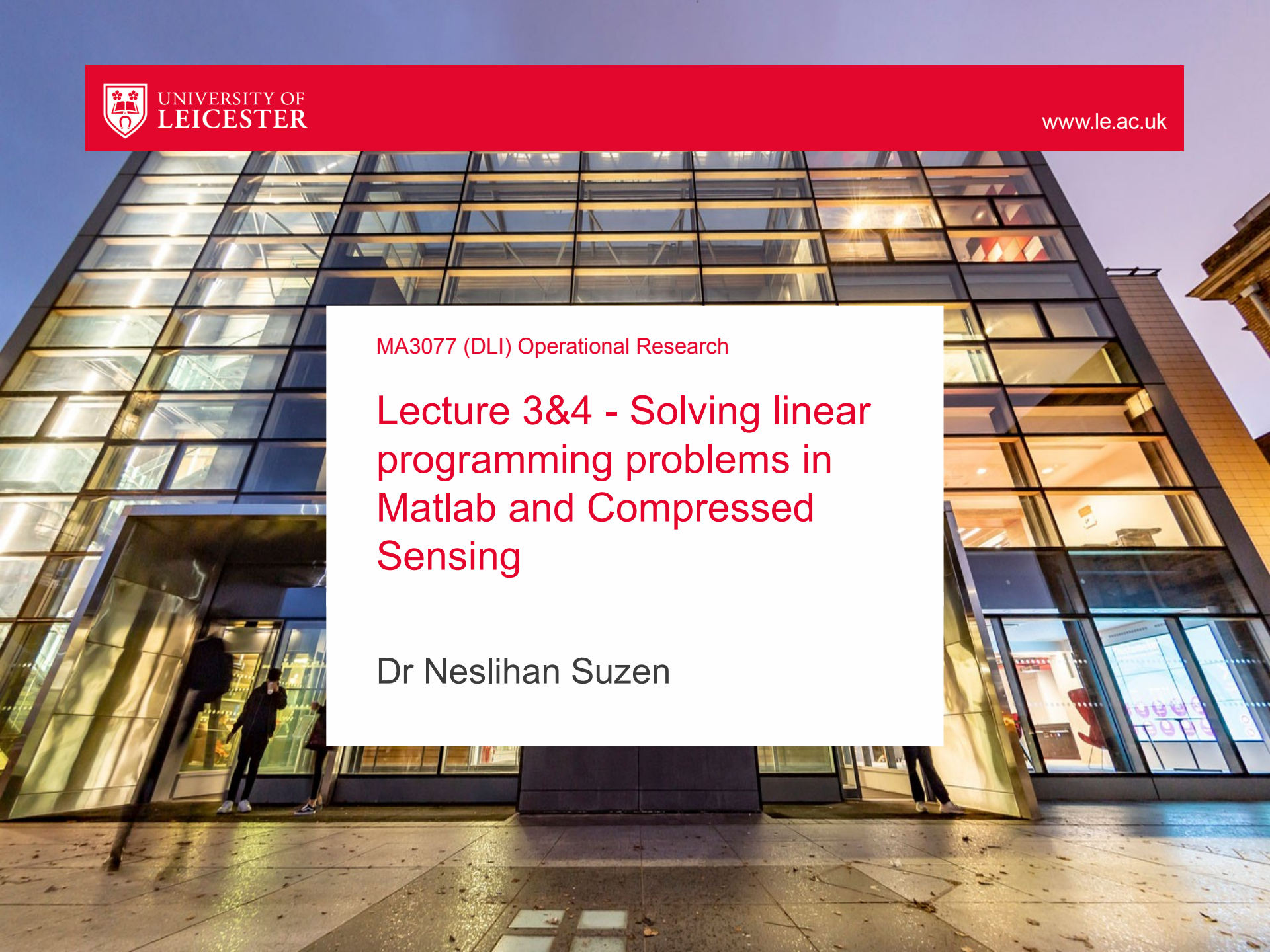



MA3077 (DLI) Operational Research

# Lecture 3&4 - Solving linear programming problems in Matlab and Compressed Sensing

Dr Neslihan Suzen

# Lecture outline

This lecture's goal is to learn:

- How to solve linear programming problems in Matlab using linprog.
- How to solve a compressed sensing problem using linear programming

# A previous example - formulation

Mathematically, we usually write the problem as follows:

Maximise:

subject to:

Maximise:

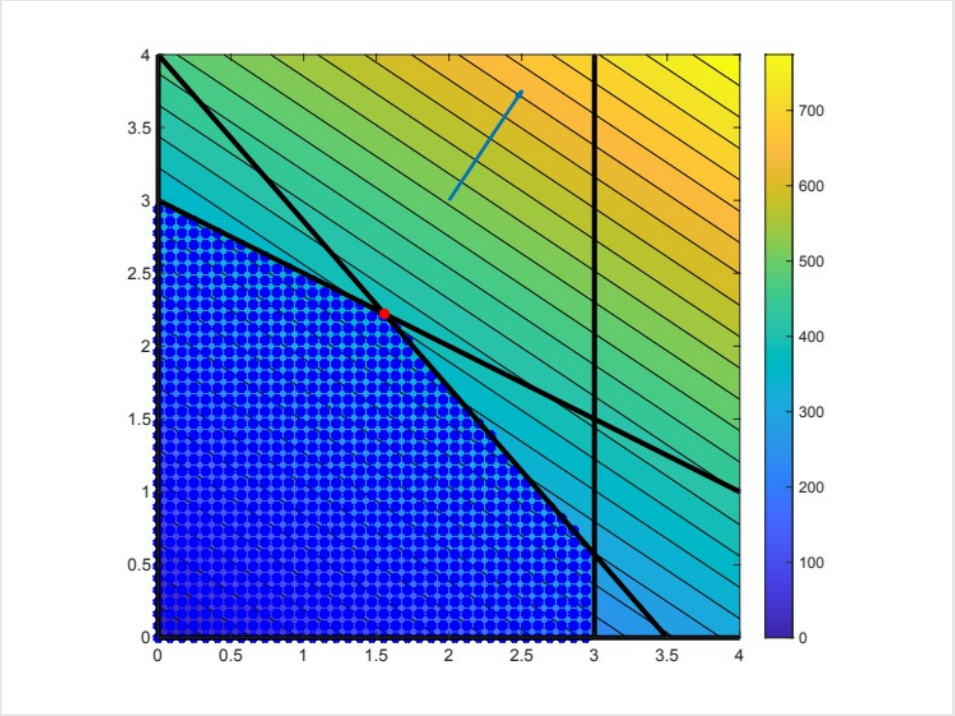
subject to:

This is a *linear programming problem* because both the objective and the constraints can be expressed with linear functions.

# A previous examplem– graphical solution

Maximize:

subject to:



# An example – solve in Matlab with linprog

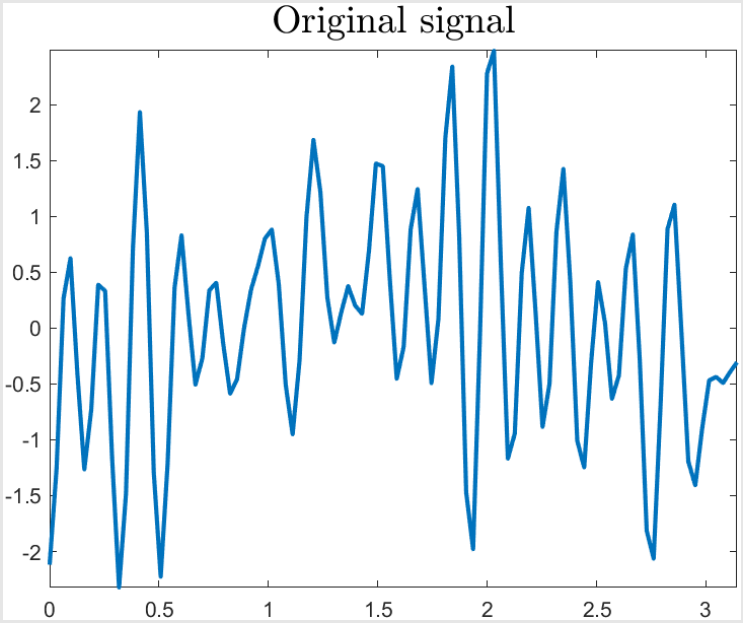
**(see matlab's documentation - OR03_linprog.m)**

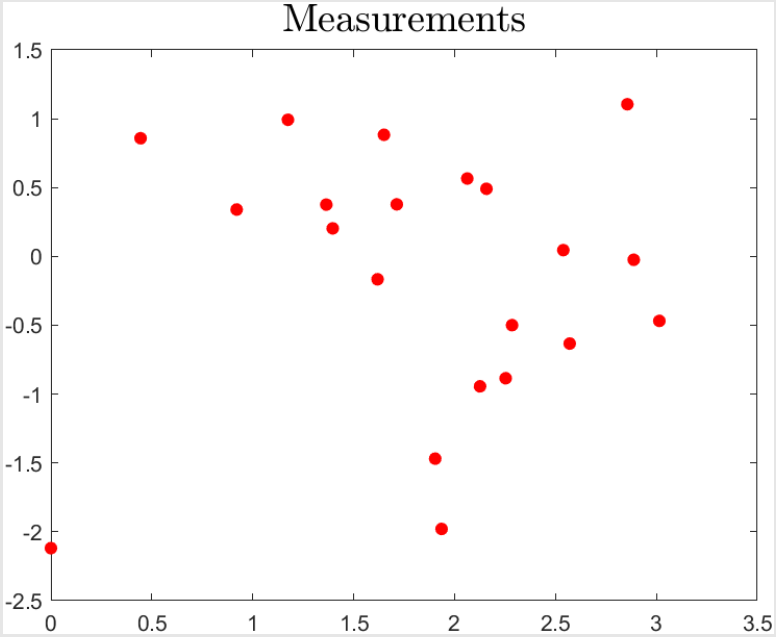
```
% set the problem specs
f = -1*[80;120];                % objective function to minimize
A = [1 2; 8 7; 1 0];            % inequality constraints matrix
b = [6 28 3];                   % inequality constraints rhs
Aeq = [];                       % equality constraints matrix
beq = [];                       % inequality constraints rhs
lb = zeros(size(f));            % lower bounds
ub = [];                        % upper bounds

% solve the problem
[x,fval,exitflag,output] = linprog(f,A,b,Aeq,beq,lb,ub);
```

# Compressed sensing – an example

**Scenario:** Your friend is sending you a signal through the aether, but your aether decoder is currently malfunctioning and can only take a discrete number of measurements/samples.




**Question:** Can you retrieve the signal from these measurements?

# Compressed sensing - questions

**Question:** Can you retrieve the signal from these measurements?

**Answer:** In general no, but if you know how the signal is generated and you have enough measurements, then you stand a chance.

**Assumptions:** Your friend tells you that the signal is a linear combination of cosine functions. More precisely, your friend says it is given by

and that very few of the weights  are nonzero.

**Good news:** We can retrieve  by solving a compressed sensing problem.

# Compressed sensing – mathematical model

More precisely, we "just" need to solve

where

- are the measurements, that is,
- and , .

As seen in OR Lecture 2.pptx, this can be modelled as

See OR04_compressed_sensing.m

# Summary and self-study

**Summary:** today we have learnt

- how to solve linear programming problems in matlab using linprog.
- how to tackle a compressed sensing problem via linear programming.

**Self-study:**

- Solve the self-study problems on the last slide of the slides OR Lecture 2_linear_programming.pptx in Matlab using linprog.
- In OR04_compressed_sensing.m, experiment with the parameters number of modes, number of nonzero weights, number of measurements. What do you observe?