KKT example

```
                      FriCAS Computer Algebra System
                        Version: FriCAS 2018-03-10
                     Timestamp: Tue Nov 19 19:16:14 UTC 2019
-----------------------------------------------------------------------------
    Issue )copyright to view copyright notices.
    Issue )summary for a summary of useful system commands.
    Issue )quit to leave FriCAS and return to shell.
-----------------------------------------------------------------------------


(1) -> )read kt.input
f := 2*x1^2 + 2*x1*x2 + x2^2 - 10*x1 - 10*x2


          2                     2
   (1)  x2  + (2 x1 - 10)x2 + 2 x1  - 10 x1
                                             Type: Polynomial(Integer)
g1 := x1^2 + x2^2 - 5


          2    2
   (2)  x2  + x1  - 5
                                             Type: Polynomial(Integer)
g2 := 3*x1 + x2 - 6


   (3)  x2 + 3 x1 - 6
                                             Type: Polynomial(Integer)

-- No active constraints
r0 := solve([D(f, x1), D(f, x2)], [x1, x2])


   (4)  [[x1 = 0, x2 = 5]]
                    Type: List(List(Equation(Fraction(Polynomial(Integer)))))

-- Check that first contraint fails
eval(g1, first(r0))


   (5)  20
                                    Type: Fraction(Polynomial(Integer))

-- Only second constraint active
-- check that g2' does not vanish on solution set
solve([D(g2, x1), D(g2, x2), g2], [x1, x2])


   (6)  []
                    Type: List(List(Equation(Fraction(Polynomial(Integer)))))
-- solve KKT equation
r2 := solve([D(f, x1) + l*D(g2, x1), D(f, x2) + l*D(g2, x2), g2], [x1, x2, l])


             2        24         2
   (7)  [[x1 = -, x2 = --, l = - -]]
             5         5         5
                    Type: List(List(Equation(Fraction(Polynomial(Integer)))))

-- Check that first contraint fails
eval(g1, [x1 = 2/5, x2 = 24/5])


        91
   (8)  --
         5
                                    Type: Polynomial(Fraction(Integer))
```

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```
-- Only first constraint active
-- check that g1' does not vanish on solution set
solve([D(g1, x1), D(g1, x2), g1], [x1, x2])
```

    (9) [[]]
                    Type: List(List(Equation(Fraction(Polynomial(Integer)))))
```
-- solve KKT equation
r1 := solve([D(f, x1) + l*D(g1, x1), D(f, x2) + l*D(g1, x2), g1], [x1, x2, l])
```

    (10)
    [[x1 = 1, x2 = 2, l = 1],
                              2   3   2
     [x1 = l + 4, x2 = - l - 6 l - 3, l + 7 l + 8 l + 4 = 0]]
                    Type: List(List(Equation(Fraction(Polynomial(Integer)))))

```
-- Extract equation for l
p := second(r1)(3)
```

          3   2
    (11) l + 7 l + 8 l + 4 = 0
                                    Type: Equation(Fraction(Polynomial(Integer)))

```
-- Numerialy solve
solve(p, 1.0e-12)
```

    (12) [l = - 5.7245767276_322112593]
                                    Type: List(Equation(Polynomial(Float)))

```
-- Extract first solution
sol := first(first(r1), 2)
```

    (13) [x1 = 1, x2 = 2]
                            Type: List(Equation(Fraction(Polynomial(Integer))))

```
-- Check second constraint
eval(g2, sol)
```

    (14) - 1
                                        Type: Fraction(Polynomial(Integer))

```
-- Compute value
eval(f, sol)
```

    (15) - 20
                                        Type: Fraction(Polynomial(Integer))

```
-- Find where both constraints are active
rxx := radicalSolve([g1, g2], [x1, x2])
```

    (16)
            +--+   +--+
          \|14 + 18   - 3 \|14 + 6
    [[x1 = ----------, x2 = -------------],
             10   10
            +--+   +--+
        - \|14 + 18   3 \|14 + 6
     [x1 = -----------, x2 = ----------]]
             10   10
                            Type: List(List(Equation(Expression(Integer))))

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```
-- Check values
numeric(eval(f, first(rxx)))
```

```
   (17)  - 9.0616796585_164820602
```
                                                            Type: Float
```
numeric(eval(f, second(rxx)))
```

```
   (18)  - 19.5383203414_8351794
```
                                                            Type: Float
```
(19) -> )quit
```