Convex Optimization

Practical session # 1

October 2, 2024

Installing CVXPY

- If you have Python installed on your computer, then you may follow the instructions at `https://www.cvxpy.org/install/index.html` and install CVXPY by running, for example

  ```
  pip install cvxpy
  ```

- If you prefer using Python without having it installed on the PC, then you may use

  `https://jupyter.org/`

  On this website, go "Try" → "JupyterLab", and there you may create a new "Notebook". The website is free and requires no registration.

Example

Let $f_0(x, y) = x + 2y$ be the objective function. We want to **minimize** its value with respect to the constraints

$$\left\{ \frac{x^2}{36} + \frac{y^2}{16} \leq 1 \;\&\&\; x + y \leq 5 \right\}$$

1. First, upload the `cvxpy` library by typing:

   ```
   import cvxpy as cp
   ```

2. Then, introduce the variables that we want to optimize:

   ```
   x = cp.Variable()
   y = cp.Variable()
   ```

3. Create two constraints (note that strict inequalities are not allowed):

   ```
   constraints = [(x**2)/36 + (y**2)/16 <= 1, x + y <= 5]
   ```

4. Add the objective:

   ```
   obj = cp.Minimize(x + 2*y)
   ```

5. Form and solve the problem. The `.solve()` function returns the optimal value.

   ```
   prob = cp.Problem(obj, constraints)
   prob.solve()
   ```

6. To show the status of the problem, use the `.status` attribute:

```
print("status:", prob.status)
```

7. To show the optimal values of the objective function and of the variables, use the `.value` attribute:

```
print("optimal value", prob.value)
print("optimal var", x.value, y.value)
```

8. Run the code. Compare the result with the solution obtained by manually solving the problem.
9. Replace the constraints in your code with $\{x \leq 0 \;\&\&\; x \geq 1\}$ and run the program. What happens with the problem status and optimal values?
10. Replace the constraints in your code with $\{x \leq 0 \;\&\&\; y \leq 0\}$ and run the program. What happens with the problem status and optimal values?