Summative evaluation 1

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Assessement modalities

You will be graded through the criterion grid presented in Table 1. It is composed of the levels ”expected”, ”almost there” and ”first step” of the three first global AAVs of the ECUE. This evaluation counts for 25% of the final grade.

Table 1 – Evaluation criterion grid

AAVs	Expected	Almost there	First step
1 - **Describe the properties of vector space subsets (point clouds, sets of functions, etc.) using linear algebra tools (inner product, norm, PCA, SVD, etc.).**	The expected properties are determined, with a relevant usage of the tools of linear algebra, and a geometrical interpretation is given. (6.5pts)	The expected properties are determined with an attempt of interpretation. Good interpretation but some properties are missing due to an ommision or a confusion. (3pt)	Some properties are missing, concept confusion and a beginning of interpretation.(1pts)
2 - **Reformulate a problem or linear application using vector notation for the purpose of optimization (improving readability, reducing line count, minimizing memory footprint, and optimizing computation time).**	The reformulation yields a complete optimization and is rigorously justified.(7pts)	A reformulation is proposed yielding an optimization direction.(4pt)	An incomplete problem reformulation attempt or one that does not necessarily yield an optimization. (2pts)
3 - **Select a simple numerical resolution method to address a specific problem (dimensionality reduction, linear regression, solving linear systems, etc.).**	The chosen method yields a solution to the problematic and its choice is justified depending on the formalized problem’s characteristics. (6.5pt)	The chosen method can solve the given problem, but the justification is not coherent with the problem. The chosen method is not the most suitable for the given problem, despite a coherent justification. (3pt)	The chosen method is not totally suitable for the problem and the justification is not consistent. (1pts)

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Exercise - Ride at the funfair

John Doe decided to do a rotating Pendulum ride at the funfair. On this ride, the passengers sit on the exterior perimeter of a circular gondola. It can be represented by a 2-meter radius disk (we neglect the height of the seat). It is attached to the crossbar by a 5-meter arm. The gondola is centered on the arm axis and is orthogonal to it. Its rotation axis is in the arm alignment. At the other extremity, the arm is attached to the horizontal part of the crossbar, 7 meters above the ground. This horizontal part is the rotation axis of the arm. At rest, the gondola is parallel to the ground and passengers ar seated with theit feet down. The arm is orthogonal to the ground.

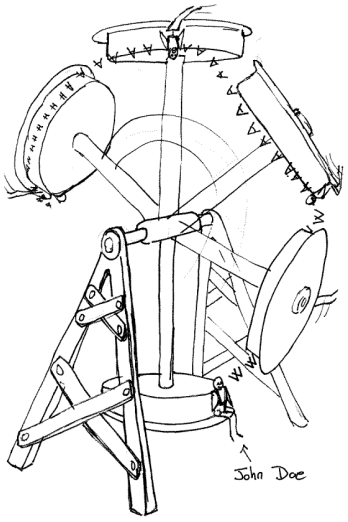
- The center of the arm rotation axis is in $(0, 0, 7)$
- The gondola center at the beginning is in $(0, 0, 2)$
- John Doe at the beginning is at the position $(2, 0, 2)$.
- The arm makes a complete turn around its axis in 3 seconds.
- The gondola makes a complete turn on itself in 2 seconds.

We want to calculate the position of John Doe in the gondola at a time $t > 0$ expressed in seconds. At the starting point ($t = 0$), he is oriented in the direction of the arm rotation. All the objects are rotating in the trigonometric sense (anticlockwise) and with a homogeneous speed (no accelerations nor decelerations).

1. Make a drawing and write the rotation matrices associated with the arm and with the gondola as a function of t. List their properties.
2. Write the function $f(t)$ giving the position of John Doe at a time t. The function can be from $\mathbb{R} \to \mathbb{R}^3$ or $\mathbb{R} \to \mathbb{R}^4$.
3. We assume the sun to be at its zenith. Suggest a method giving the position on the ground of John Doe's shadow as a function of t. Write the corresponding function $s(t)$. It can be from $\mathbb{R} \to \mathbb{R}^3$ or $\mathbb{R} \to \mathbb{R}^4$ and you can use the previous function.
4. Suggest a method giving the distance of John Doe to the ground at each instant t in meters. Write the corresponding function $d(t)$. You can use the previous function.

The activities of the funfair are disposed as square blocks surrounded by four 10-meter long pathways (we neglect their width). The pathways thus form a regular network of segments of 10 meters, perpendicular to each other and aligned on the axes $\mathbf{x}$ and $\mathbf{y}$. The entry of the funfair is in $(-40, -20, 0)$.

5. What is the distance to the ride where John Doe is, "as the crow flies"? What distance did he walk knowing that he took the shortest path?



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