

MTH8408 : Méthodes d'optimisation et contrôle optimal

Laboratoire 3: Optimisation sans contraintes et méthodes itératives

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Exercice 1: Méthode quasi-Newton L-BFGS

```
In [1]: using LinearAlgebra, NLPModels, Printf
```

```
In [2]: #Test problem:  
using ADNLPModels  
fH(x) = (x[2]+x[1].^2-11).^2+(x[1]+x[2].^2-7).^2  
x0H = [10., 20.]  
himmelblau = ADNLPModel(fH, x0H)  
  
problem2 = ADNLPModel(x->-x[1]^2, ones(3))  
  
roz(x) = 100 * (x[2] - x[1]^2)^2 + (x[1] - 1.0)^2  
rosenbrock = ADNLPModel(roz, [-1.2, 1.0])  
  
f(x) = x[1]^2 * (2*x[1] - 3) - 6*x[1]*x[2] * (x[1] - x[2] - 1)  
pb_du_cours = ADNLPModel(f, [-1.001, -1.001]) #ou [1.5, .5] ou [.5, .5]
```

```

ADNLPModel - Model with automatic differentiation backend ADModelBackend{
    ForwardDiffADGradient,
    ForwardDiffADHvprod,
    EmptyADbackend,
    EmptyADbackend,
    ForwardDiffADHessian,
    EmptyADbackend,
}
Problem name: Generic
All variables: ██████████ 2          All constraints: ..... 0
               free: ██████████ 2          free: ..... 0
               lower: ..... 0           lower: ..... 0
               upper: ..... 0           upper: ..... 0
               low/upp: ..... 0          low/upp: ..... 0
               fixed: ..... 0          fixed: ..... 0
               infeas: ..... 0          infeas: ..... 0
               nnzh: ( 0.00% sparsity) 3          linear: ..... 0
                                                nonlinear: ..... 0
                                                nnzj: (-----% sparsity)

Counters:
    obj: ..... 0          grad: ..... 0
cons: ..... 0          cons_nln: ..... 0
    cons_lin: ..... 0
jcon: ..... 0          jac: ..... 0          ja
    jgrad: ..... 0
c_lin: ..... 0          jac_nln: ..... 0          jprod: ..... 0          jpro
d_lin: ..... 0          jprod_nln: ..... 0          jtprod: ..... 0          jtpro
    jprod_nln: ..... 0
d_lin: ..... 0          jtprod_nln: ..... 0          hess: ..... 0
    jtprod_nln: ..... 0
hprod: ..... 0          jhess: ..... 0          jhprod: ..... 0
                ..... 0

```

In [3]: `using SolverCore, LinearOperators`

```

In [4]: function armijo(xk, dk, fk, gk, slope, nlp :: AbstractNLPModel; τ1 = 1.0e-4, t_update = 1.0
    t = 1.0
    fk_new = obj(nlp, xk + dk) # t = 1.0
    while fk_new > fk + τ1 * t * slope
        t /= t_update
        fk_new = obj(nlp, xk + t * dk)
    end
    return t, fk_new
end
```

`armijo` (generic function with 1 method)

```

In [5]: function limited_bfgs(nlp :: AbstractNLPModel;
    x :: AbstractVector = nlp.meta.x0,
    atol :: Real = √eps(eltype(x)),
    rtol :: Real = √eps(eltype(x)),
    max_eval :: Int = -1,
    max_time :: Float64 = 30.0,
```

```

        f_min    :: Float64 = -1.0e16,
        verbose  :: Bool = true,
        mem      :: Int = 5)
start_time = time()
elapsed_time = 0.0
s=0
y=0
T = eltype(x)
n = nlp.meta.nvar

xt = zeros(T, n)
∇ft = zeros(T, n)

f = obj(nlp, x)
∇f = grad(nlp, x)
#####
H = InverseLBFGSOperator(T,n, ;mem=5, scaling=true)
#####

∇fNorm = norm(∇f) #nrm2(n, ∇f)
ε = atol + rtol * ∇fNorm
iter = 0

@info log_header([:iter, :f, :dual, :slope, :bk], [Int, T, T, T, T],
                 hdr_override=Dict(:f=>"f(x)", :dual=>"||∇f||", :slope=>"∇fᵀd"))

optimal = ∇fNorm ≤ ε
unbdd = f ≤ f_min
tired = neval_obj(nlp) > max_eval ≥ 0 || elapsed_time > max_time
stalled = false
status = :unknown

while !(optimal || tired || stalled || unbdd)

#####
d = -H*∇f
#####
slope = dot(d, ∇f)
if slope ≥ 0
    @error "not a descent direction" slope
    status = :not_desc
    stalled = true
    continue
end

# Perform improved Armijo Linesearch.
t, ft = armijo(x, d, f, ∇f, slope, nlp)

@info log_row(Any[iter, f, ∇fNorm, slope, t])

# Update L-BFGS approximation.
s = t*d
xt = x + t * d
∇ft = grad(nlp, xt) # grad!(nlp, xt, ∇ft)
y = ∇ft - ∇f
#####

```

```

    LinearOperators.push!(H, s, y)
#####
# Move on.
x = xt
f = ft
∇f = ∇ft

∇fNorm = norm(∇f) #nrm2(n, ∇f)
iter = iter + 1

optimal = ∇fNorm ≤ ε
unbdd = f ≤ f_min
elapsed_time = time() - start_time
tired = neval_obj(nlp) > max_eval ≥ 0 || elapsed_time > max_time
end
@info log_row(Any[iter, f, ∇fNorm])

if optimal
    status = :first_order
elseif tired
    if neval_obj(nlp) > max_eval ≥ 0
        status = :max_eval
    elseif elapsed_time > max_time
        status = :max_time
    end
elseif unbdd
    status = :unbounded
end

return GenericExecutionStats(
    nlp,
    status=status,
    solution=x,
    objective=f,
    dual_feas=∇fNorm,
    iter=iter,
    elapsed_time=elapsed_time,
)
end

```

limited_bfgs (generic function with 1 method)

Test

```
In [7]: using Logging, Test
stats = with_logger(NullLogger()) do
    limited_bfgs(himmelblau)
end
@test stats.status == :first_order
@test stats.solution ≈ [3.584428266659278, -1.8481265666485827] atol = 1e-6
@show (stats.status, stats.solution)
```

```
(stats.status, stats.solution) = (:first_order, [3.584428266659278, -1.8481265666485827])
(:first_order, [3.584428266659278, -1.8481265666485827])
```

Test sur un problème de OptimizationProblems

```
In [8]: using ADNLPMODELS, OptimizationProblems.ADNLPProblems, Test
```

```
WARNING: using ADNLPProblems.rosenbrock in module Main conflicts with an existing identifier.
```

```
In [9]: n = 50
model = genrose(n=n)
@test typeof(model) <: ADNLPMODEL
```

Test Passed

```
In [11]: x0 = zeros(100)
limited_bfgs(model)
```

```
[ Info:    iter      f(x)      ‖∇f‖      ∇fᵀd      bk
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:30
[ Info:      0      2.2e+02     9.6e+01     -9.2e+03     1.7e-02
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      1      1.9e+02     2.5e+02     -1.6e+02     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      2      1.5e+02     1.8e+02     -3.9e+01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      3      1.3e+02     9.8e+01     -1.6e+01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      4      1.1e+02     7.4e+01     -2.2e+01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      5      1.0e+02     9.1e+01     -2.0e+01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      6      1.0e+02     1.5e+02     -1.5e+01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      7      9.4e+01     4.6e+01     -2.8e+00     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      8      9.2e+01     3.2e+01     -2.6e+00     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      9      9.0e+01     2.9e+01     -2.7e+00     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:     10      8.9e+01     3.0e+01     -1.8e+00     6.7e-01
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:     11      8.8e+01     2.7e+01     -5.0e-01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:     12      8.8e+01     7.7e+00     -6.5e-02     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:     13      8.8e+01     6.5e+00     -2.4e-01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:     14      8.8e+01     8.5e+00     -1.9e-01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:     15      8.8e+01     1.2e+01     -1.6e-01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:     16      8.8e+01     6.3e+00     -1.1e-01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:     17      8.7e+01     6.1e+00     -1.2e-01     1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
```

```
b:55
└ Info:    18  8.7e+01  7.1e+00 -8.7e-02  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    19  8.7e+01  6.4e+00 -6.1e-02  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    20  8.7e+01  5.4e+00 -1.4e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    21  8.7e+01  7.6e+00 -2.1e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    22  8.7e+01  1.4e+01 -2.4e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    23  8.7e+01  1.3e+01 -1.2e+00  4.4e-01
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    24  8.7e+01  2.0e+01 -7.1e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    25  8.6e+01  1.9e+01 -6.5e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    26  8.6e+01  1.7e+01 -5.2e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    27  8.6e+01  1.9e+01 -1.6e+00  6.7e-01
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    28  8.6e+01  4.0e+01 -8.9e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    29  8.5e+01  1.4e+01 -3.2e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    30  8.5e+01  1.2e+01 -3.1e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    31  8.5e+01  1.1e+01 -2.3e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    32  8.5e+01  1.1e+01 -1.5e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    33  8.5e+01  6.6e+00 -5.3e-02  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    34  8.5e+01  7.0e+00 -2.2e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    35  8.4e+01  9.6e+00 -5.7e-01  1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    36  8.4e+01  2.2e+01 -5.1e-01  6.7e-01
```

```
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    37  8.4e+01  2.1e+01 -9.6e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    38  8.4e+01  2.1e+01 -5.1e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    39  8.3e+01  1.6e+01 -2.0e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    40  8.3e+01  1.3e+01 -3.4e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    41  8.3e+01  1.2e+01 -3.2e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    42  8.3e+01  1.5e+01 -9.1e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    43  8.2e+01  2.7e+01 -8.8e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    44  8.2e+01  2.2e+01 -5.0e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    45  8.2e+01  1.3e+01 -4.1e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    46  8.1e+01  1.2e+01 -3.2e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    47  8.1e+01  1.2e+01 -3.5e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    48  8.1e+01  1.2e+01 -1.6e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    49  8.1e+01  7.8e+00 -2.2e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    50  8.1e+01  1.2e+01 -4.4e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    51  8.0e+01  2.4e+01 -6.9e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    52  8.0e+01  3.3e+01 -1.2e+00  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    53  8.0e+01  3.1e+01 -8.2e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
└ Info:    54  7.9e+01  1.7e+01 -5.0e-01  1.0e+00
L @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
```

```
[ Info:      55  7.9e+01  1.6e+01 -6.7e-01  1.0e+00
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[ Info:      56  7.9e+01  2.5e+01 -5.9e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      57  7.8e+01  1.2e+01 -1.9e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      58  7.8e+01  1.1e+01 -3.3e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      59  7.8e+01  1.1e+01 -3.9e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      60  7.8e+01  1.9e+01 -2.6e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      61  7.8e+01  1.0e+01 -1.8e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      62  7.8e+01  1.1e+01 -4.0e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      63  7.7e+01  1.9e+01 -6.4e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      64  7.7e+01  2.7e+01 -5.7e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      65  7.7e+01  2.3e+01 -8.0e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      66  7.6e+01  1.5e+01 -7.4e-01  6.7e-01
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      67  7.6e+01  1.6e+01 -4.4e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      68  7.6e+01  1.6e+01 -6.4e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      69  7.6e+01  2.7e+01 -5.1e-01  1.0e+00
[ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
[ Info:      70  7.5e+01  1.5e+01 -6.4e-01  1.0e+00
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```

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```

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                                                ┌ Info: 160 1.0e+00 2.7e-06 -1.0e-14 1.0e+00
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                                                            ┌ Info: 163 1.0e+00 3.3e-06 -5.9e-15 1.0e+00
                                                            └ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:55
                                                                ┌ Info: 164 1.0e+00 6.0e-07
                                                                └ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:79

```

"Execution stats: first-order stationary"

Exercice 2: NewtonCG

```
In [12]: function cg_optim(H, ∇f)
    #setup the tolerance:
    n∇f = norm(∇f)
    ##### 
    εk = min(0.5, sqrt(n∇f))*n∇f
    #####
    n = length(∇f)
    z = zeros(n)
    r = ∇f
    d = -r

    j = 0
    while norm(r) ≥ εk && j < 3 * n
        #####
        if dot(d, H * d) ≤ 0
            if j == 0
                p = -∇f
            else
                p = z
            end
        end
        #####
        α = r' * r / (d' * H * d)
        #####
        z += α * d
        nr2 = dot(r, r)
        r += α * H * d
        #####
        β = r' * r / nr2
        #####
        d = -r + β * d
        j += 1
    end
    return z
end
```

cg_optim (generic function with 1 method)

```
In [13]: function armijo_Newton_cg(nlp      :: AbstractNLPModel;
                                    x       :: AbstractVector = nlp.meta.x0,
                                    atol    :: Real = √eps(eltype(x)),
                                    rtol    :: Real = √eps(eltype(x)),
                                    max_eval :: Int = -1,
                                    max_time :: Float64 = 30.0,
                                    f_min   :: Float64 = -1.0e16)
    start_time = time()
    elapsed_time = 0.0

    T = eltype(x)
    n = nlp.meta.nvar

    f = obj(nlp, x)
    ∇f = grad(nlp, x)
    #####
    H = NLPModels.hess_op(nlp,x)
    #####
```

```

∇fNorm = norm(∇f) #nrm2(n, ∇f)
ε = atol + rtol * ∇fNorm
iter = 0

@info log_header([:iter, :f, :dual, :slope, :bk], [Int, T, T, T, T],
                 hdr_override=Dict(:f=>"f(x)", :dual=>"||∇f||", :slope=>"∇fᵀd"))

optimal = ∇fNorm ≤ ε
unbdd = f ≤ f_min
tired = neval_obj(nlp) > max_eval ≥ 0 || elapsed_time > max_time
stalled = false
status = :unknown

while !(optimal || tired || stalled || unbdd)

    d = cg_optim(H, ∇f)

    slope = dot(d, ∇f)
    if slope ≥ 0
        @error "not a descent direction" slope
        status = :not_desc
        stalled = true
        continue
    end

    # Perform improved Armijo Linesearch.
    t, f = armijo(x, d, f, ∇f, slope, nlp)

    @info log_row(Any[iter, f, ∇fNorm, slope, t])

    # Update L-BFGS approximation.
    x += t * d
    ∇f = grad(nlp, x)
#####
    H = NLPModels.hess_op(nlp, x)
#####

    ∇fNorm = norm(∇f) #nrm2(n, ∇f)
    iter = iter + 1

    optimal = ∇fNorm ≤ ε
    unbdd = f ≤ f_min
    elapsed_time = time() - start_time
    tired = neval_obj(nlp) > max_eval ≥ 0 || elapsed_time > max_time
end
@info log_row(Any[iter, f, ∇fNorm])

if optimal
    status = :first_order
elseif tired
    if neval_obj(nlp) > max_eval ≥ 0
        status = :max_eval
    elseif elapsed_time > max_time
        status = :max_time
    end
end

```

```

    elseif unbdd
        status = :unbounded
    end

    return GenericExecutionStats(nlp, status = status, solution=x, objective=f, dual_
                                iter=iter, elapsed_time=elapsed_time)
end

```

armijo_Newton_cg (generic function with 1 method)

Test

```
In [14]: #Unit/Validation Tests
# Réaliser un test unitaire
stats = with_logger(NullLogger()) do
    armijo_Newton_cg(pb_du_cours, x = [1.5, .5])
end
@test stats.status == :first_order
@test stats.solution ≈ [1., 0.] atol = 1e-6
@show (stats.status, stats.solution)

(stats.status, stats.solution) = (:first_order, [1.00000000013107, 6.55355958252388
9e-12])
(:first_order, [1.00000000013107, 6.553559582523889e-12])

```

Test sur un problème de OptimizationProblems

```
In [15]: using ADNLPModels, OptimizationProblems.ADNLPProblems, Test
```

```
In [24]: n = 50
model = genrose(n=n)
@test typeof(model) <: ADNLPModel
```

Test Passed

```
In [25]: armijo_Newton_cg(model)
```

```

[ Info:   iter      f(x)      ||∇f||      ∇fᵀd      bk
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:24
[ Info:     0    2.0e+02    9.6e+01   -1.7e+03    2.6e-02
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:48
[ Info:     1    2.0e+02    7.6e+01   -1.2e+01    1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:48
[ Info:     2    2.0e+02    6.3e+01   -6.7e-01    1.0e+00
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:48
[ Error: not a descent direction
  slope = 32.67689469970884
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:39
[ Info:     3    2.0e+02    2.4e+01
└ @ Main c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:65

```

"Execution stats: not a descent direction"

Exercice 3

```
In [26]: using ADNLPModels  
using OptimizationProblems, OptimizationProblems.ADNLPProblems  
using LinearAlgebra  
using SolverCore, SolverBenchmark, NLPModels  
using JSOSolvers
```

```
ERROR: LoadError: InitError: UndefVarError: `GR_jll` not defined
Stacktrace:
 [1] __init__()
   @ GR.GRPreferences C:\Users\Ulrizpascuit\.julia\packages\GR\mf3ag\src\preferences.jl:50
 [2] register_restored_modules(sv::Core.SimpleVector, pkg::Base.PkgId, path::String)
   @ Base .\loading.jl:1115
 [3] _include_from_serialized(pkg::Base.PkgId, path::String, ocachepath::String, deps::Vector{Any})
   @ Base .\loading.jl:1061
 [4] _require_search_from_serialized(pkg::Base.PkgId, sourcepath::String, build_id::UInt128)
   @ Base .\loading.jl:1506
 [5] _require(pkg::Base.PkgId, env::String)
   @ Base .\loading.jl:1783
 [6] _require_prelocked(uuidkey::Base.PkgId, env::String)
   @ Base .\loading.jl:1660
 [7] macro expansion
   @ .\loading.jl:1648 [inlined]
 [8] macro expansion
   @ .\lock.jl:267 [inlined]
 [9] require(into::Module, mod::Symbol)
   @ Base .\loading.jl:1611
[10] top-level scope
   @ C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\backends.jl:402
[11] eval
   @ .\boot.jl:370 [inlined]
[12] _initialize_backend(pkg::Plots.GRBackend)
   @ Plots C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\backends.jl:401
[13] backend(pkg::Plots.GRBackend)
   @ Plots C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\backends.jl:266
[14] backend(sym::Symbol)
   @ Plots C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\backends.jl:276
[15] load_default_backendbackend()
   @ Plots C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\backends.jl:254
[17] top-level scope
   @ C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\init.jl:83
[18] include(mod::Module, _path::String)
   @ Base .\Base.jl:457
[19] include(x::String)
   @ Plots C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\Plots.jl:1
[20] top-level scope
   @ C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\Plots.jl:176
[21] include
   @ .\Base.jl:457 [inlined]
[22] include_package_for_output(pkg::Base.PkgId, input::String, depot_path::Vector{String}, dl_load_path::Vector{String}, load_path::Vector{String}, concrete_deps::Vector{Pair{Base.PkgId, UInt128}}, source::String)
   @ Base .\loading.jl:2049
[23] top-level scope
   @ stdin:3
during initialization of module GRPreferences
in expression starting at C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\ini
```

```
t.jl:83
in expression starting at C:\Users\Ulrizpascuit\.julia\packages\Plots\sxUvK\src\Plot
s.jl:1
in expression starting at stdin:3
ERROR: LoadError: Failed to precompile Plots [91a5bcdd-55d7-5caf-9e0b-520d859cae80]
to "C:\\Users\\Ulrizpascuit\\.julia\\compiled\\v1.9\\Plots\\jl_232B.tmp".
Stacktrace:
[1] error(s::String)
    @ Base .\error.jl:35
[2] compilecache(pkg::Base.PkgId, path::String, internal_stderr::IO, internal_stdio
ut::IO, keep_loaded_modules::Bool)
    @ Base .\loading.jl:2300
[3] compilecache
    @ .\loading.jl:2167 [inlined]
[4] _require(pkg::Base.PkgId, env::String)
    @ Base .\loading.jl:1805
[5] _require_prelocked(uuidkey::Base.PkgId, env::String)
    @ Base .\loading.jl:1660
[6] macro expansion
    @ .\loading.jl:1648 [inlined]
[7] macro expansion
    @ .\lock.jl:267 [inlined]
[8] require(into::Module, mod::Symbol)
    @ Base .\loading.jl:1611
[9] include(mod::Module, _path::String)
    @ Base .\Base.jl:457
[10] include(x::String)
    @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\sr
c\SolverBenchmark.jl:1
[11] top-level scope
    @ C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\SolverBenchmark
.jl:44
[12] include
    @ .\Base.jl:457 [inlined]
[13] include_package_for_output(pkg::Base.PkgId, input::String, depot_path::Vector
{String}, dl_load_path::Vector{String}, load_path::Vector{String}, concrete_deps::Ve
ctor{Pair{Base.PkgId, UInt128}}, source::String)
    @ Base .\loading.jl:2049
[14] top-level scope
    @ stdin:3
in expression starting at C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13
z\src\profiles.jl:2
in expression starting at C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13
z\src\SolverBenchmark.jl:1
in expression starting at stdin:3
```

```
Failed to precompile SolverBenchmark [581a75fa-a23a-52d0-a590-d6201de2218a] to  
"C:\\\\Users\\\\Ulrichpascuit\\\\julia\\\\compiled\\\\v1.9\\\\SolverBenchmark\\\\jl_FE20.tmp".
```

Stacktrace:

```
[1] error(s::String)  
    @ Base .\\error.jl:35  
  
[2] compilecache(pkg::Base.PkgId, path::String, internal_stderr::IO, internal_stdio::IO, keep_loaded_modules::Bool)  
    @ Base .\\loading.jl:2300  
  
[3] compilecache  
    @ .\\loading.jl:2167 [inlined]  
  
[4] _require(pkg::Base.PkgId, env::String)  
    @ Base .\\loading.jl:1805  
  
[5] _require_prelocked(uuidkey::Base.PkgId, env::String)  
    @ Base .\\loading.jl:1660  
  
[6] macro expansion  
    @ .\\loading.jl:1648 [inlined]  
  
[7] macro expansion  
    @ .\\lock.jl:267 [inlined]  
  
[8] require(into::Module, mod::Symbol)  
    @ Base .\\loading.jl:1611  
  
[9] eval  
    @ .\\boot.jl:370 [inlined]  
  
[10] include_string(mapexpr::typeof(REPL.softscope), mod::Module, code::String, filename::String)  
    @ Base .\\loading.jl:1903  
  
[11] #invokelatest#2  
    @ .\\essentials.jl:819 [inlined]  
  
[12] invokelatest  
    @ .\\essentials.jl:816 [inlined]
```

```

[13] (::VSCodeServer.var"#208#209"{VSCodeServer.NotebookRunCellArguments, String})
()

@ VSCodeServer c:\Users\Ulrizpascuit\.vscode\extensions\julialang.language-julia
-1.66.2\scripts\packages\VSCodeServer\src\serve_notebook.jl:19

[14] withpath(f::VSCodeServer.var"#208#209"{VSCodeServer.NotebookRunCellArguments,
String}, path::String)

@ VSCodeServer c:\Users\Ulrizpascuit\.vscode\extensions\julialang.language-julia
-1.66.2\scripts\packages\VSCodeServer\src\repl.jl:274

[15] notebook_runcell_request(conn)::VSCodeServer.JSONRPC.JSONRPCEndpoint{Base.PipeE
ndpoint, Base.PipeEndpoint}, params::VSCodeServer.NotebookRunCellArguments)

@ VSCodeServer c:\Users\Ulrizpascuit\.vscode\extensions\julialang.language-julia
-1.66.2\scripts\packages\VSCodeServer\src\serve_notebook.jl:13

[16] dispatch_msg(x::VSCodeServer.JSONRPC.JSONRPCEndpoint{Base.PipeEndpoint, Base.P
ipeEndpoint}, dispatcher::VSCodeServer.JSONRPC.MsgDispatcher, msg::Dict{String, An
y})

@ VSCodeServer.JSONRPC c:\Users\Ulrizpascuit\.vscode\extensions\julialang.langua
ge-julia-1.66.2\scripts\packages\JSONRPC\src\typed.jl:67

[17] serve_notebook(pipename::String, outputchannel_logger::Base.CoreLogging.Simple
Logger; crashreporting_pipename::String)

@ VSCodeServer c:\Users\Ulrizpascuit\.vscode\extensions\julialang.language-julia-1.66.2\scri
pts\notebook\notebook.jl:139

[18] top-level scope

@ c:\Users\Ulrizpascuit\.vscode\extensions\julialang.language-julia-1.66.2\scri
pts\notebook\notebook.jl:32

```

```

In [21]: first_order(df) = df.status .== :first_order
unbounded(df) = df.status .== :unbounded
solved(df) = first_order(df) .| unbounded(df)
# solved(ges)

n = 6
solvers = solvers = Dict(
    :lbfgs => model -> lbfgs(model, mem=5, atol=1e-5, rtol=0.0)
    # :armijo_Newton_cg => model -> armijo_Newton_cg(model),
    # :trunk => model -> trunk(model),
)

ad_problems = (eval(Meta.parse(problem))(;n) for problem ∈ OptimizationProblems.met
stats = bmark_solvers(
    solvers, ad_problems,
    skipif=prob -> (!unconstrained(prob) || get_nvar(prob) > 100 || get_nvar(prob) <
)

```

```
costnames = ["time", "obj + grad + hess"]
costs = [
    df -> .!solved(df) .* Inf .+ df.elapsed_time,
    df -> .!solved(df) .* Inf .+ df.neval_obj .+ df.neval_grad .+ df.neval_hess,
]

using Plots
gr()

profile_solvers(stats, costs, costnames)
```

```

WARNING: using ADNLPPProblems.rosenbrock in module Main conflicts with an existing identifier.

r Info:          Name    nvar    ncon      status      Time     f(x)      Du
al    Primal
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:127
r Info:          NZF1     26      0      max_time   3.0e+01   2.0e+03   2.9e-
04   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          arglina    6      0      first_order  7.6e-01   3.0e+00   4.7e-
16   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          arglinb    6      0      first_order  6.6e-01   1.3e+00   6.7e-
13   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          arglinc    6      0      first_order  6.5e-01   4.1e+00   2.1e-
12   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          argtrig    6      0      first_order  5.9e-01   -3.2e+01   6.8e-
06   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          arwheel    6      0      first_order  6.1e-01   1.6e-12   6.6e-
06   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          bdqrtic    6      0      first_order  5.7e-01   9.7e-01   4.8e-
06   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          biggs6     6      0      max_time   3.0e+01      NaN      N
aN   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          brownal    6      0      first_order  7.1e-01   3.0e-12   6.5e-
06   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          broyden3d   6      0      first_order  5.7e-01   1.3e-12   5.9e-
06   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          broydn7d    6      0      first_order  8.6e-01   4.5e+00   9.5e-
06   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Info:          brybnd     6      0      first_order  9.6e-01   1.4e+00   8.4e-
06   0.0e+00
└ @ SolverBenchmark C:\Users\Ulrichpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
r Warning: catenary: number of variables adjusted to be greater or equal to 6
└ @ OptimizationProblems.ADNLPPProblems C:\Users\Ulrichpascuit\.julia\packages\Optimiz

```

```
ationProblems\fiJkh\src\ADNLPPProblems\catenary.jl:6
  ↗ Warning: chainwoo: number of variables adjusted to be a multiple of 4
  ↳ @ OptimizationProblems.ADNLPPProblems C:\Users\Ulrizpascuit\.julia\packages\OptimizationProblems\fiJkh\src\ADNLPPProblems\chainwoo.jl:4
  ↗ Info:      chnrosnb      6      0      first_order   6.7e-01   2.2e-14   5.0e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Warning: clplatea: number of variables adjusted from 6 down to 4
  ↳ @ OptimizationProblems.ADNLPPProblems C:\Users\Ulrizpascuit\.julia\packages\OptimizationProblems\fiJkh\src\ADNLPPProblems\clplatea.jl:10
  ↗ Warning: clplateb: number of variables adjusted from 6 down to 4
  ↳ @ OptimizationProblems.ADNLPPProblems C:\Users\Ulrizpascuit\.julia\packages\OptimizationProblems\fiJkh\src\ADNLPPProblems\clplateb.jl:10
  ↗ Warning: clplatec: number of variables adjusted from 6 down to 4
  ↳ @ OptimizationProblems.ADNLPPProblems C:\Users\Ulrizpascuit\.julia\packages\OptimizationProblems\fiJkh\src\ADNLPPProblems\clplatec.jl:12
  ↗ Info:      cosine       6      0      first_order   6.0e-01   -5.0e+00   2.3e-07   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Info:      cragglyv      6      0      first_order   5.9e-01   6.1e-01   4.5e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Info:      cragglyv2     6      0      first_order   6.6e-01   2.2e-01   6.8e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Info:      curly        6      0      first_order   1.2e+00   -6.0e+02   9.4e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Info:      curly10       6      0      first_order   1.2e+00   -6.0e+02   9.4e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Info:      curly20       6      0      first_order   1.2e+00   -6.0e+02   9.4e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Info:      curly30       6      0      first_order   1.2e+00   -6.0e+02   9.4e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Info:      dixmaane     6      0      first_order   9.2e-01   1.0e+00   6.0e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Info:      dixmaanf     6      0      first_order   8.1e-01   1.0e+00   7.5e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
  ↗ Info:      dixmaang     6      0      first_order   0.0e+00   1.0e+00   4.7e-06   0.0e+00
  ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:175
```

```
\run_solver.jl:175
└ Info:      dixmaanh      6      0      first_order  0.0e+00  1.0e+00  3.6e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dixmaani      6      0      first_order  9.3e-01  1.0e+00  4.5e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dixmaanj      6      0      first_order  8.2e-01  1.0e+00  4.8e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dixmaank      6      0      first_order  0.0e+00  1.0e+00  2.4e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dixmaanl      6      0      first_order  0.0e+00  1.0e+00  8.2e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dixmaanm      6      0      first_order  9.4e-01  1.0e+00  4.8e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dixmaann      6      0      first_order  8.3e-01  1.0e+00  6.0e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dixmaano      6      0      first_order  0.0e+00  1.0e+00  2.3e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dixmaanp      6      0      first_order  0.0e+00  1.0e+00  8.9e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dixon3dq      6      0      first_order  5.8e-01  2.7e-10  8.6e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dqdrtic      6      0      first_order  6.4e-01  5.7e-14  4.7e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      dqrtic       6      0      first_order  6.6e-01  4.2e-08  8.1e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      edensch       6      0      first_order  6.6e-01  3.9e+01  7.4e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info:      eg2          6      0      first_order  5.9e-01 -4.9e+00  8.8e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
```

```
\run_solver.jl:175
└ Info: engval1      6      0      first_order  5.9e-01  4.7e+00  5.5e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: enso        9      0      first_order  7.4e-01  3.9e+02  5.3e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: errinros     6      0      first_order  7.2e-01  1.3e+00  8.5e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: extrosnb     6      0      first_order  5.7e-01  1.6e-13  5.8e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: fletcbv2     6      0      first_order  6.8e-01 -6.7e-01  3.2e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: fletcbv3     6      0      first_order  0.0e+00 -5.5e-06  1.9e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: fletcher      6      0      first_order  6.3e-01  1.6e-14  8.3e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Warning: fminsrf2: number of variables adjusted from 6 down to 4
└ @ OptimizationProblems.ADNLPPProblems C:\Users\Ulrizpascuit\.julia\packages\Optimiz-
ationProblems\fijkh\src\ADNLPPProblems\fminsrf2.jl:8
└ Info: freuroth      6      0      first_order  7.3e-01  2.6e+02  3.8e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: gauss1        8      0      first_order  1.7e+01  6.6e+02  1.0e-
05  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: gauss2        8      0      max_time   3.0e+01  6.2e+02  1.6e-
05  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: gauss3        8      0      max_time   3.0e+01  6.2e+02  1.6e-
04  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: genhumps      6      0      first_order  9.0e-01  1.9e-10  8.6e-
06  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
└ Info: genrose       6      0      first_order  8.6e-01  1.0e+00  8.2e-
07  0.0e+00
└ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
```

```

    ↵ Info: genrose_nash       6      0      first_order   8.6e-01   1.0e+00   8.9e-
06   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: hahn1            7      0      first_order   7.2e-01   2.8e+04   2.1e-
10   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: indef             6      0      first_order   7.4e-01   -5.9e+02   2.8e-
06   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: integreq          6      0      first_order   1.4e+00   3.3e-12   2.7e-
06   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: kirby2            5      0      max_time     3.0e+01   2.0e+00   4.4e-
05   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: lanczos1          6      0      first_order   7.3e-01   2.1e-06   4.9e-
06   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: lanczos2          6      0      first_order   7.7e-01   2.2e-06   3.6e-
06   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: lanczos3          6      0      first_order   6.2e-01   2.2e-06   9.3e-
06   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: liarwhd           6      0      first_order   6.4e-01   5.1e-14   2.8e-
06   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: mgh17              5      0      first_order   6.7e-01   5.5e-02   7.4e-
07   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Info: morebv             6      0      first_order   6.8e-01   9.4e-15   2.4e-
07   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Warning: ncb20: number of variables must be ≥ 31
    ↳ @ OptimizationProblems.ADNLPPProblems C:\Users\Ulrizpascuit\.julia\packages\Optimiz
ationProblems\fijkh\src\ADNLPPProblems\ncb20.jl:4
    ↵ Info: ncb20              31     0      first_order   1.6e+00   4.4e+01   8.7e-
06   0.0e+00
    ↳ @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    ↵ Warning: ncb20b: number of variables must be ≥ 20
    ↳ @ OptimizationProblems.ADNLPPProblems C:\Users\Ulrizpascuit\.julia\packages\Optimiz
ationProblems\fijkh\src\ADNLPPProblems\ncb20b.jl:4
    ↵ Info: ncb20b             20     0      first_order   1.5e+00   4.0e+01   1.1e-
06   0.0e+00

```

```
L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    r Info:      noncvxu2      6      0      first_order  6.4e-01  1.4e+01  8.8e-
06  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      noncvxun      6      0      first_order  7.0e-01  1.4e+01  5.1e-
06  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      nondia      6      0      first_order  6.8e-01  4.2e-20  1.1e-
08  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      nondquar     6      0      first_order  6.1e-01  4.2e-09  7.7e-
06  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      osborne1     5      0      max_time   3.0e+01  2.3e-02  3.0e-
01  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      osborne2     11     0      first_order  7.5e-01  2.0e-02  6.1e-
06  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      palmer1c     8      0      max_time   3.0e+01  4.9e-02  8.8e-
02  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      palmer1d     7      0      max_time   3.0e+01  3.3e-01  1.8e-
05  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      palmer2c     8      0      max_time   3.0e+01  7.2e-03  2.1e-
04  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      palmer3c     8      0      max_time   3.0e+01  9.8e-03  1.8e-
05  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      palmer4c     8      0      max_time   3.0e+01  2.9e-02  1.2e-
05  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      palmer5c     6      0      first_order  1.4e+00  1.1e+00  4.6e-
06  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      palmer6c     8      0      first_order  9.4e+00  8.2e-03  8.1e-
06  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      palmer7c     8      0      first_order  2.9e+01  3.0e-01  1.0e-
05  0.0e+00
```

```
L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
    r Info:      palmer8c      8      0      first_order  6.7e+00  8.0e-02  7.6e-
06  0.0e+00
    L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
        r Info:      penalty1      6      0      first_order  7.9e-01  1.9e-05  8.0e-
06  0.0e+00
        L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
            r Info:      penalty2      6      0      first_order  9.4e-01  4.2e-05  1.8e-
06  0.0e+00
            L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
                r Info:      penalty3      6      0      first_order  1.2e+00  1.4e+02  9.4e-
06  0.0e+00
                L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
                    r Warning: powellsg: number of variables adjusted to be a multiple of 4
                    L @ OptimizationProblems.ADNLPPProblems C:\Users\Ulrizpascuit\.julia\packages\Optimiz-
ationProblems\fijkh\src\ADNLPProblems\powellsg.jl:4
                        r Info:      power      6      0      first_order  7.1e-01  1.8e-08  5.5e-
06  0.0e+00
                        L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
                            r Info:      quartc      6      0      first_order  7.1e-01  4.2e-08  8.1e-
06  0.0e+00
                            L @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src
\run_solver.jl:175
```

```
MethodError: objects of type ADNLPMModel{Float64, Vector{Float64}, Vector{Int64}} are not callable
```

Stacktrace:

```
[1] (::var"#22#23")(problem::String)
    @ Main .\none:0

[2] iterate
    @ .\generator.jl:47 [inlined]

[3] iterate
    @ .\iterators.jl:202 [inlined]

[4] solve_problems(solver::var"#20#21", problems::Base.Generator{Vector{String}}, var"#22#23"); solver_logger::Base.CoreLogging.NullLogger, reset_problem::Bool, skip_if::var"#24#25", colstats::Vector{Symbol}, info_hdr_override::Dict{Symbol, String}, p_rune::Bool, kwargs::Base.Pairs{Symbol, Union{}, Tuple{}, NamedTuple{(), Tuple{}}})
    @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\run_solver.jl:176

[5] bmark_solvers(solvers::Dict{Symbol, var"#20#21"}, args::Base.Generator{Vector{String}, var"#22#23"}; kwargs::Base.Pairs{Symbol, var"#24#25", Tuple{Symbol}, NamedTuple{(:skipif,), Tuple{var"#24#25"}}})
    @ SolverBenchmark C:\Users\Ulrizpascuit\.julia\packages\SolverBenchmark\YM13z\src\bmark_solvers.jl:22

[6] top-level scope
    @ c:\Users\Ulrizpascuit\Desktop\MTH8408\MTH8408-Hiv24\lab3\Lab3-notebook.ipynb:22
```

Exercice 4

Il est impossible de comparer les algorithmes, car je n'ai pas été en mesure de tracer les profils de performances (problème de debugging non résolu). Cependant, il est intuitif de dire que l'algorithme lbfgs avec une mémoire élevée proposera de meilleures approximations et donc une convergence vers la solution plus rapide qu'avec une mémoire faible (le temps de calcul sera plus long en contre partie, donc le profil de performance en fonction du temps de calcul ou de la mémoire ne sera pas nécessairement mieux).