20181019d chain rule

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19 October 2018

### the chain rule

There are three functions: f(x,y); x(t); y(t)  
And we would like to find the derivatives of f(x,y) against t  
The first method we will be going for would be expressing f(x,y) in terms of t  
Which would cause alot of manipulations

The chain rule simplify these calculations:  
##### d/dt f(x,y) = df(x,y)/dx \* dx/dt + df(x,y)/dy \* dy/dt

library(Ryacas)  
library(mosaic)

f(x,y) = x^2*y*  
*x(t) = 3+2*t  
y(t) = 10-0.2\*t

x = Sym('x'); y = Sym('y'); t = Sym('t')  
f = x^2\*y   
xt = 3+2\*t  
yt = 10-0.2\*t

# LHS  
fx = makeFun(x^2\*y ~ x & y)  
fx\_t = fx(x=xt,y=yt)  
LHS = deriv(fx\_t,t)  
Simplify(LHS)

## expression(-2.4 \* t^2 + 75.2 \* t + 118.2)

# RHS  
dfdx = deriv(f,x)  
dfdy = deriv(f,y)  
dxdt = deriv(xt,t)  
dydt = deriv(yt,t)  
RHS = dfdx\*dxdt + dfdy\*dydt  
RHS

## expression(4 \* (x \* y) - 0.2 \* x^2)

RHS\_t = makeFun(4 \* (x \* y) - 0.2 \* x^2 ~ x & y)  
RHS = RHS\_t(x=xt,y=yt)  
Simplify(RHS)

## expression(-2.4 \* t^2 + 75.2 \* t + 118.2)