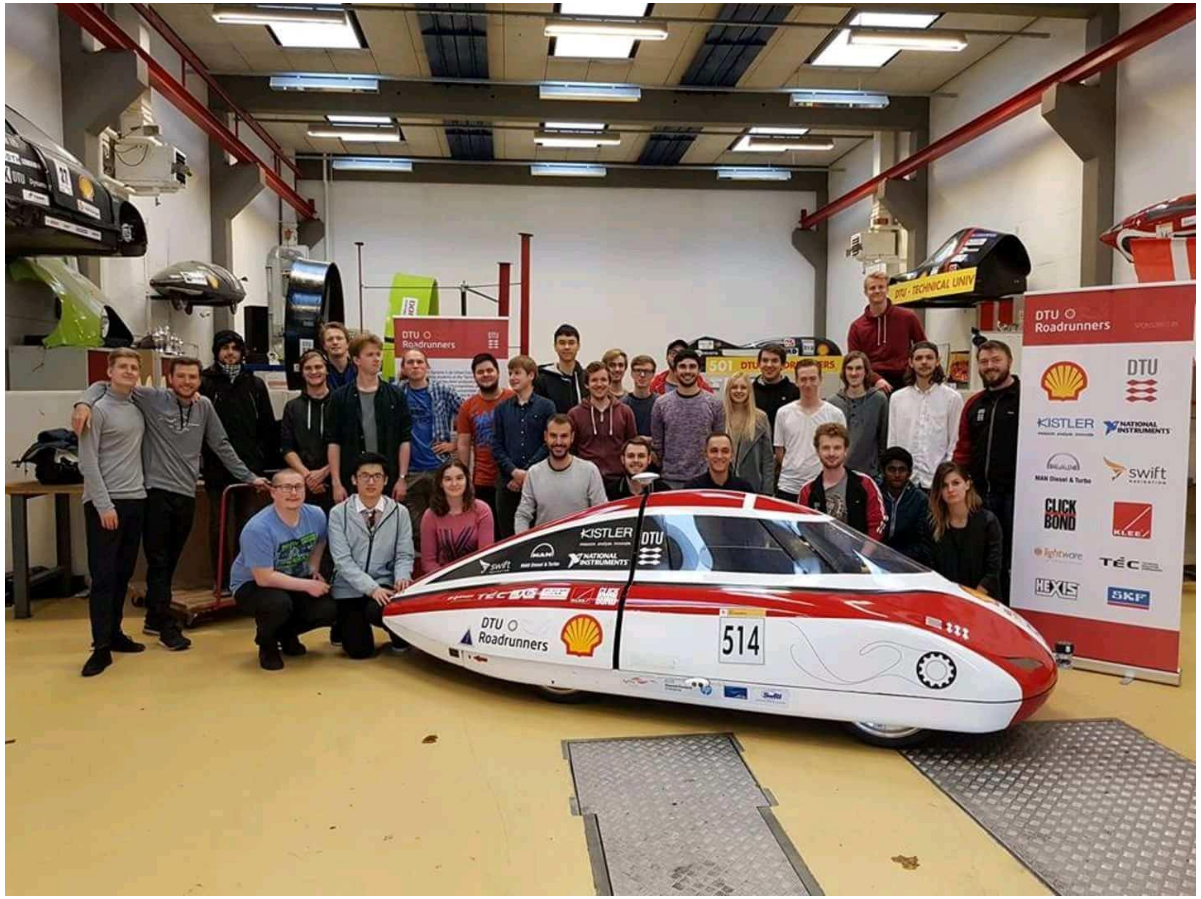
Ph.D. in Aeronautics and Astronautics

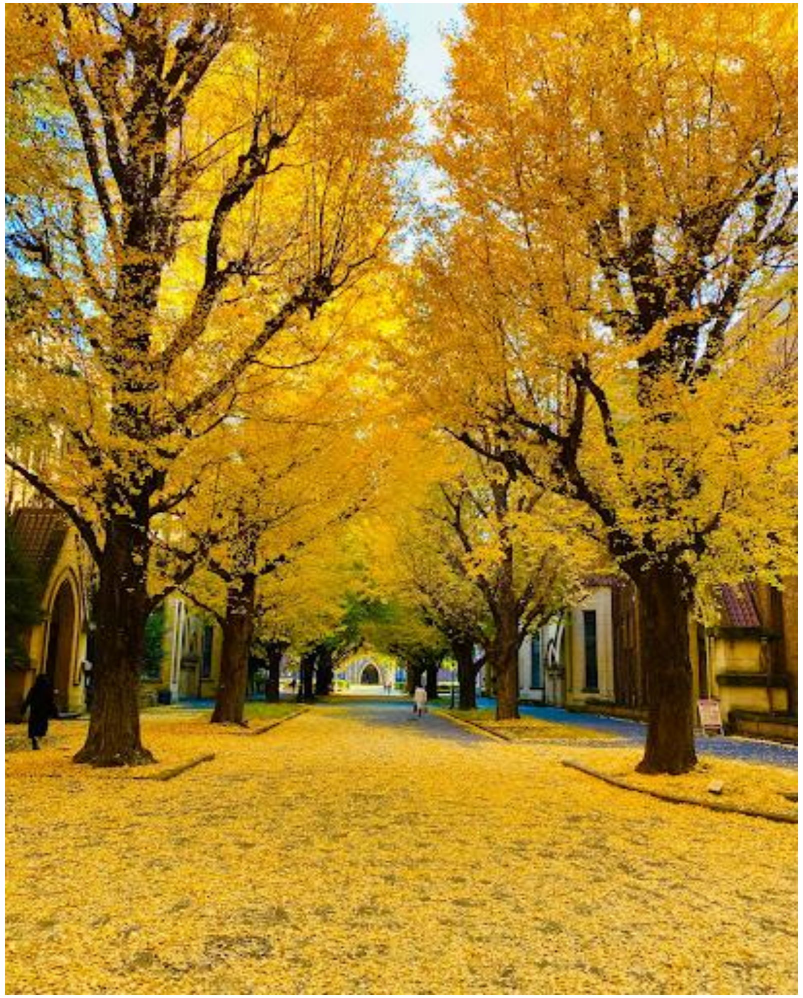
Jeg vil tilbage til Danmark

Shen

Table of Contents

Birth	Master (Technical University of Denmark)	Doctor (The University of Tokyo)
1995	2017-2019	2020-2023





Birth	Master (Technical University of Denmark)	Doctor (The University of Tokyo)
1995	2017-2019	2020-2023

English (Native)

Chinese (Mother Tongue)

Japanese (Medium)

Danish (Beginner)

Shen, Z.; Tsuchiya, T. Singular Zone in Quadrotor Yaw–Position Feedback Linearization. *Drones* **2022**, *6*, 20, doi:doi.org/10.3390/drones6040084.

Shen, Z.; Tsuchiya, T. Gait Analysis for a Tiltrotor: The Dynamic Invertible Gait. *Robotics* **2022**, *11*, 33, doi:10.3390/robotics11020033.

Shen, Z.; Tsuchiya, T. Cat-Inspired Gaits for a Tilt-Rotor—From Symmetrical to Asymmetrical. *Robotics* **2022**, *11*, 60, doi:10.3390/robotics11030060.

Shen, Z.; Ma, Y.; Tsuchiya, T. Four-Dimensional Gait Surfaces for a Tilt-Rotor—Two Color Map Theorem. *Drones* **2022**, *6*, 103, doi:10.3390/drones6050103.

Shen, Z.; Ma, Y.; Tsuchiya, T. Feedback Linearization-Based Tracking Control of a Tilt-Rotor with Cat-Trot Gait Plan. *International Journal of Advanced Robotic Systems* **2022**, *19*, 17298806221109360, doi:10.1177/17298806221109360.

Shen, Z.; Ma, Y.; Tsuchiya, T. Stability Analysis of a Feedback-Linearization-Based Controller with Saturation: A Tilt Vehicle with the Penguin-Inspired Gait Plan. *arXiv preprint arXiv:2111.14456* **2021**.

Shen, Z.; Tsuchiya, T. State Drift and Gait Plan in Feedback Linearization Control of a Tilt Vehicle. In Proceedings of the Computer Science & Information Technology (CS & IT); Academy & Industry Research Collaboration Center (AIRCC): Vienna, Austria, March 19 **2022**; Vol. 12, pp. 1–17.

Shen, Z.; Tsuchiya, T. The Robust Gait of a Tilt-Rotor and Its Application to Tracking Control -- Application of Two Color Map Theorem. *International Conference on Control, Automation and Systems (ICCAS)* **2022**.

Shen, Z.; Ma, Y.; Tsuchiya, T. Generalized Two Color Map Theorem -- Complete Theorem of Robust Gait Plan for a Tilt-Rotor. *arXiv preprint arXiv:2206.13422*. **2022**.

Shen, Z.; Tsuchiya, T. Tracking Control for a Tilt-rotor with Input Constraints by Robust Gaits. *IEEE Aerospace Conference* **2023**.

Robot Dynamics

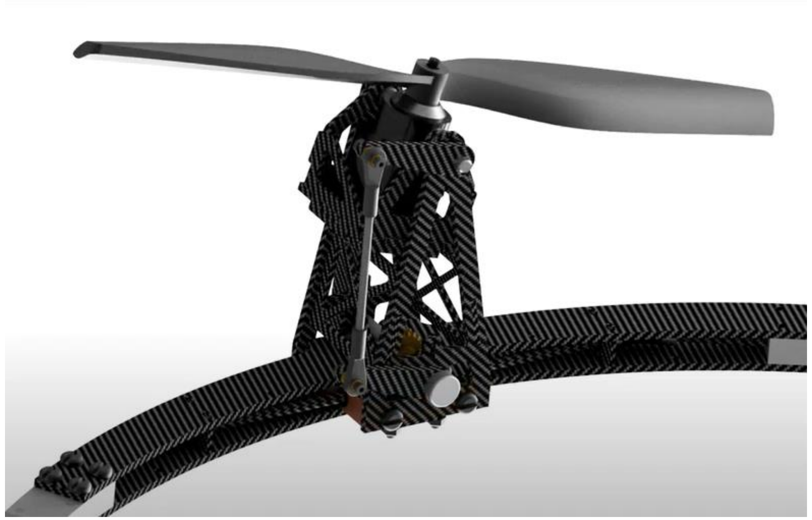
4 magnitudes

$$\|F_1\| \quad \|F_2\| \quad \|F_3\| \quad \|F_4\|$$

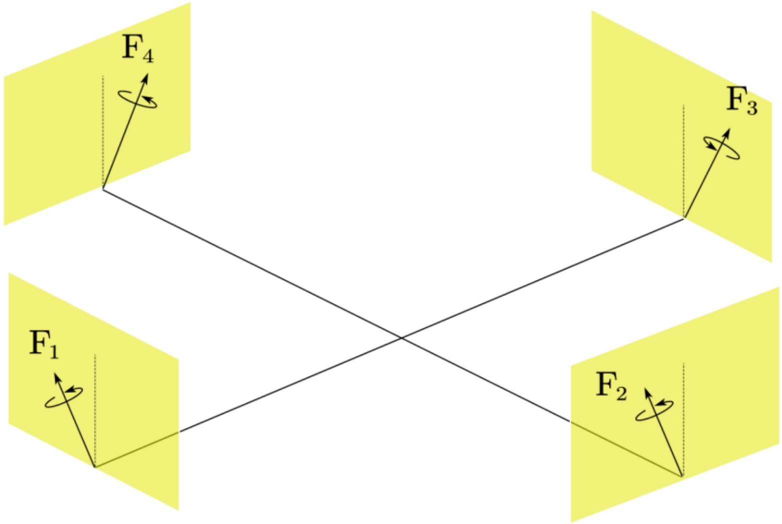
4 tilting angles

$$\alpha_1 \quad \alpha_2 \quad \alpha_3 \quad \alpha_4$$

The direction of the thrust is adjustable.



Ryll, Markus, Heinrich H. Bülthoff, and Paolo Robuffo Giordano. "Modeling and control of a quadrotor UAV with tilting propellers." *2012 IEEE international conference on robotics and automation*. IEEE, 2012.



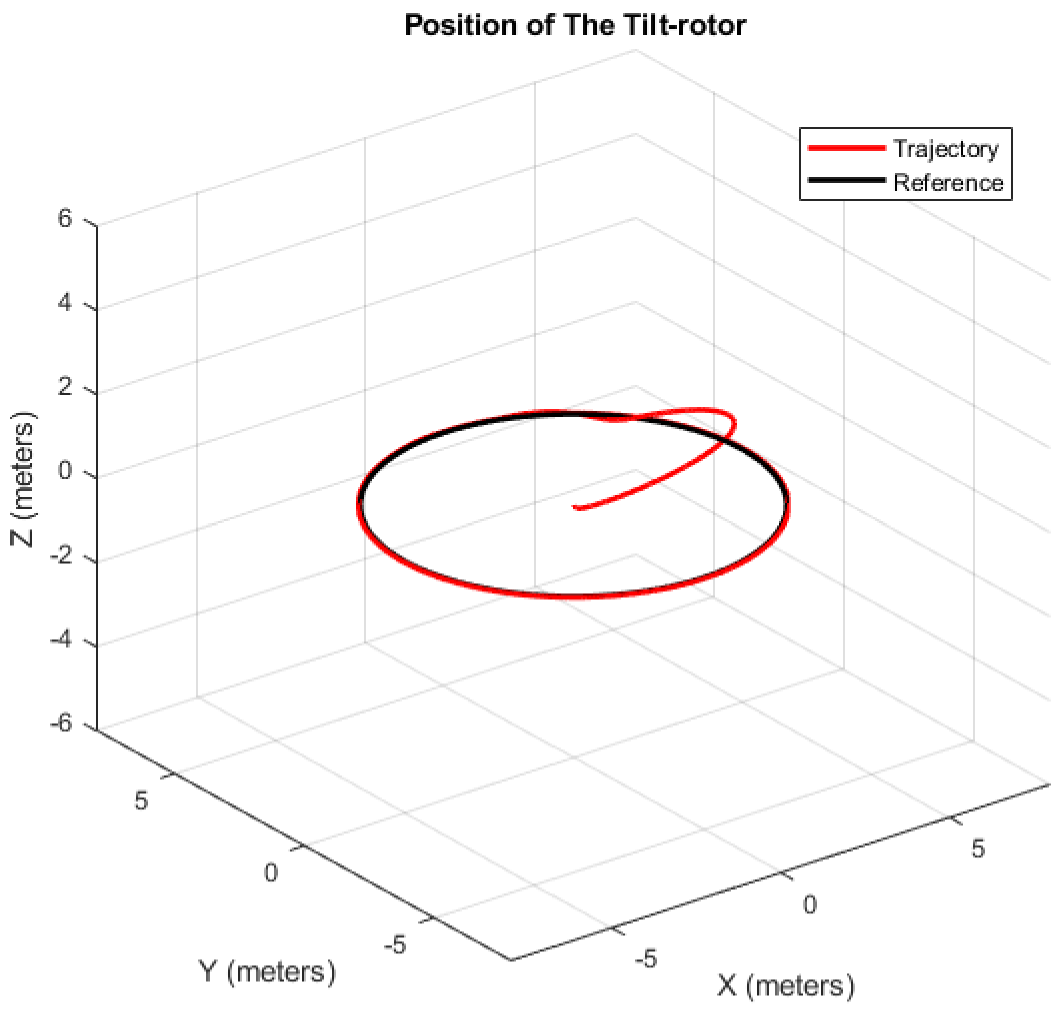
Tilt-rotor

$$\dot{\omega}_B = {I_B}^{-1} \cdot \tau(\alpha) \cdot w \qquad {}^W\dot{R} = {}^W R \cdot \widehat{\omega}_B$$

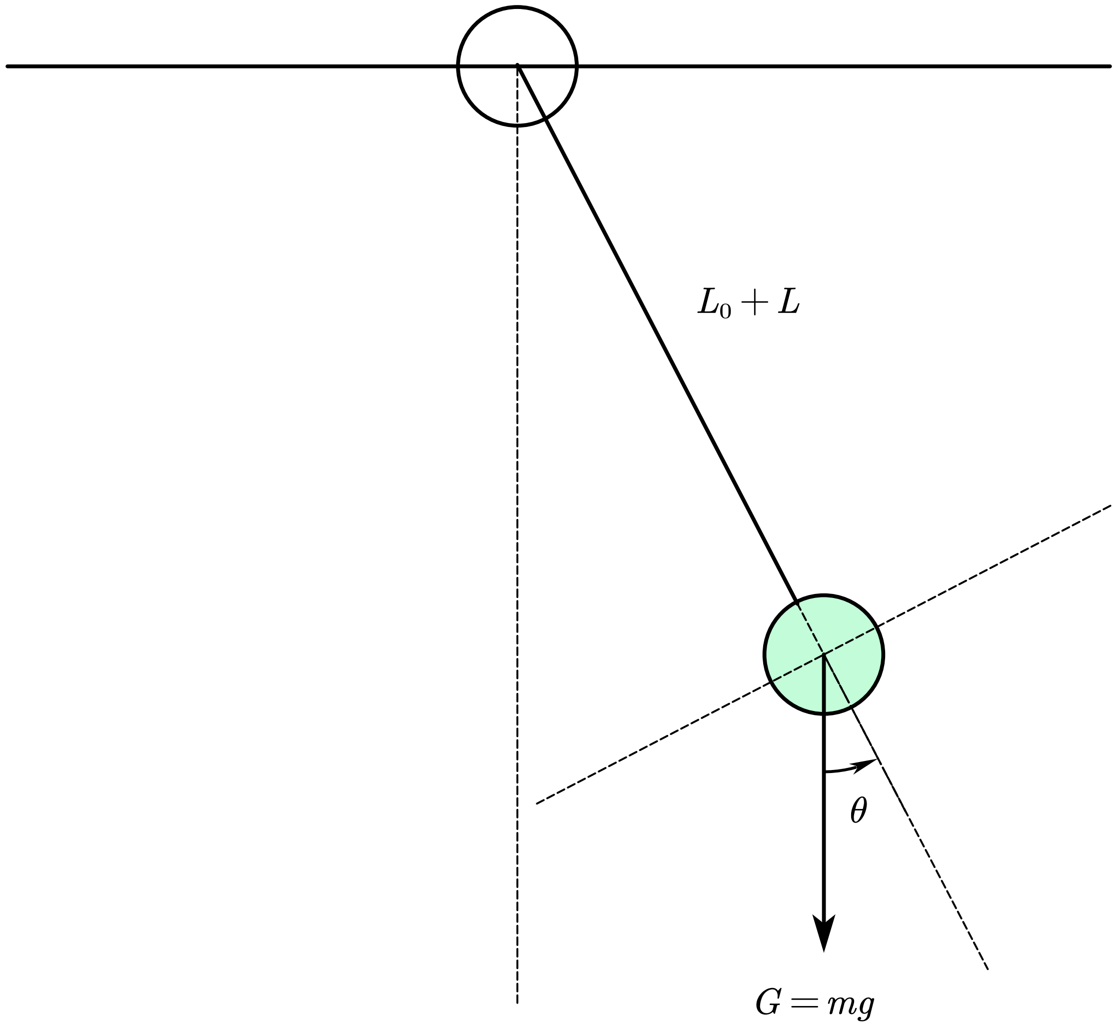
$$\ddot{P} = \begin{bmatrix} 0 \\ 0 \\ -g \end{bmatrix} + \frac{1}{m} \cdot {}^W R \cdot F(\alpha) \cdot \begin{bmatrix} \varpi_1 \cdot |\varpi_1| \\ \varpi_2 \cdot |\varpi_2| \\ \varpi_3 \cdot |\varpi_3| \\ \varpi_4 \cdot |\varpi_4| \end{bmatrix}$$

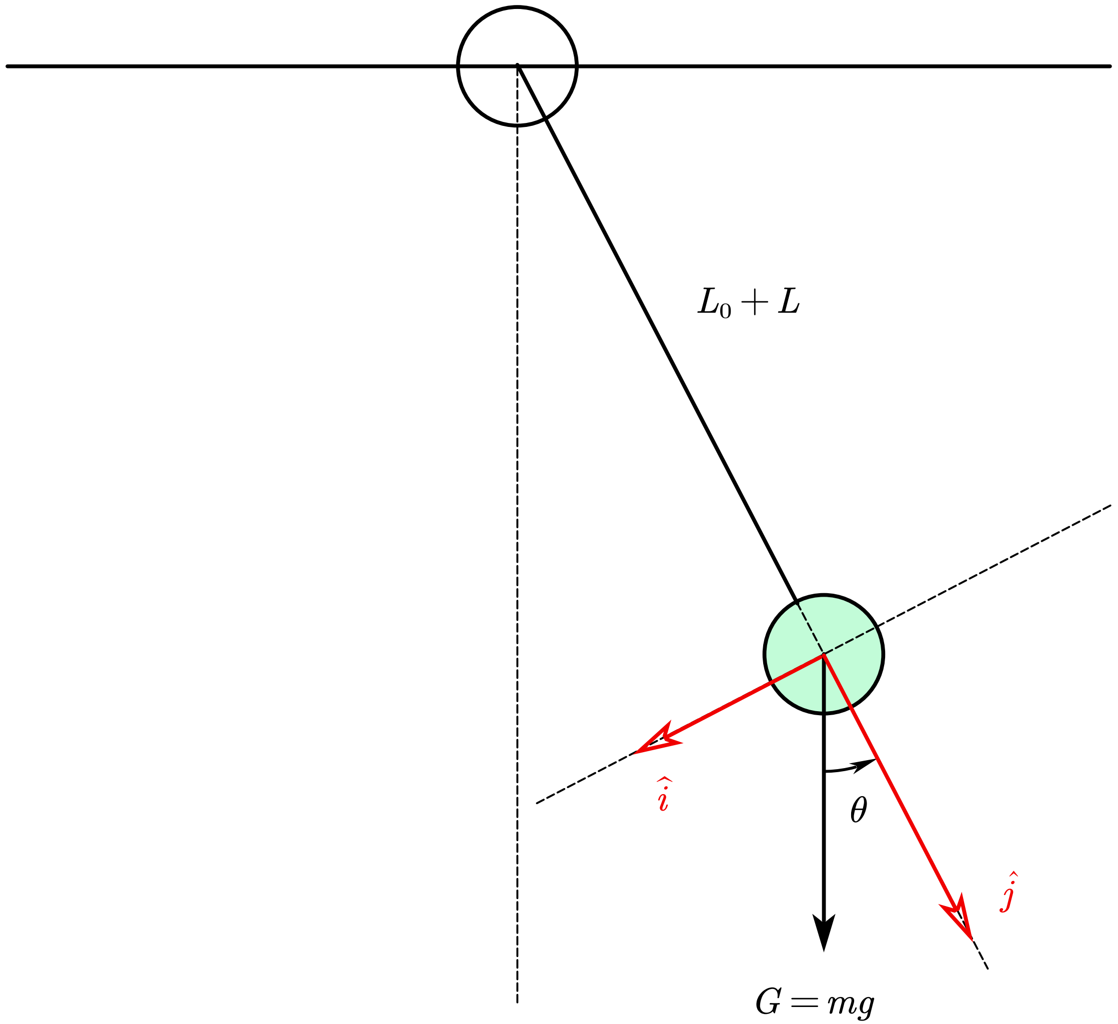
$$\triangleq \begin{bmatrix} 0 \\ 0 \\ -g \end{bmatrix} + \frac{1}{m} \cdot {}^W R \cdot F(\alpha) \cdot w$$

Simulator Environment



The Simulation

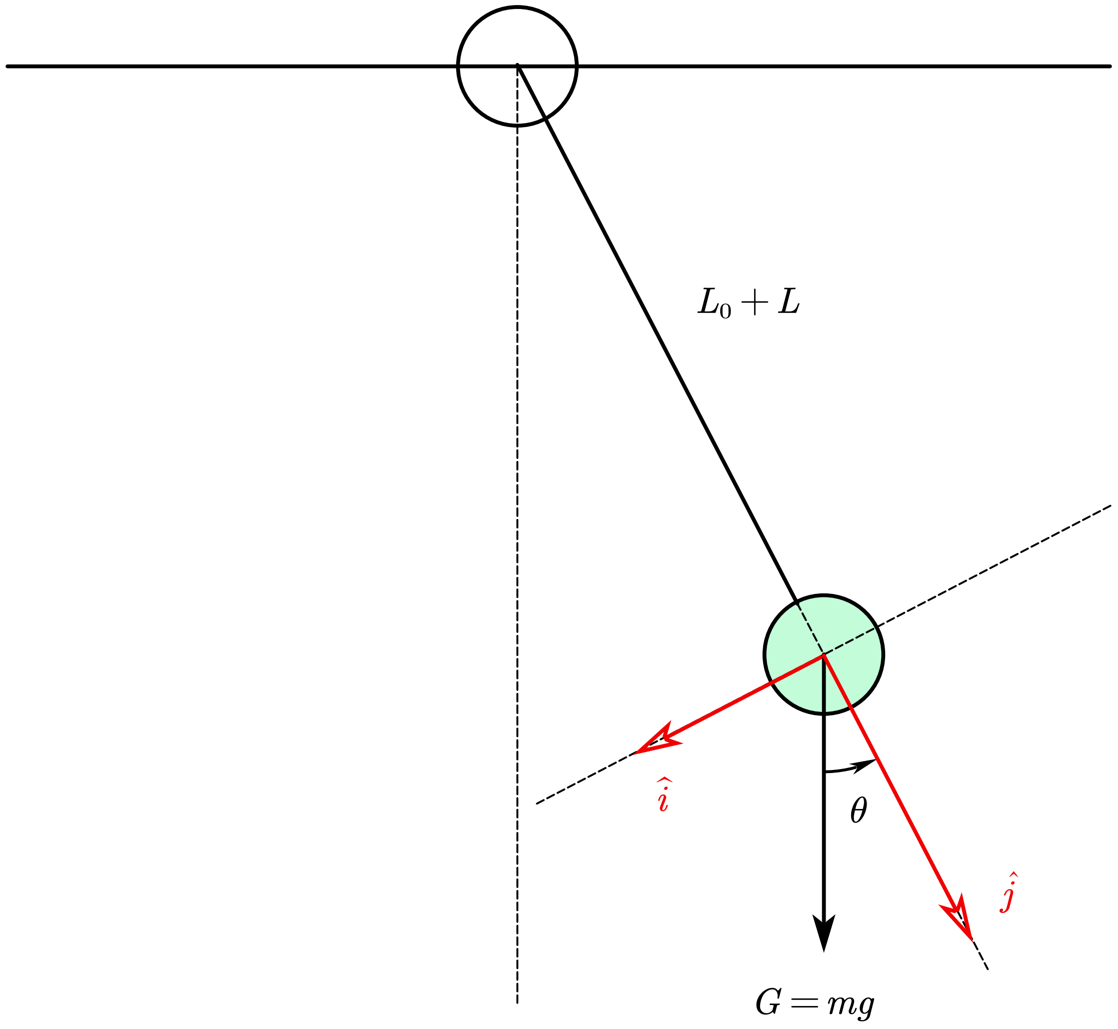

$L_0 + L$
θ
$G = mg$



$$\hat{i}: \quad mg \cdot \sin(\theta) = m \cdot a_{\hat{i}}$$

$$a_{\hat{i}} = -\ddot{\theta} \cdot (L_0 + L) - \dot{\theta} \cdot \dot{L}$$

$$\hat{j}: \quad mg \cdot \cos(\theta) - k \cdot L - \beta \cdot \dot{L} = m \cdot \ddot{L}$$



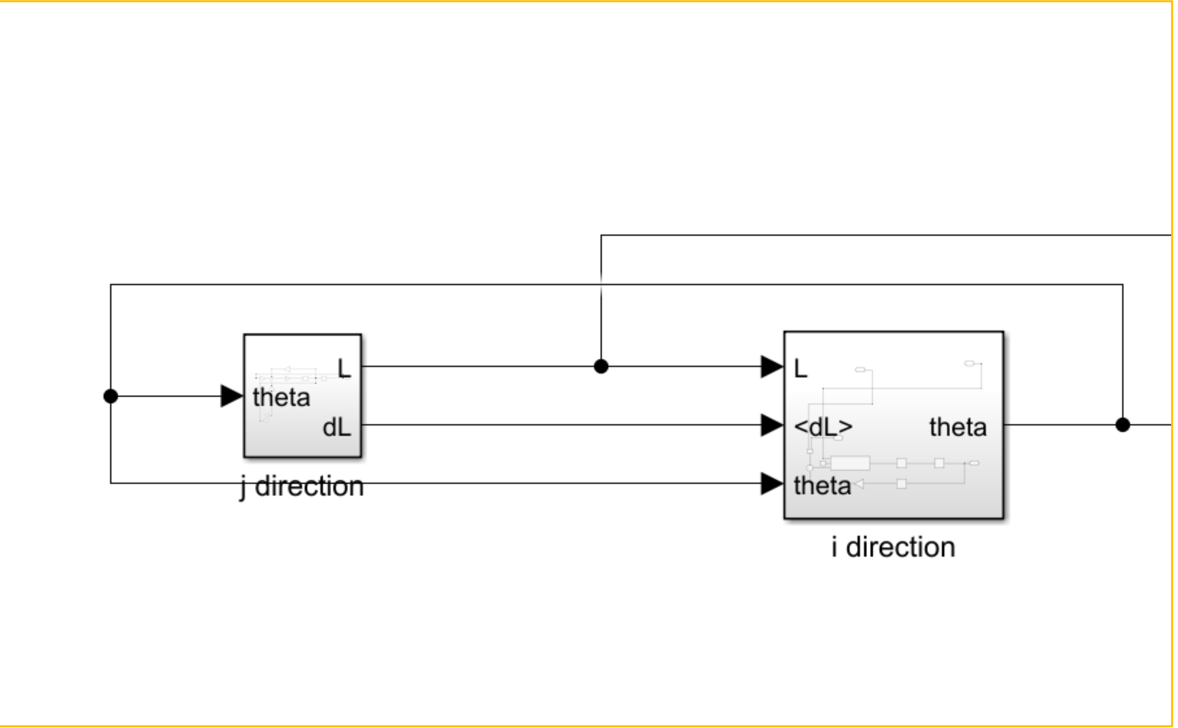
MATLAB SIMULINK

$$\hat{i}: \quad mg \cdot \sin(\theta) = m \cdot a_{\hat{i}}$$

$$a_{\hat{i}} = -\ddot{\theta} \cdot (L_0 + L) - \dot{\theta} \cdot \dot{L}$$

$$\hat{j}: \quad mg \cdot \cos(\theta) - k \cdot L - \beta \cdot \dot{L} = m \cdot \ddot{L}$$

Simulator Environment



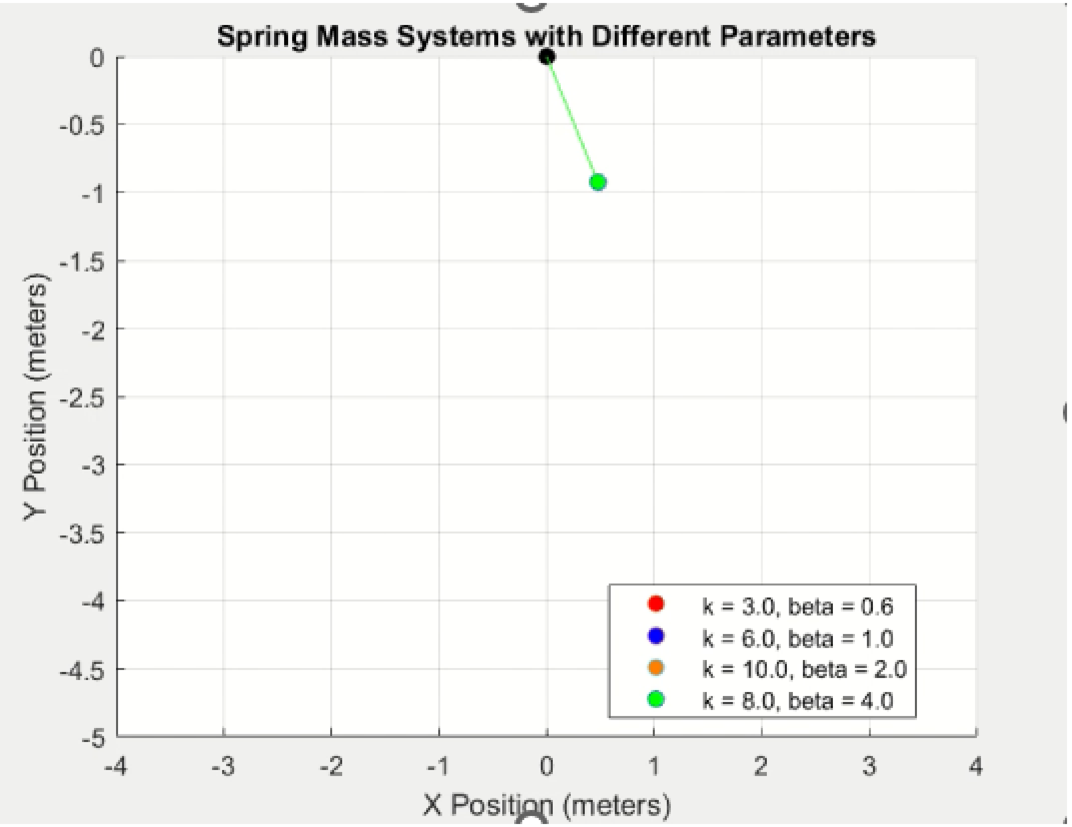
SIMULINK

$$\hat{i}: \quad mg \cdot \sin(\theta) = m \cdot a_{\hat{i}}$$

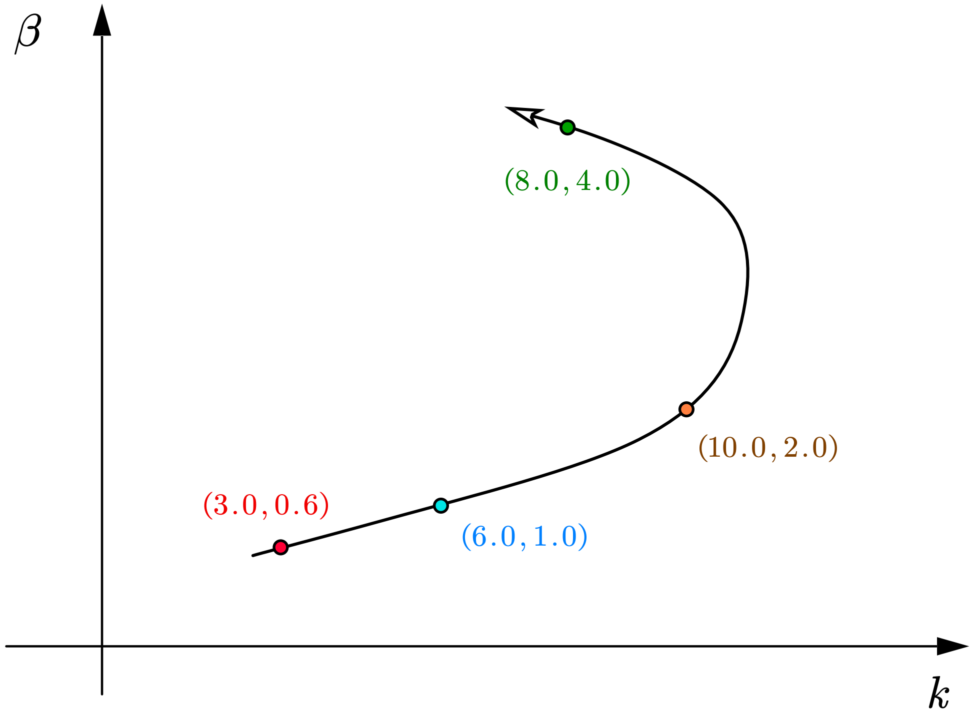
$$a_{\hat{i}} = -\ddot{\theta} \cdot (L_0 + L) - \dot{\theta} \cdot \dot{L}$$

$$\hat{j}: \quad mg \cdot \cos(\theta) - k \cdot L - \beta \cdot \dot{L} = m \cdot \ddot{L}$$

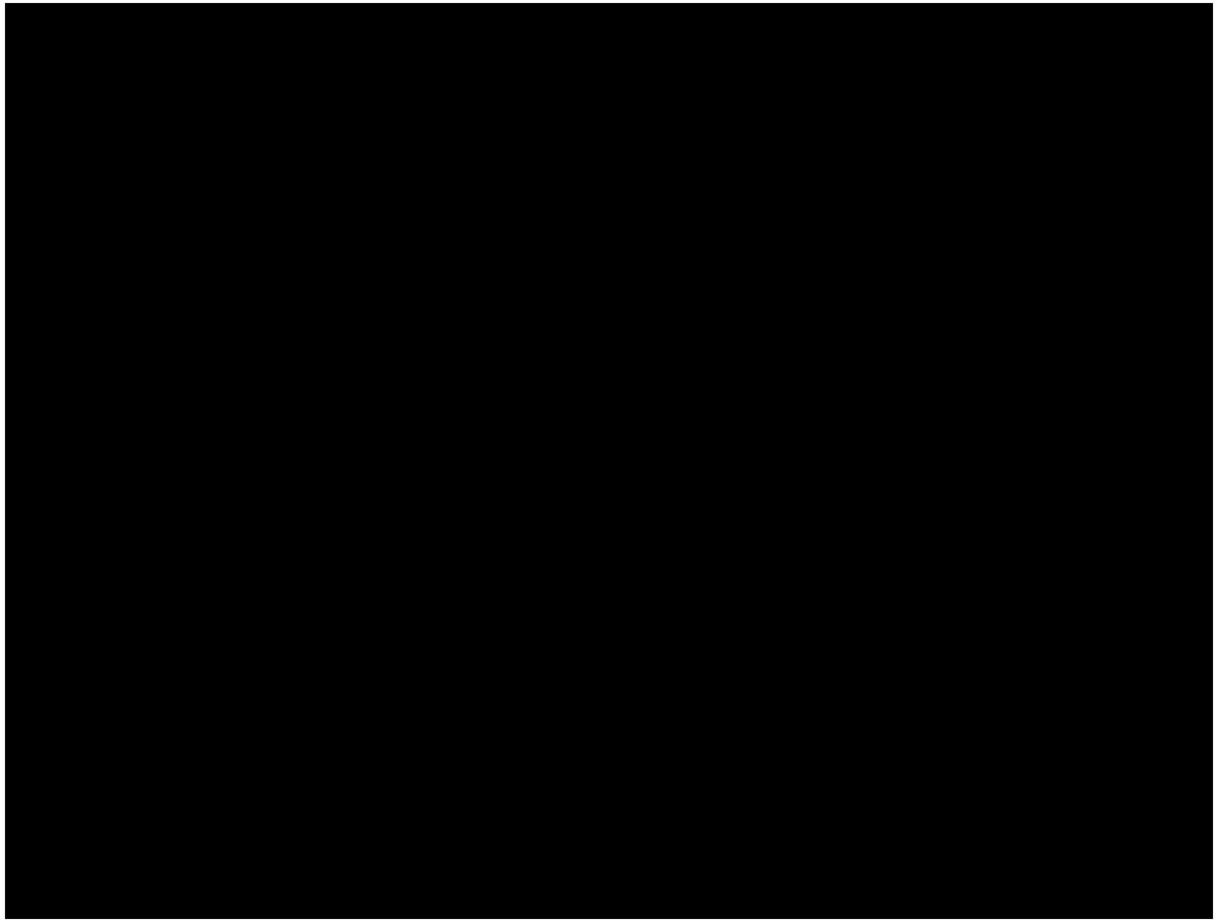
Simulator Environment

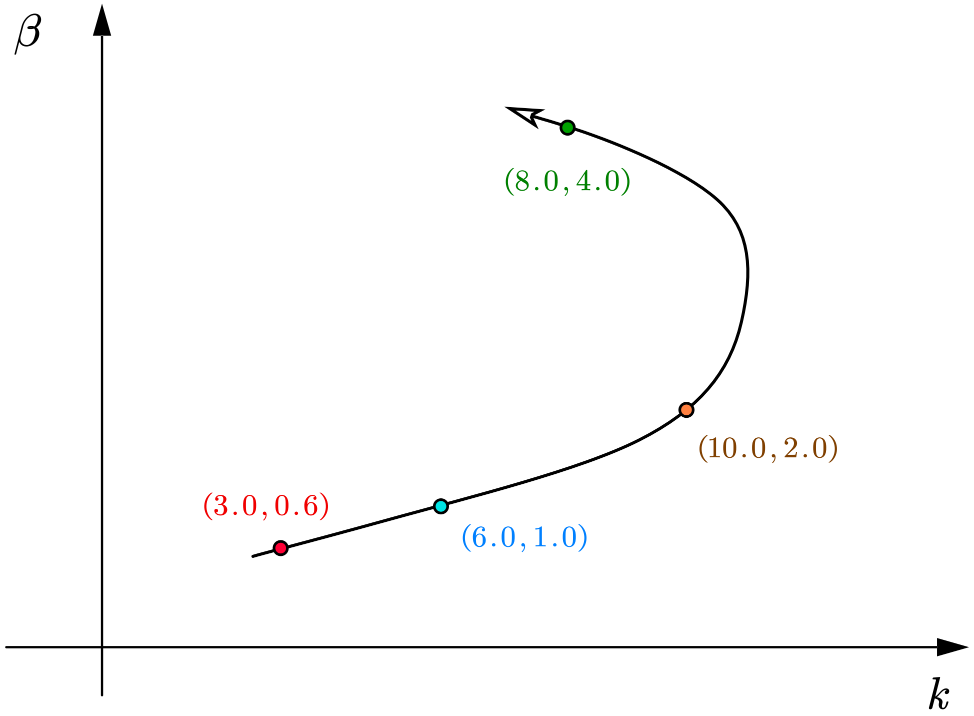


Initial States

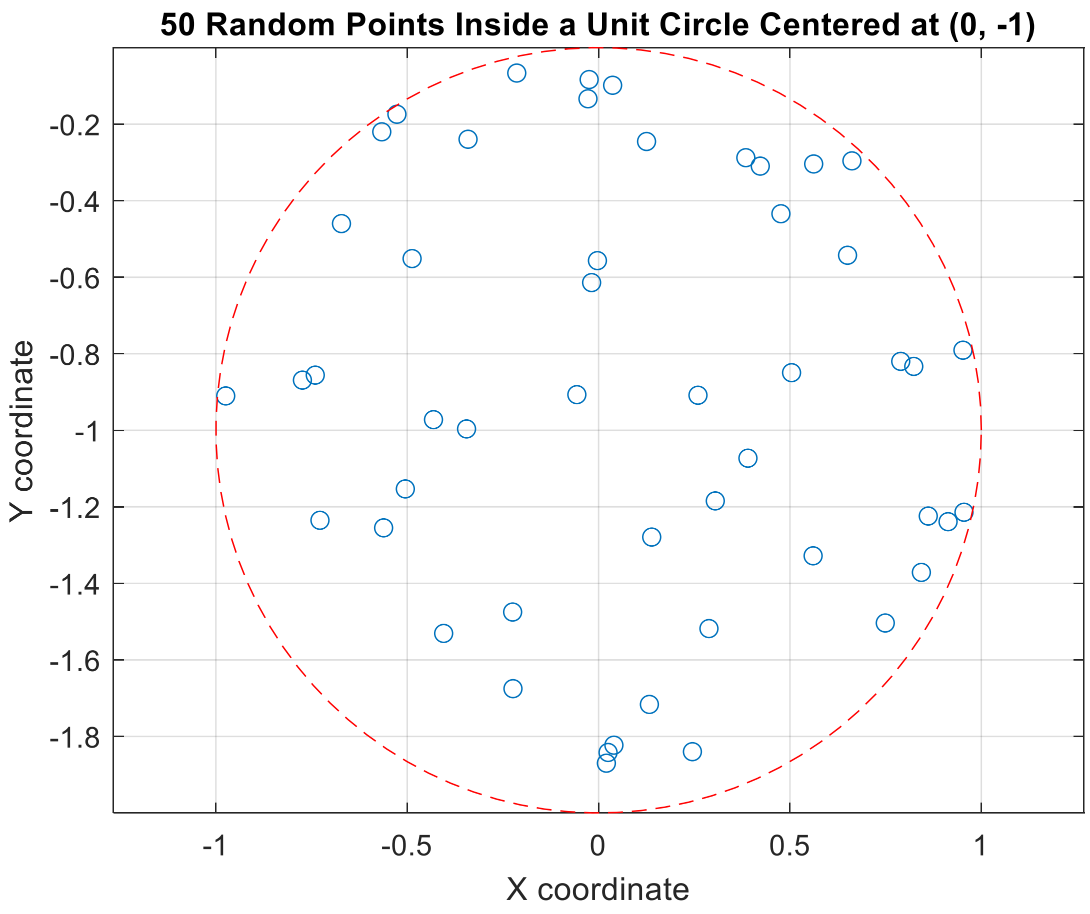


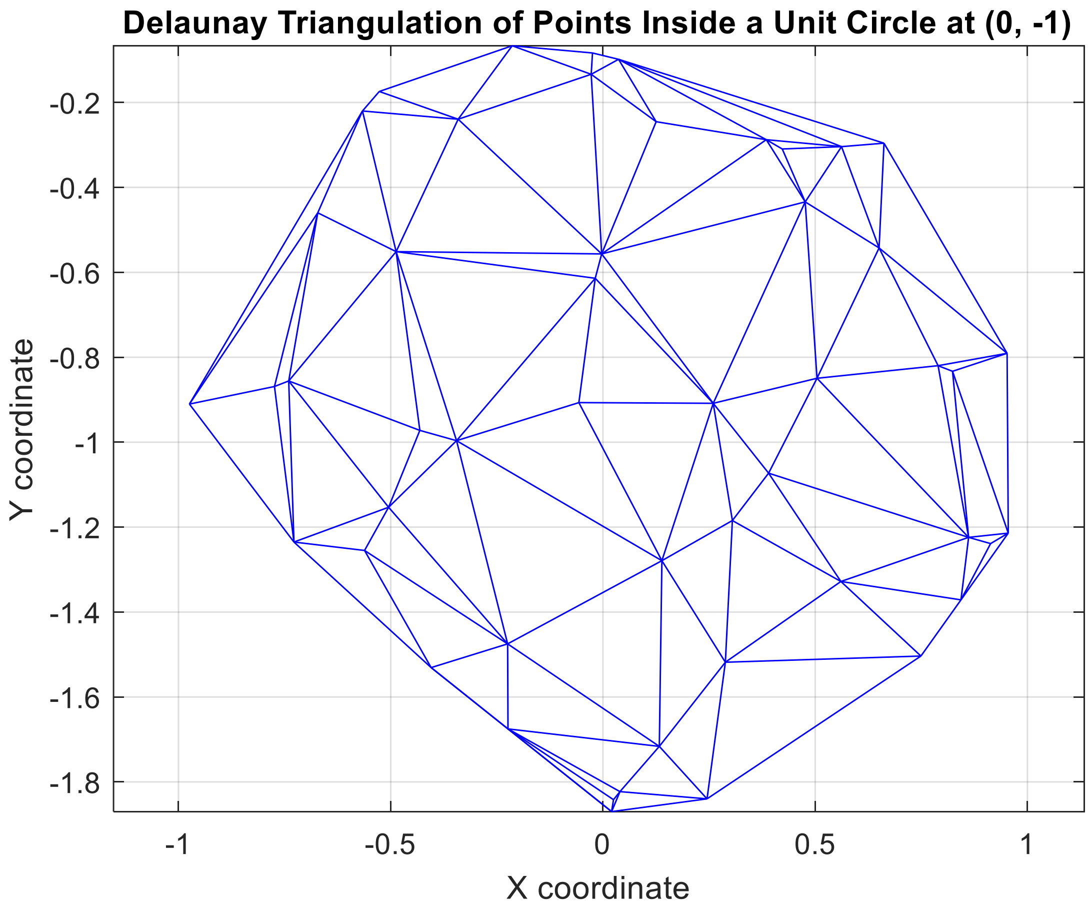
Parameters

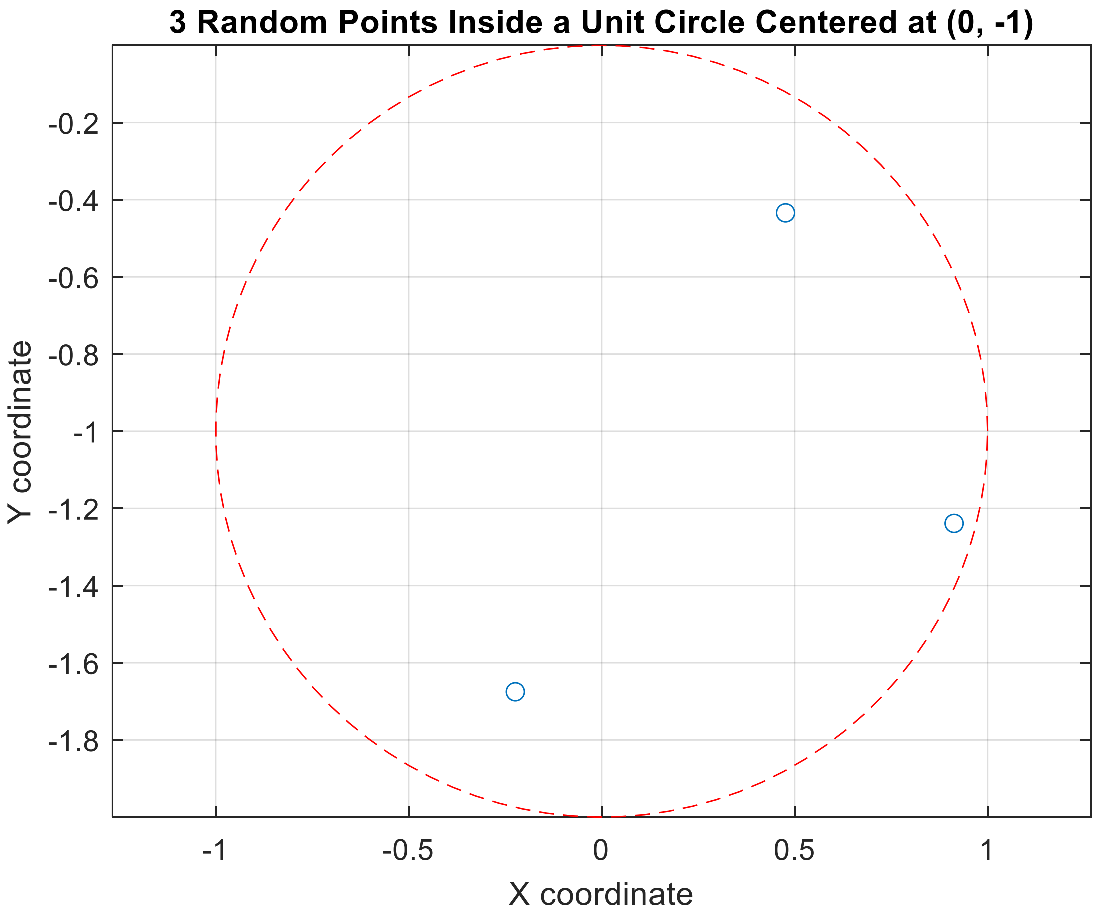


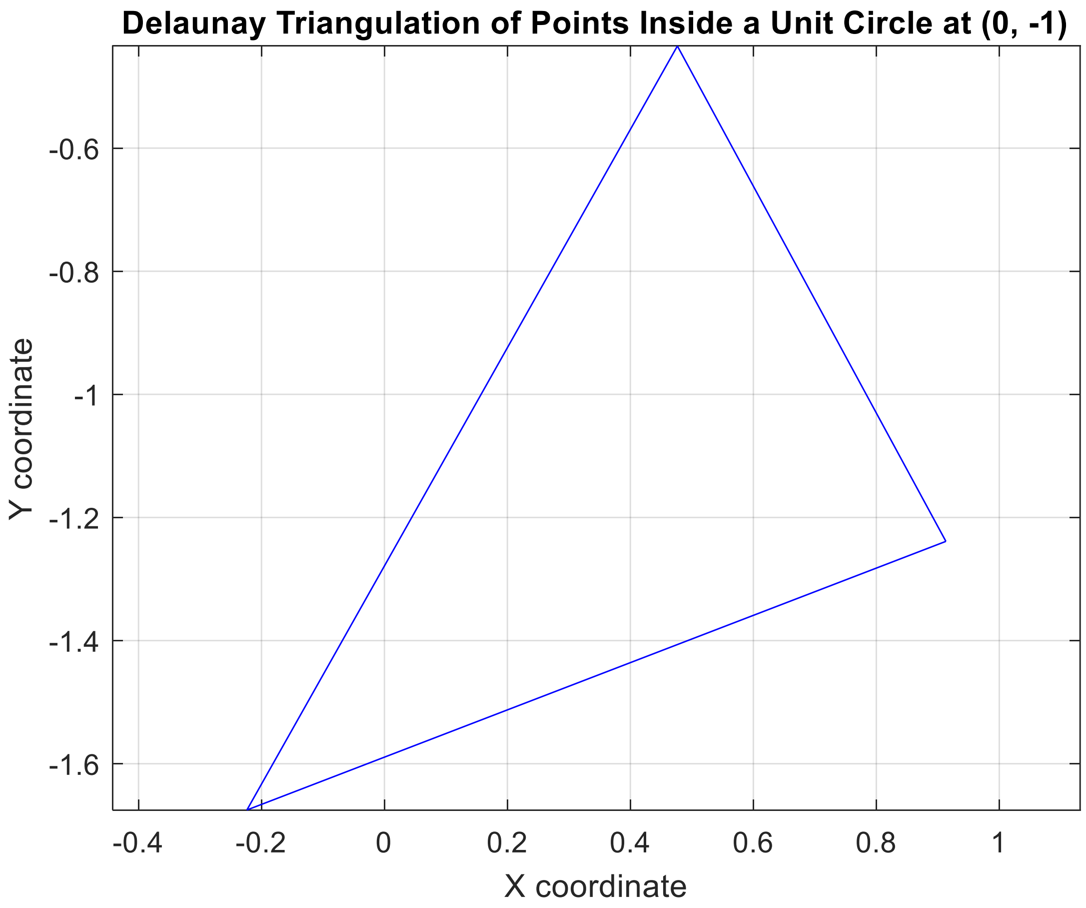


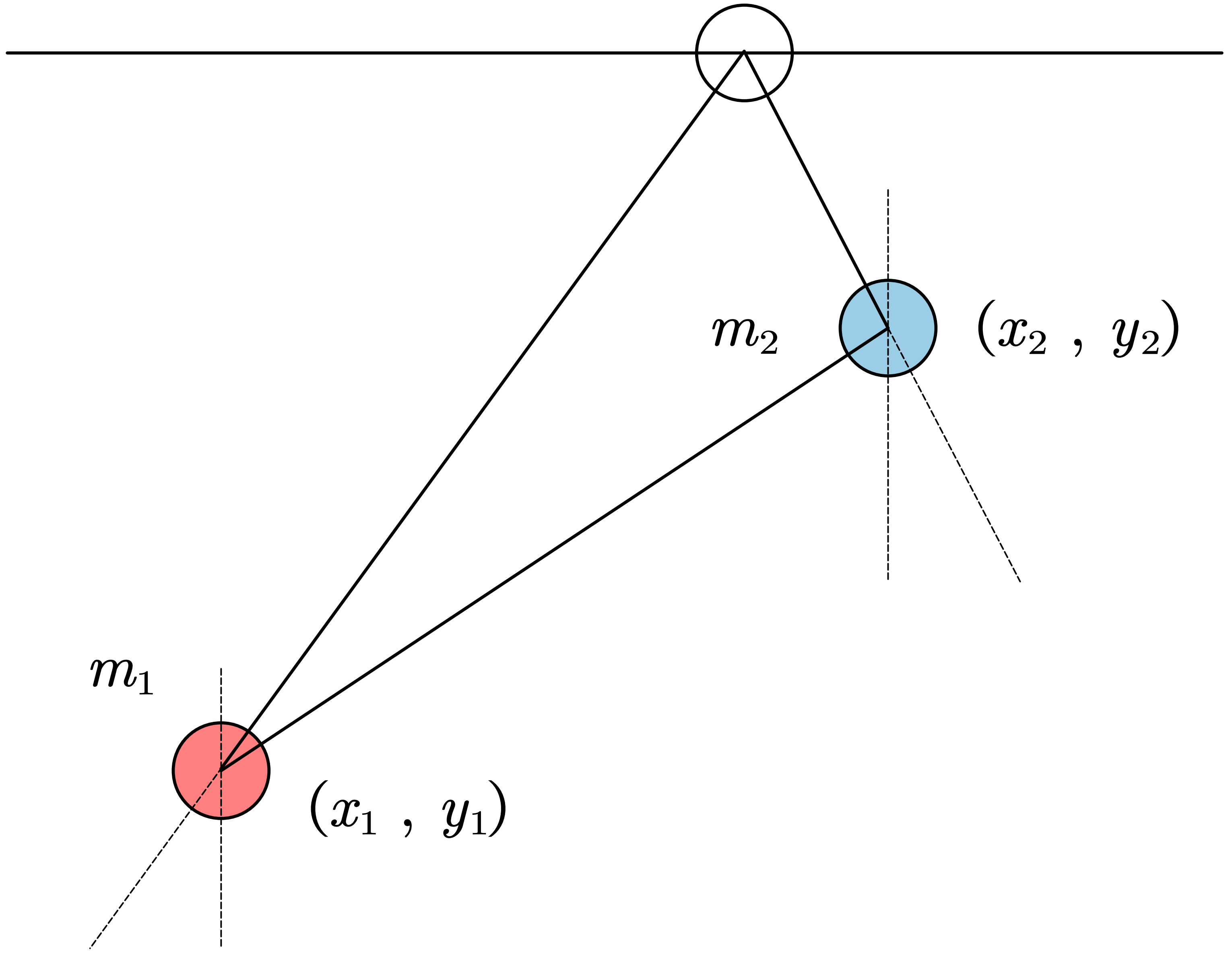
Parameters


50 Random Points Inside a Unit Circle Centered at (0, -1)
X coordinate
Y coordinate


Delaunay Triangulation of Points Inside a Unit Circle at (0, -1)
X coordinate
Y coordinate

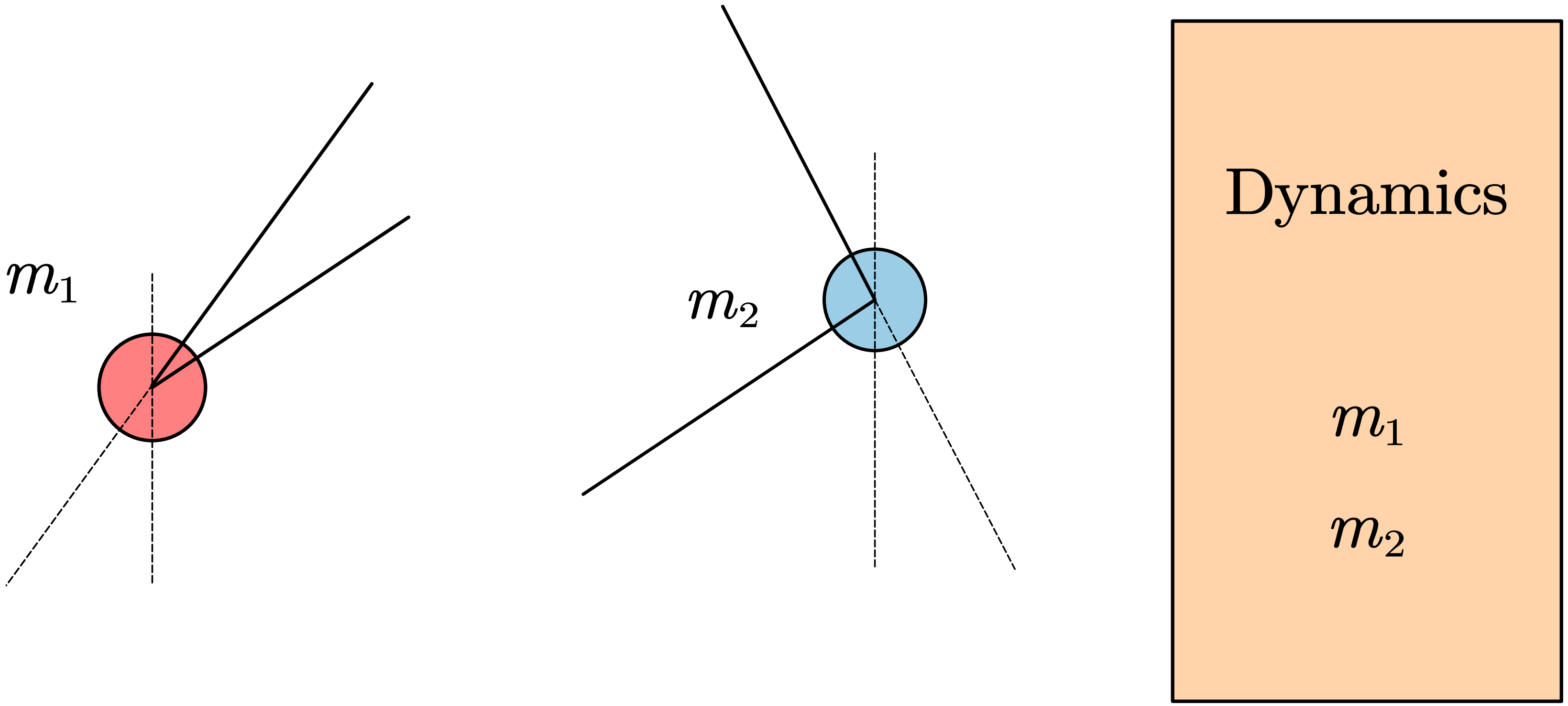

3 Random Points Inside a Unit Circle Centered at (0, -1)
Y coordinate
X coordinate
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-1
-0.5
0
0.5
1


Delaunay Triangulation of Points Inside a Unit Circle at (0, -1)
Y coordinate
X coordinate
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1



m_2
$(x_2\ ,\ y_2)$
m_1
$(x_1\ ,\ y_1)$

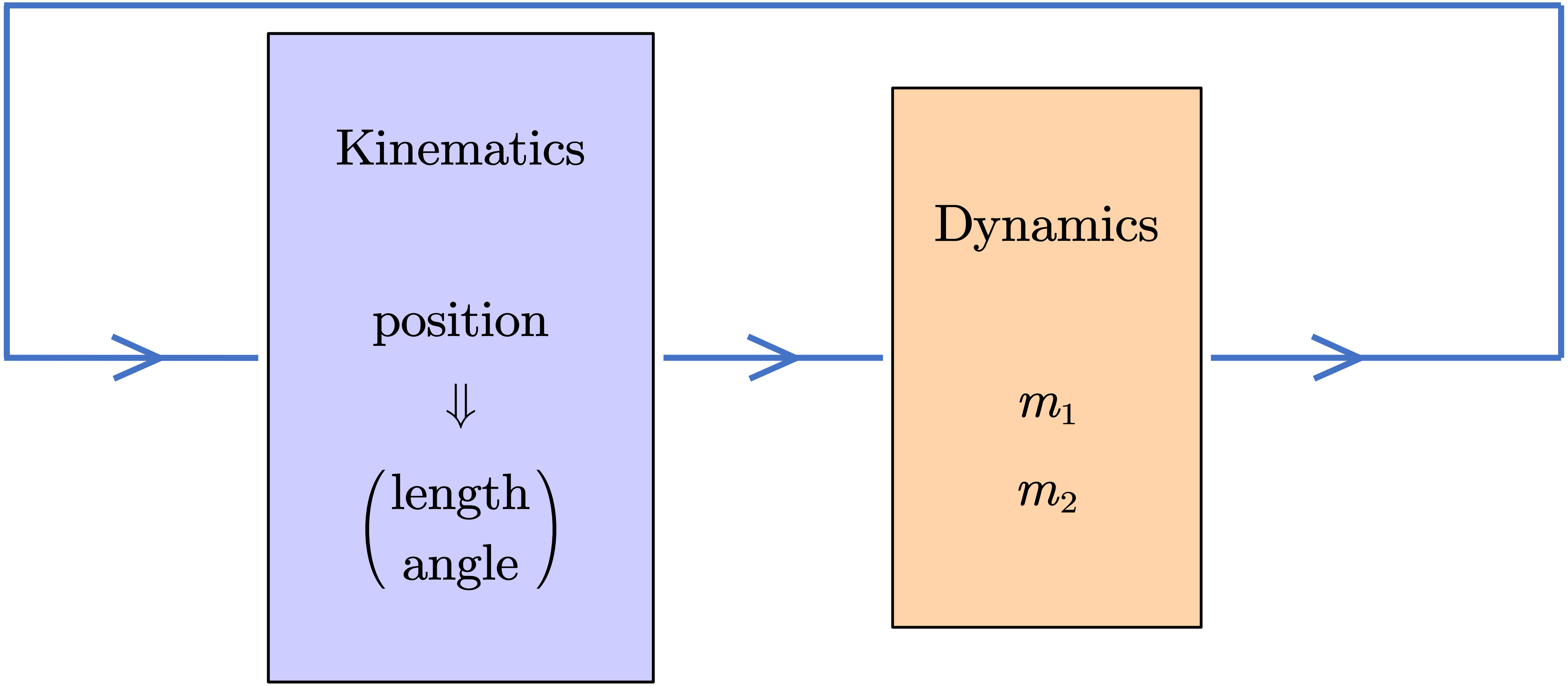
Newton's Equation

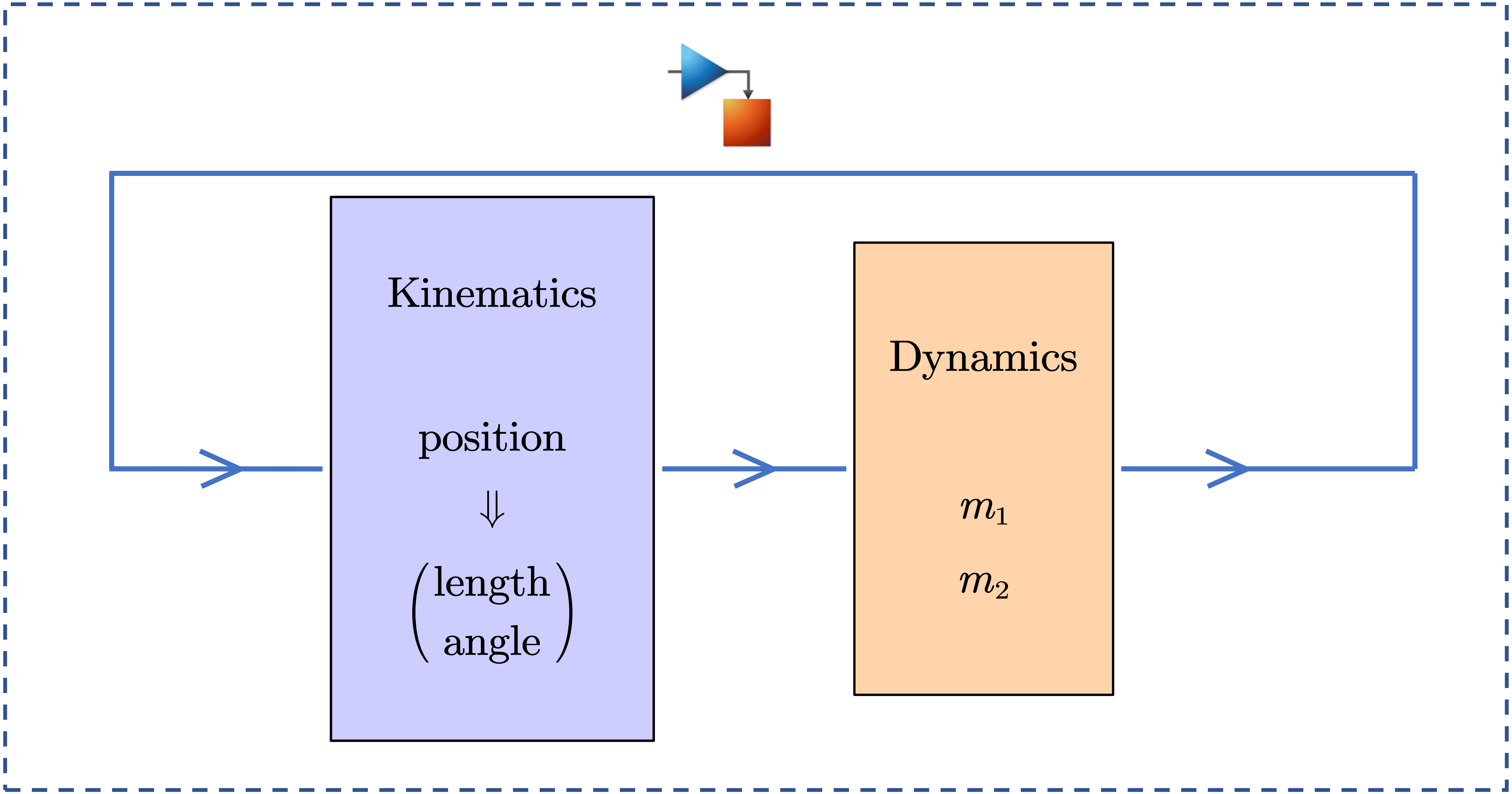


Dynamics

m_1

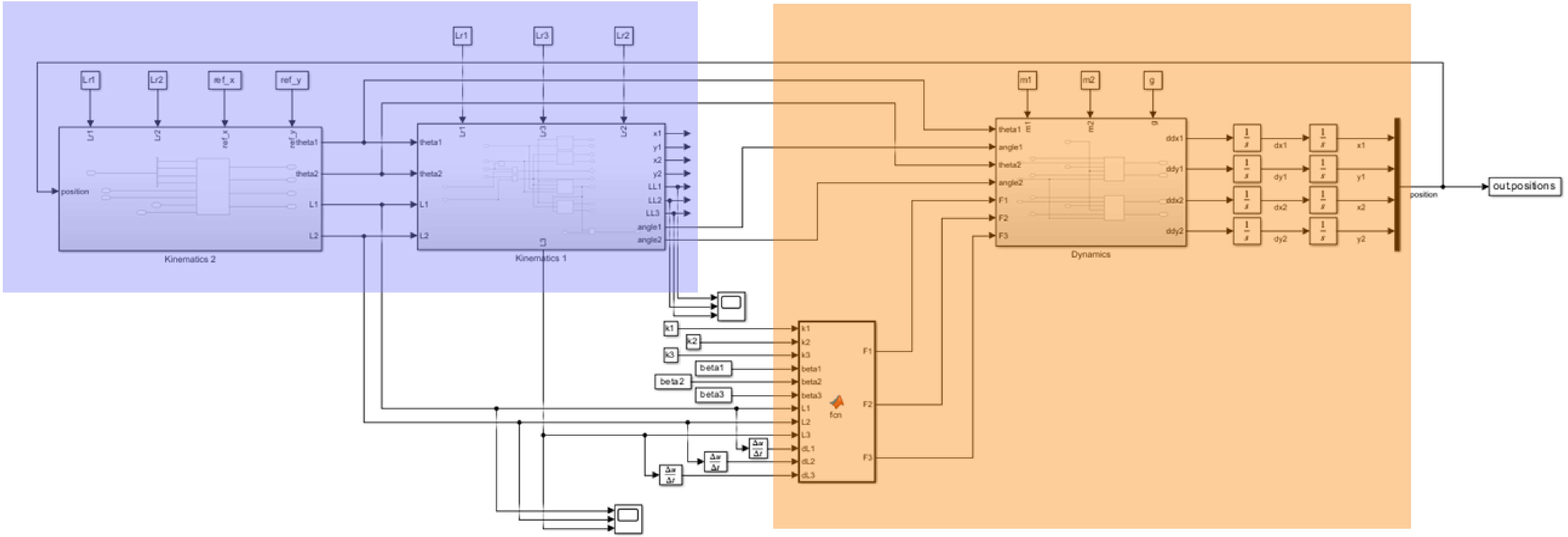
m_2

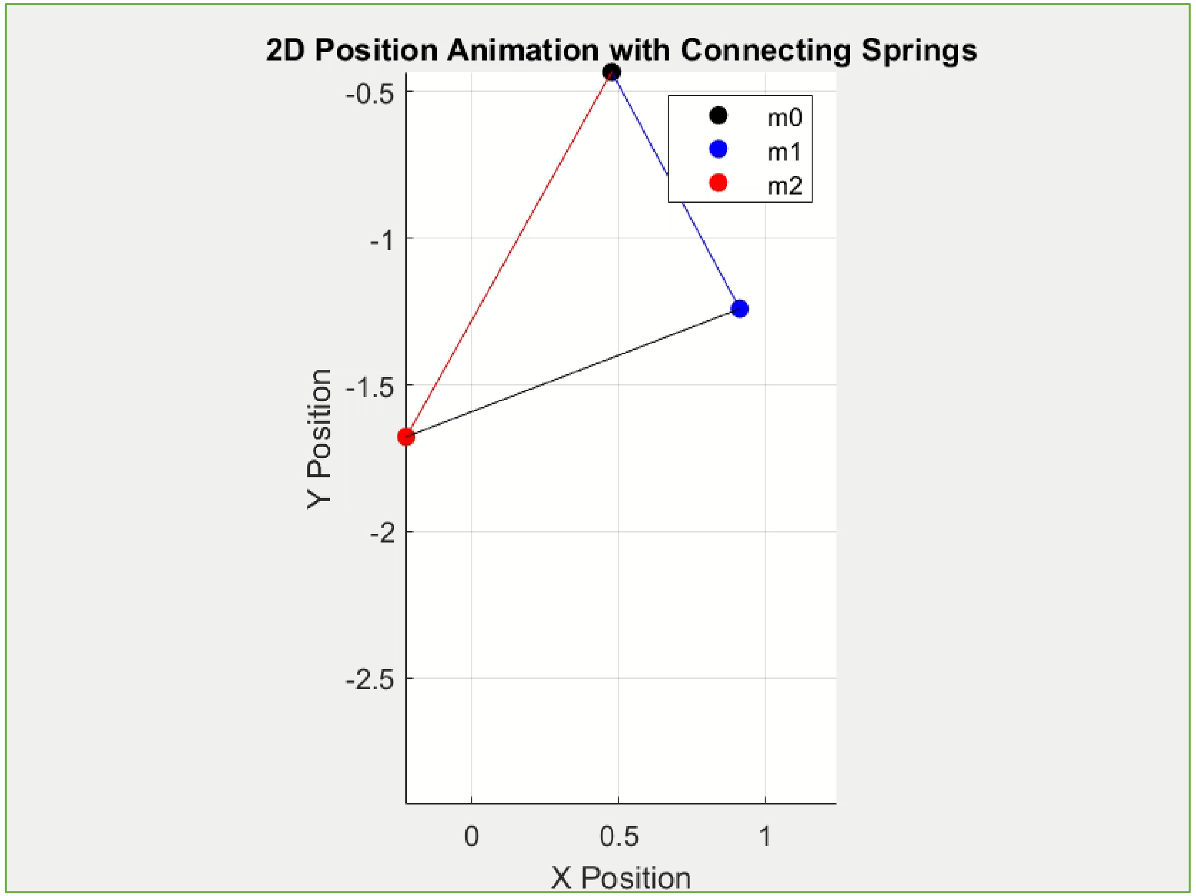

Kinematics
position
$\Downarrow$
$\begin{pmatrix}\text{length}\\ \text{angle}\end{pmatrix}$
Dynamics
m_1
m_2

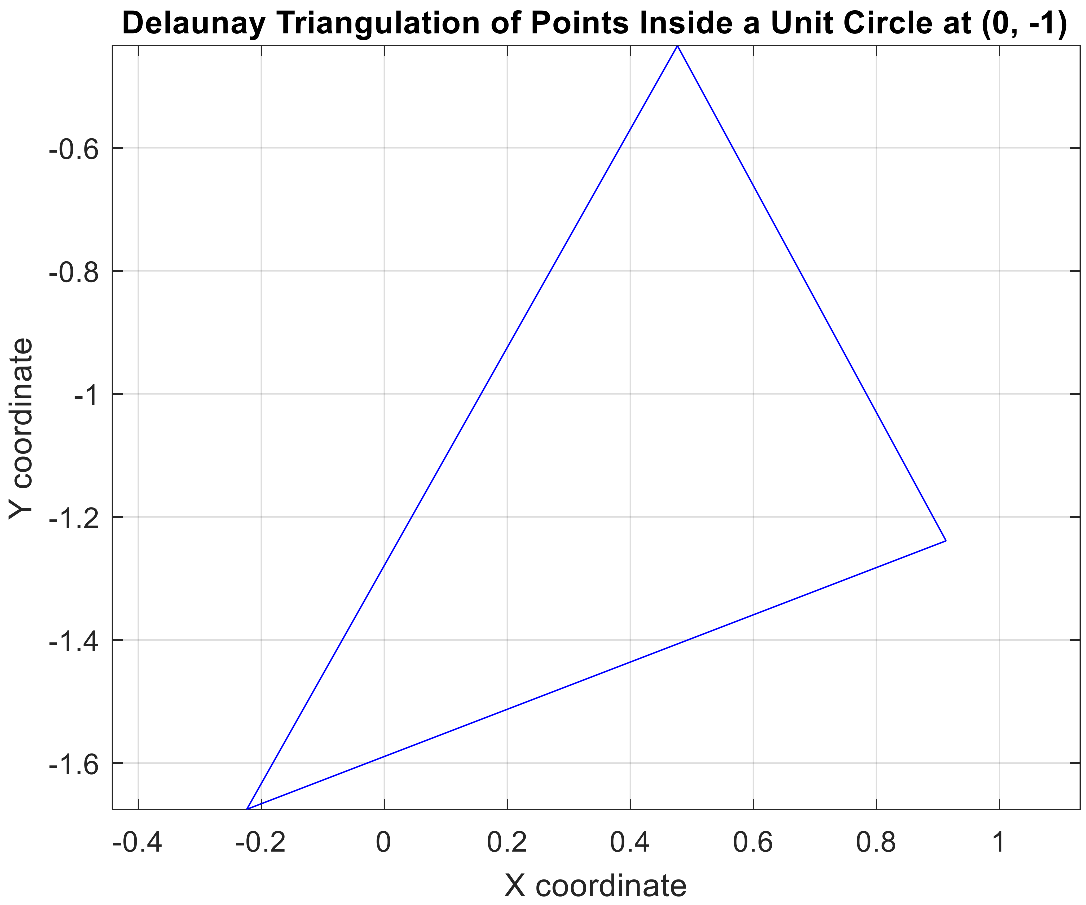

Kinematics
position
⇓
(length angle)
Dynamics
m_1
m_2

Kinematics

Dynamics




2D Position Animation with Connecting Springs
m0
m1
m2
Y Position
X Position
-0.5
-1
-1.5
-2
-2.5
0
0.5
1


Delaunay Triangulation of Points Inside a Unit Circle at (0, -1)
Y coordinate
X coordinate
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

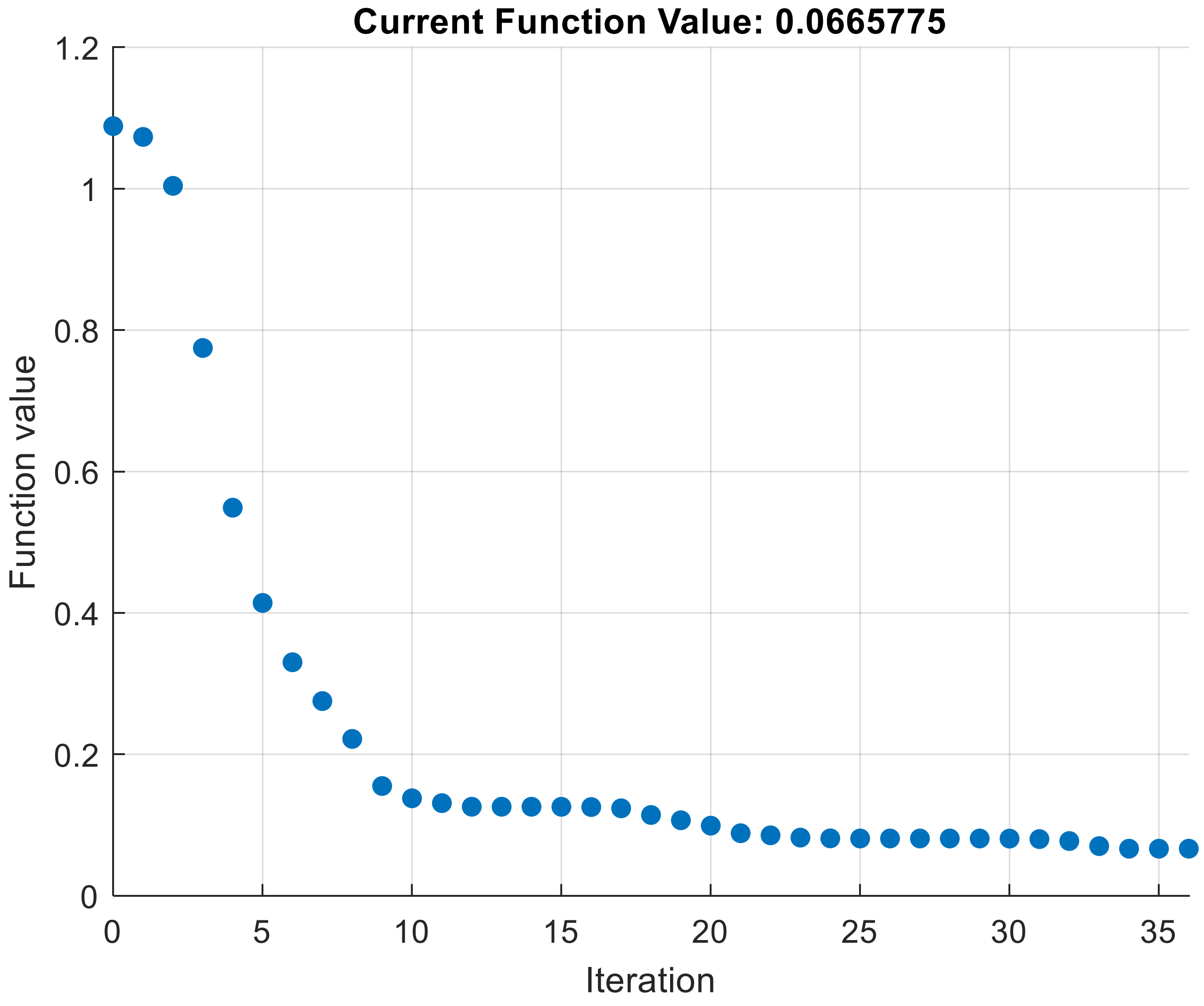
$K = [10; 10; 10]$

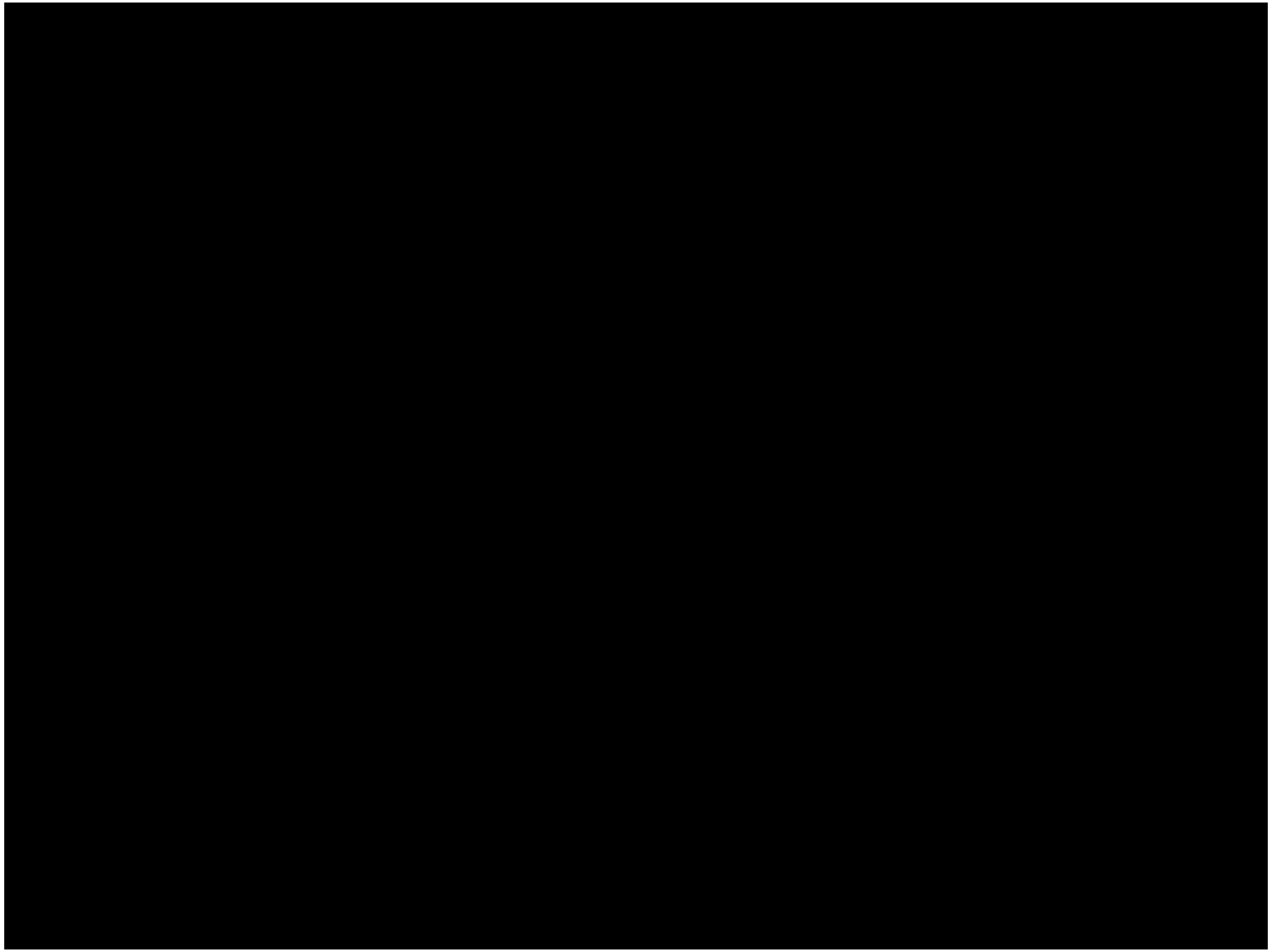
$$\min_{k_1,k_2,k_3}\left[(L_1-\bar{L})^2+(L_2-\bar{L})^2+(L_3-\bar{L})^2\right]$$

S. T.

$$\bar{L}=\frac{1}{3}(L_1+L_2+L_3)$$

$$k_i\in[10,100],\ (i=1,2,3)$$





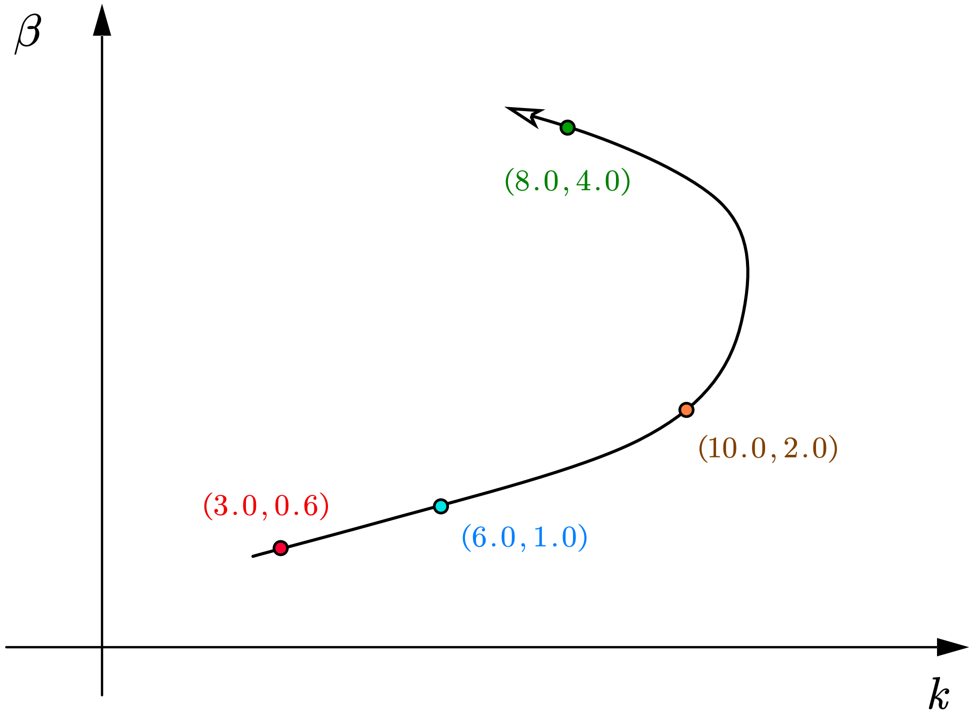
K = [22.8375; 10.0000; 10.0000]

Effects of **age** on **elastic** moduli of human lungs
SJ Lai-Fook, RE Hyatt - Journal of applied physiology, 2000 - journals.physiology.org
… of **age** 10 yr, all the lungs studied were in the adult **age** group (>17 yr). Thus the **age**-related increases in **elastic** … disease on the **age**-related change in the **elastic** moduli cannot be ruled …
☆ Save 99 Cite Cited by 176 Related articles All 6 versions

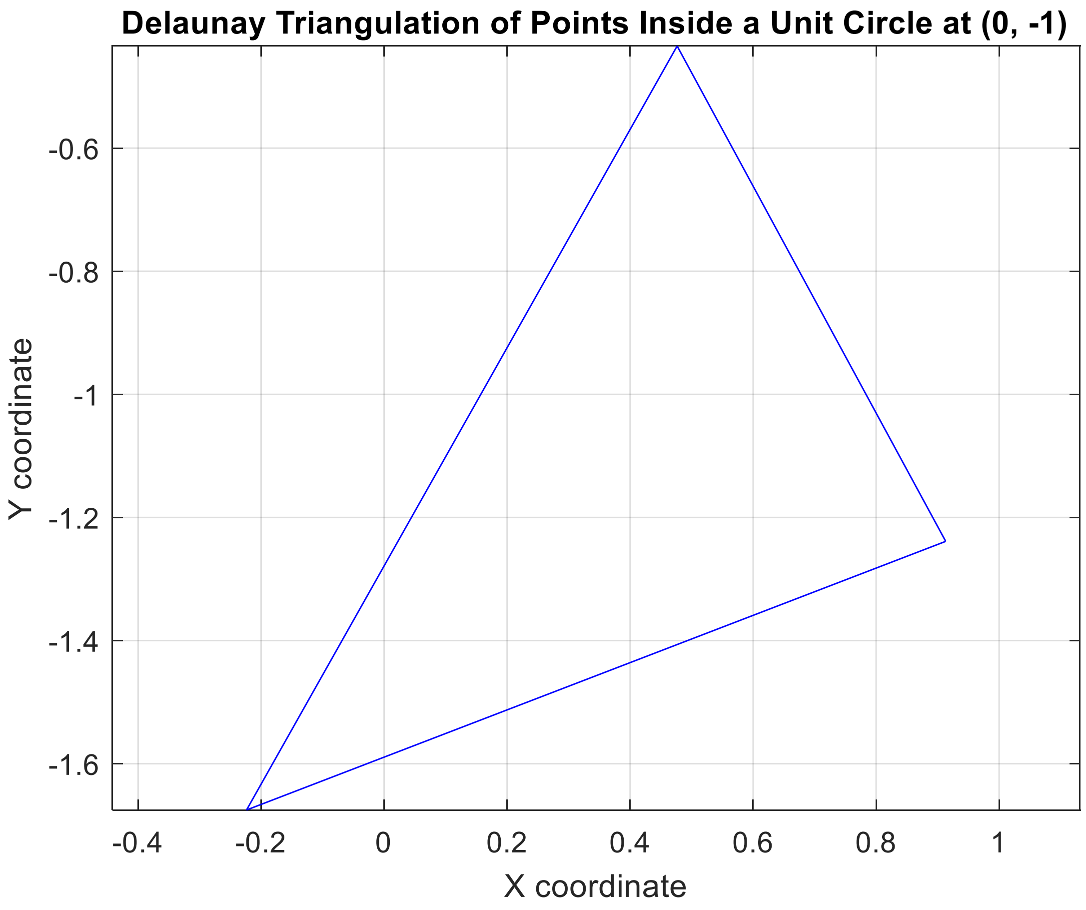
Elasticity of human lungs in relation to **age**
JM Turner, J Mead, ME Wohl - Journal of applied physiology, 1968 - journals.physiology.org
… between **age** and lung **elasticity** was reinvestigated. … compliance of the chest wall with **age** to our own measurements of changes of lung **elastic** recoil with **age**. Mittman …
☆ Save 99 Cite Cited by 721 Related articles All 6 versions

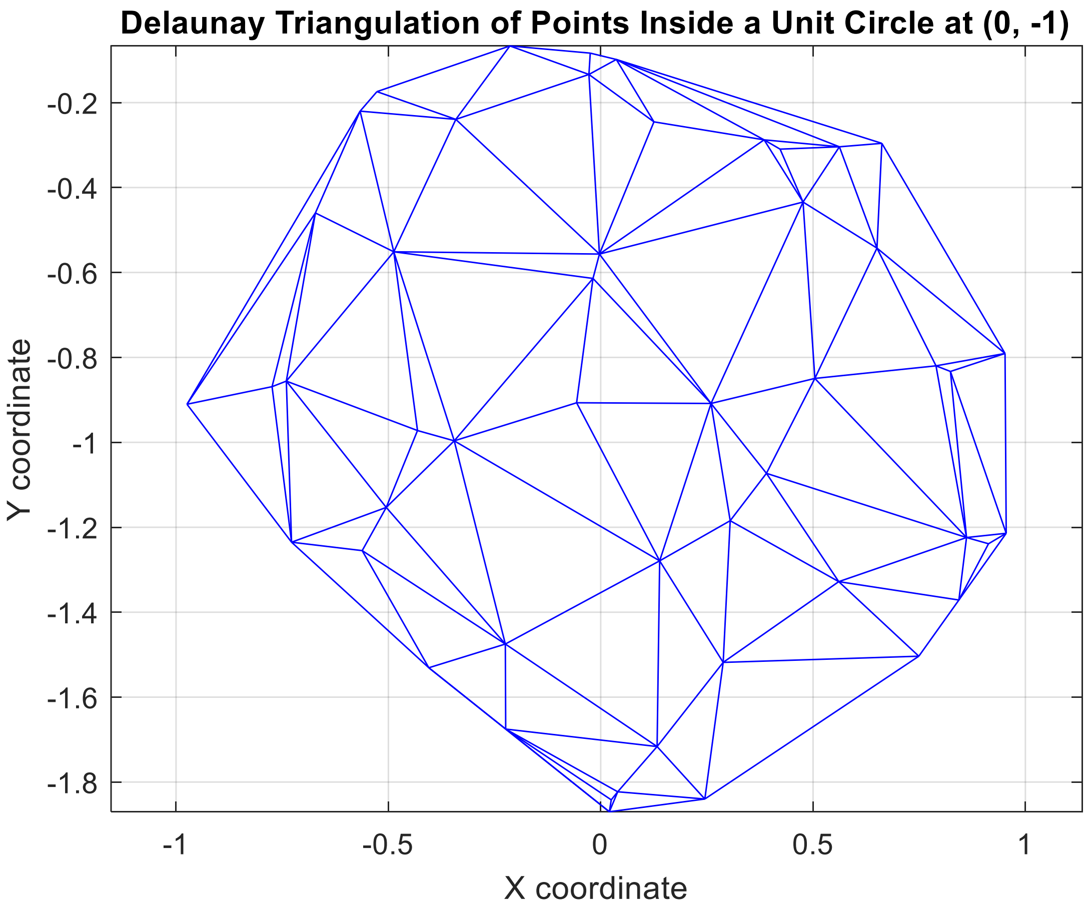
[HTML] **Age**-related differences in the **elasticity** of the human cornea
NEK Cartwright, JR Tyrer… - … ophthalmology & visual …, 2011 - iovs.arvojournals.org
… The goal of this study was to determine **age**-related variation in the **elasticity** of the human … linear manner with **age** from approximately 0.25 MPa at **age** 20 to 0.5 MPa at **age** 100. These …
☆ Save 99 Cite Cited by 219 Related articles All 8 versions

Tissue **elasticity** and the ageing **elastic** fibre
MJ Sherratt - **Age**, 2009 - Springer
… **elastic** fibre components in both mediating tissue **elasticity** and maintaining tissue homeostasis. This review considers how **age**-related changes in the **elasticity** … of ageing on **elastic** fibre …
☆ Save 99 Cite Cited by 393 Related articles All 18 versions



Parameters of the Springs


Delaunay Triangulation of Points Inside a Unit Circle at (0, -1)
Y coordinate
X coordinate
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1


Delaunay Triangulation of Points Inside a Unit Circle at (0, -1)
Y coordinate
X coordinate
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-1
-0.5
0
0.5
1

MATLAB

SIMULINK

$$\hat{i}: \quad mg \cdot \sin(\theta) = m \cdot a_{\hat{i}}$$

$$a_{\hat{i}} = -\ddot{\theta} \cdot (L_0 + L) - \dot{\theta} \cdot \dot{L}$$

$$\hat{j}: \quad mg \cdot \cos(\theta) - k \cdot L - \beta \cdot \dot{L} = m \cdot \ddot{L}$$

Simulator Environment

GitHub

ROS 2

Open Source

Thanks