In [11]:
```
using Gadfly
```

最速下降法

In [67]:
```
norm(x) = sqrt(x'*x)
function steepest_descent(f, g, x0;
        ϵx=0.01, # precision for step size
        ϵf=0.01,
        ϵg=0.01,
        maxIterations=128,
        debug=false)


    xk = x0
    l = [xk]
    fk = f(xk...)
    for i in 1:maxIterations
        # iteration
        d =-g(xk...)
        α = search_for_alpha(f, xk, fk, d, -d)
        δ = α*d
        xn = xk .+ δ
        push!(l,xn)
        fn = f(xn...)
        # convegence?
        if (norm(δ)<=ϵx)&&(abs(fn-fk)<=ϵf)&&(norm(d)<=ϵg)
            println("Convergence is reached after ", i, " iterations.")
            return l
        end
        if debug
            println("i=",i, " α=", α, " xk=", xk, " d=", d, " δ= ", δ)
        end
        xk = xn
        fk = fn
    end
    println("WARN:", maxIterations, " iterations have been exceeded!")
end
```

Out[67]:
```
steepest_descent (generic function with 1 method)
```

In [68]:
```
function search_for_alpha(f, xk, fk, d, g; α0=100, ϵ=0.5, τ=0.5)
    α = α0
    ϕ0= d'*g
    while f((xk .+ α*d)...) > fk + ϵ*α*ϕ0
        α = τ*α
    end
    return α
end
```

Out[68]:
```
search_for_alpha (generic function with 1 method)
```

In [69]:
```
l1 = steepest_descent(
    (x1,x2)->x1^2+4.5x2^2+3x1*x2-x1-5x2,
    (x1,x2)->[2x1+3x2-1; 9x2+3x1-5],
    [1., 3.],
    maxIterations = 10000,
    debug=false
)
```

```
Convergence is reached after 13 iterations.
```

Out[69]:
```
14-element Array{Array{Float64,1},1}:
 [1.0, 3.0]
 [0.0234375, 0.558594]
 [-0.117706, 0.53952]
 [-0.19254, 0.636676]
 [-0.295069, 0.606898]
 [-0.340099, 0.689539]
 [-0.378031, 0.671419]
 [-0.579745, 0.742766]
 [-0.606624, 0.763992]
 [-0.614312, 0.758518]
 [-0.650975, 0.771234]
 [-0.655566, 0.775851]
 [-0.657169, 0.774292]
 [-0.66384, 0.776541]
```

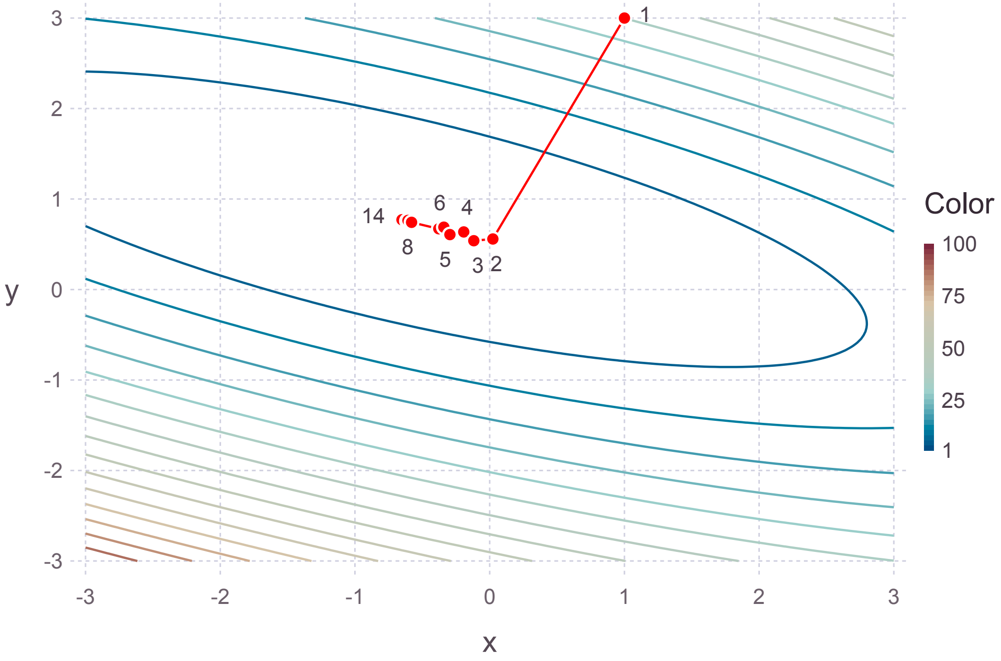
In [70]:
```
fit = layer((x1,x2)->x1^2+4.5x2^2+3x1*x2-x1-5x2, -3, 3, -3, 3)
```

Out[70]:
```
1-element Array{Layer,1}:
 Layer(nothing, Dict{Symbol,Any}(:xmin=>[-3],:xmax=>[3],:ymin=>[-3],:ymax=>[3],:z=>##160#161()), Gadfly.StatisticElement[], Gadfly.
Geom.LineGeometry(Gadfly.Stat.ContourStatistic(15, 150), true, 2, Symbol("")), nothing, 0)
```

In [71]:

```
pic1=
layer(x=[l1[i][1] for i in 1:length(l1)],
      y=[l1[i][2] for i in 1:length(l1)],
      label=[string(i) for i in 1:length(l1)],
      #coord = Coord.cartesian(xmin=-1, xmax=1, ymin=0, ymax=1)
      Geom.point,Geom.line,Geom.label,#Geom.vector
    Theme(default_color = "red")
)
plot(pic1,fit)
```

Out[71]:



牛顿法

In [72]:

```
function Newton(f, g, h, x0;
        ϵx=0.01, # precision for step size
        ϵf=0.01,
        ϵg=0.01,
        maxIterations=128,
        debug=false)

    xk = x0
    l = [xk]
    fk = f(xk...)
    for i in 1:maxIterations
        # iteration
        d =-inv(h(xk...))*g(xk...)
        α = 1
        δ = α*d
        xn = xk .+ δ
        push!(l,xn)
        fn = f(xn...)
        # convegence?
        if (norm(δ)<=ϵx)&&(abs(fn-fk)<=ϵf)&&(norm(d)<=ϵg)
            println("Convergence is reached after ", i, " iterations.")
            return l
        end
        if debug
            println("i=",i, " α=", α, " xk=", xk, " xn=", xn, " d=", d, " δ=", δ)
            println("fk=", fk, "\tfn=", fn)
        end
        xk = xn
        fk = fn
    end
    println("WARN:", maxIterations, " iterations have been exceeded!")
end
```

Out[72]: Newton (generic function with 1 method)

In [73]:
```
l2 = Newton(
    (x1,x2)->x1^2+4.5x2^2+3x1*x2-x1-5x2,
    (x1,x2)->[2x1+3x2-1; 9x2+3x1-5],
    (x,y)->[2 3;
            3 9],
    [1.,3.],
    maxIterations = 10000000,
    debug=true
)
```

```
i=1 α=1 xk=[1.0, 3.0] xn=[-0.666667, 0.777778] d=[-1.66667, -2.22222] δ= [-1.66667, -2.22222]
fk=34.5 fn=-1.6111111111111112
Convergence is reached after 2 iterations.
```

Out[73]:
```
3-element Array{Array{Float64,1},1}:
 [1.0, 3.0]
 [-0.666667, 0.777778]
 [-0.666667, 0.777778]
```

In [74]:
```
fit = layer((x1,x2)->x1^2+4.5x2^2+3x1*x2-x1-5x2, -3, 3, -3, 3)
```

Out[74]:
```
1-element Array{Layer,1}:
 Layer(nothing, Dict{Symbol,Any}(:xmin=>[-3],:xmax=>[3],:ymin=>[-3],:ymax=>[3],:z=>##173#174()), Gadfly.StatisticElement[], Gadfly.
Geom.LineGeometry(Gadfly.Stat.ContourStatistic(15, 150), true, 2, Symbol("")), nothing, 0)
```

In [75]:
```
l2
```

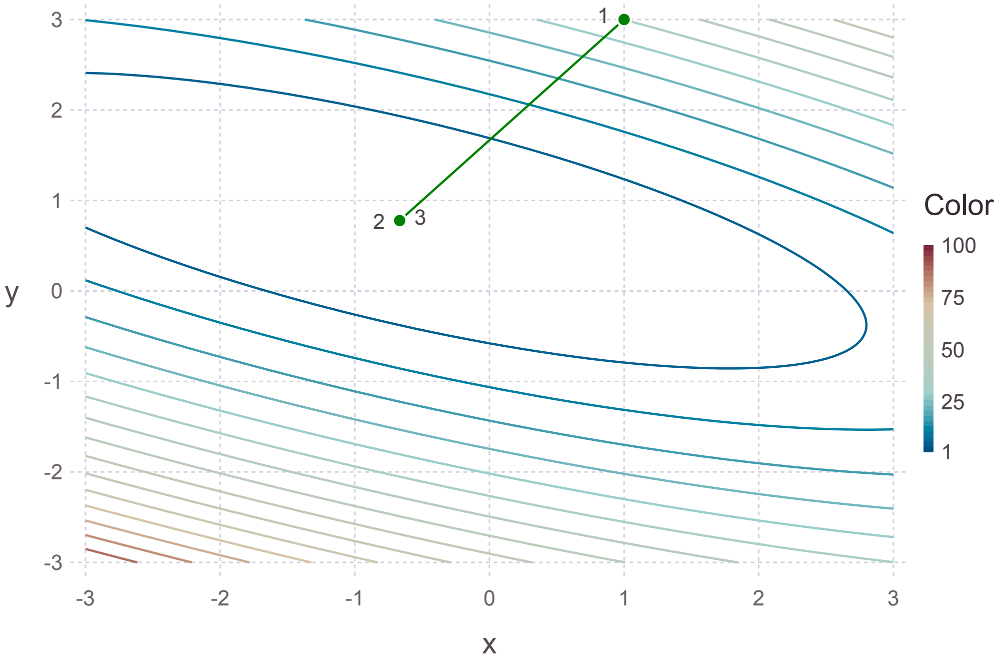
Out[75]:
```
3-element Array{Array{Float64,1},1}:
 [1.0, 3.0]
 [-0.666667, 0.777778]
 [-0.666667, 0.777778]
```

In [126]:
```
cdata = rand(12), rand(12), rand(12)
```

Out[126]:
```
([0.494053, 0.00411875, 0.920613, 0.148633, 0.527149, 0.159405, 0.618761, 0.925758, 0.39609, 0.538764, 0.0714216, 0.39942], [0.8413
01, 0.767753, 0.335835, 0.724892, 0.486562, 0.514412, 0.196624, 0.138977, 0.739239, 0.529985, 0.0593796, 0.2825], [0.698853, 0.5197
62, 0.031294, 0.70643, 0.456529, 0.825538, 0.441986, 0.392667, 0.497437, 0.918595, 0.594467, 0.422142])
```

In [130]:
```
pic2=
layer(x=[l2[i][1] for i in 1:length(l2)],
      y=[l2[i][2] for i in 1:length(l2)],
      label=[string(i) for i in 1:length(l2)],
      #coord = Coord.cartesian(xmin=-1, xmax=1, ymin=0, ymax=1)
      Geom.point,Geom.line,Geom.label,#Geom.vector
      Theme(default_color = "green")
)
plot(pic2,fit)
```

Out[130]:



共轭梯度法

In [5]:

```
function GE_ge(f,fd,hessian,X0;
                      accuracy::Float64 = 0.00001,
                      verbose::Bool = false)
    if ndims(hessian) != 2
        return false           #判断黑塞矩阵
    end
    nr, nc = size(hessian)
    if nr != nc
        return false
    end
    h = hessian
    x0 = X0
    l = [x0]
    if x0 == 0
        x0 = zeros(nc)
    elseif length(x0) != nc
        return false
    end
    r0 = -fd(x0...)
    rs0= sum(r0'*r0)
    d0 = r0
    for i = 1:nc
        a = sum(r0'*r0/(d0'*h*d0))
        x = x0 .+ a*d0
        push!(l,x)
        if i==1
            g1=fd(x...)
            println(0,"  g0=",-r0,"  d0=",d0,"  a0=",a,"  x1=",x,"  g1=",g1)
        end
        r = r0 .- a*h*d0
        rs=sum(r'*r )
        if rs < accuracy
            return l
        end
        b = rs/rs0
        d = r + b*d0
        ai = sum(r'*d/(d'*h*d))
        xi = x+ai*d
        gi = fd(xi...)
        if verbose
            println(i,"  b",i-1,"=",b,"  d",i,"=", d,"  a",i,"=",ai,"  x",i+1,"=",xi,"  g",i+1,"=",gi)
        end
        x0 = x
        r0 = r
        rs0= rs
        d0 = d
    end
    println(nc, " iterations have been calculated.")
    println("Final step rs = ", rs0)
    return x0, f(x0...)
end
```

Out[5]:

```
GE_ge (generic function with 1 method)
```

In [6]:

```
l3 = GE_ge((x1,x2)->x1^2+4.5x2^2+3x1*x2-x1-5x2,
             (x1,x2)->[2x1+3x2-1; 9x2+3x1-5],
              [2 3;
               3 9],
              [1.,3.],
              verbose=true)
```

```
0  g0=[10.0, 25.0]  d0=[-10.0, -25.0]  a0=0.09897610921501707  x1=[0.0102389, 0.525597]  g1=[0.59727, -0.238908]
1  b0=0.0005707696071008404  d1=[-0.602977, 0.224639]  a1=1.1226053639846743  x2=[-0.666667, 0.777778]  g2=[4.21885e-15, 1.15463e-1
4]
```

Out[6]:

```
3-element Array{Array{Float64,1},1}:
 [1.0, 3.0]
 [0.0102389, 0.525597]
 [-0.666667, 0.777778]
```

In [92]:

```
fit = layer((x1,x2)->x1^2+4.5x2^2+3x1*x2-x1-5x2, -3, 3, -3, 3)
```

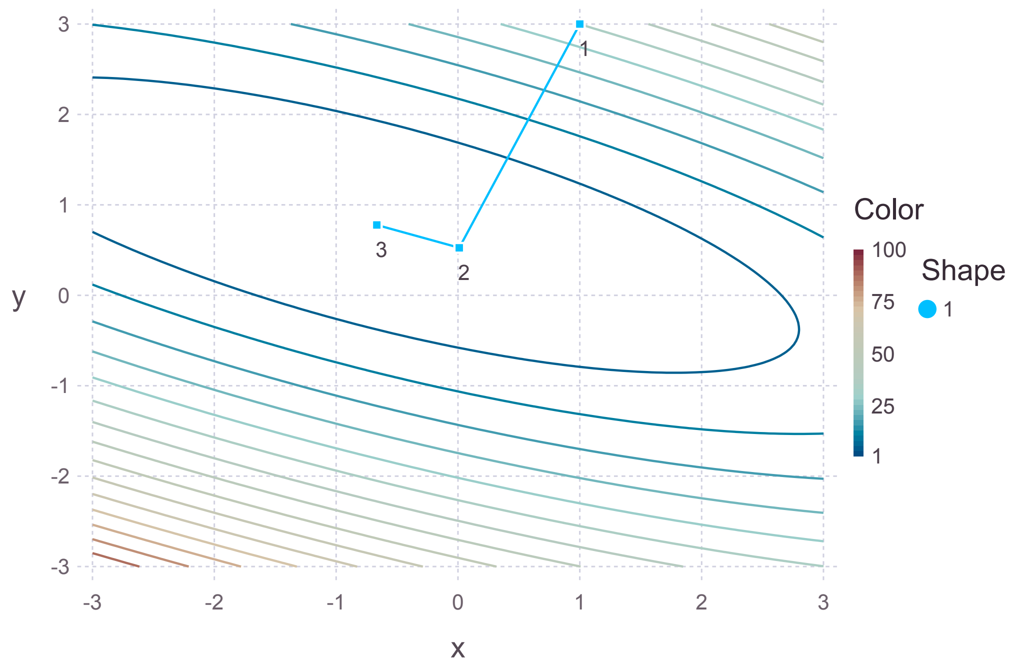
Out[92]:

```
1-element Array{Layer,1}:
 Layer(nothing, Dict{Symbol,Any}(:xmin=>[-3],:xmax=>[3],:ymin=>[-3],:ymax=>[3],:z=>##213#214()), Gadfly.StatisticElement[], Gadfly.
Geom.LineGeometry(Gadfly.Stat.ContourStatistic(15, 150), true, 2, Symbol("")), nothing, 0)
```

In [125]:

```
pic3=
layer(x=[l3[i][1] for i in 1:length(l3)],
      y=[l3[i][2] for i in 1:length(l3)],
      label=[string(i) for i in 1:length(l3)],
      #coord = Coord.cartesian(xmin=-1, xmax=1, ymin=0, ymax=1)
      Geom.point,Geom.line,Geom.label,#Geom.vector
      shape=[Shape.square]
)
plot(pic3,fit)
```

Out[125]:

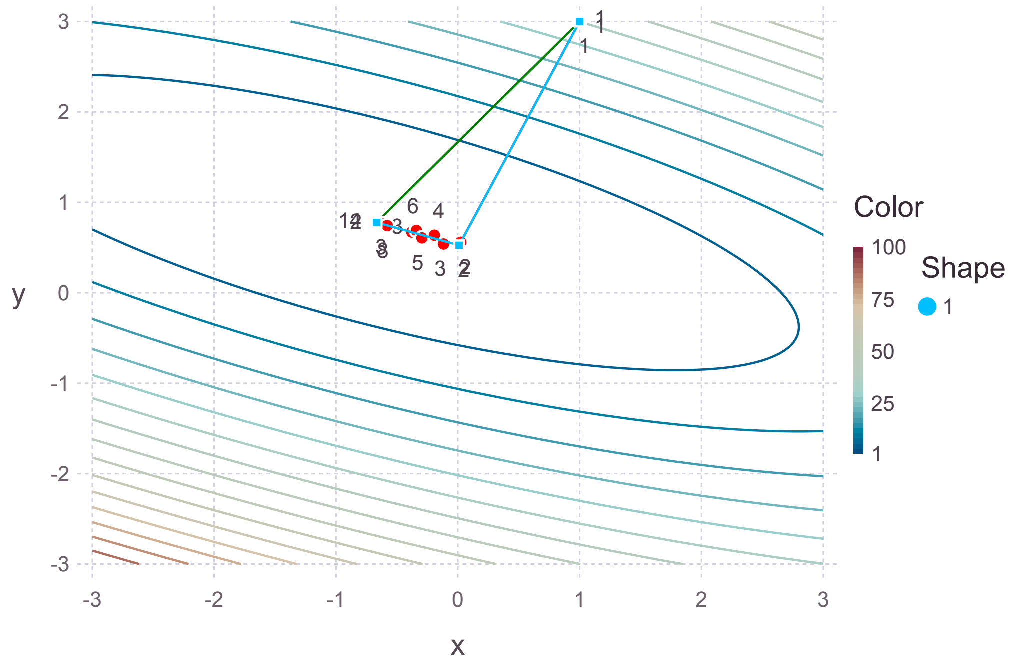


画在一张图中

In [131]:

```
plot(pic3,pic1,pic2,fit)
```

Out[131]:



In [ ]: