[MathWorks - MPC](https://www.youtube.com/watch?v=8U0xiOkDcmw)

*Connect unfamiliar things to things you understand, like robotic arms to your own arms, MPC Control algorithm to the processes and calculations that go on inside your Motor Cortex and Hippocampus*

**Video 1**

Context:

A robot controller is a program that take in the error between the desired state of the robot (reference) and the current state (estimated), and comes up with commands the robot system (how to change torques), which the robot then enacts.

Model Predictive Control (MPC) is a feedback control algorithm used by **controllers** that uses a model (of what) to make predictions about the outputs of a process.

Analogy: Keeping car in middle of road

First driving a car, you’re nervous, and all the situation are running through your head each time you take the wheel. Now let’s day you are on the road and a turn is coming up, how do you decide what to do?

Algorithm:

Simulate where your car will go based on the control actions you take

Select you do whatever gets you closest to the path you want to take

e.g. staying on the road

Benefits:

Handle Constraints

Foresight (can incorporate future reference information)

Costs:

Solves an online optimization problem each iteration, that will drive the output to the reference

Robotic Arm

MPC is an algorithm that uses a model (of the robotic arm) to make predictions about the output position and cost of movement based on controls, and chooses the control action that maximizes movement towards the reference and minimizes cost of that movement.

Analogous to the processes and calculations that go on in the motor cortex and hippocampus when orchestrating a reach movement.

**Video 2**

How does MPC work?

Definitions

Time Step = amount of time elapsed between each time controller sends commands to robotic arm

Predicted time(p) = How far into future the MPC algorithm optimizes the path taken

Schematics

1. Feed in a desired output state (reference) into the controller
2. The controller has two components:
   1. Model of the robot arm
   2. Optimizer
3. MPC runs simulations on its model of the robot arm to generate trajectories moving towards the goal based on controls
   1. Optimizer is used to calculate (describe) the costs of each of those paths
4. Optimal control sequence is selected (for the time horizon), and the first set of controls for this path are enacted
5. Measure current state of robot arm
6. Resolve optimization problem until at desired state

Graphical user interface, diagram, application

Description automatically generated

What is the optimization problem optimizer solves?

Find the minimum of cost function *J(path)*

Taking a Weighted SSE (Summing up the squares of distance from reference and Acceleration each time step)