VAGC_grad_scalar.wxm

A development document for Geometric Algebra using wxMaxima

Exercise 5.13, VAGC page 66 for the gradient of a scalar function in 3D

Initialization

```
(%i1)  ext:["wxm"]$
       file_type_maxima:append(ext,file_type_maxima)$
       batchload("initialize_fns")$
```

the pseudoscalar and its inverse
the lowest useable dimension pseudoscalar should be {e1,e2} i.e. Plen = 2
e.g. for four dimensions edit Pseudos:{e1,e2,e3}$ to Pseudos:{e1,e2,e3,e4}$

```
(%i1)  Pseudos:{e1,e2,e3}$
       Pvar:listofvars(Pseudos)$
       Plen:length(Pvar)$
       I:Pseudos$
       ni:(Plen-1)*Plen/2$
       Ii:(-1)^ni*I$
       kill(ni)$
       ldisplay(Pvar)$

 (%t8) Pvar=[e1,e2,e3]

(%i9)  batchload("initialize_lsts")$

 (%t9) lstblds=[[{e1},{e2},{e3}],[{e1,e2},{e1,e3},{e2,e3}],[{e1,e2,e3}]]
(%t10) allblds=[{e1},{e2},{e3},{e1,e2},{e1,e3},{e2,e3},{e1,e2,e3}]
(%t11) invblds=[{e1},{e2},{e3},-{e1,e2},-{e1,e3},-{e2,e3},-{e1,e2,e3}]
```

end of Initialization

set derivabbrev:false$

```
(%i12)  derivabbrev:false$
```

Exercise 5.13
VAGC page 66

form the coordinate vector, x from the lists of coefficients

```
(%i13)  xstr:"x"$
        xlst:lstvector(xstr)$
        ldisplay(xlst)$

(%t15) xlst=[x1,x2,x3,0,0,0,0]

(%i16)  x:makevector(xlst)$
        ldisplay(x)$

(%t17) x={e3}*x3+{e2}*x2+{e1}*x1
```

form the scalar valued function, f(x,y,z)=x^2+y^2+z^2

```
(%i18)  f(x):=normod(x)^2$
        fxyz:ev(f(x))$
        ldisplay(fxyz)$
```

(%t20) $fxyz=x3^{2}+x2^{2}+x1^{2}$

part a) the level surfaces of f are the spheres

part b) the normals would be the in the direction of the radial vectors, x

```
(%i21)  Fstr:"fxyz"$
        gradF:mvgrad(Fstr,xlst)$
        ldisplay(gradF)$
```

(%t23) $$gradF=\{e3\}\&*\left(\frac{d}{d*x3}*fxyz\right)+\{e2\}\&*\left(\frac{d}{d*x2}*fxyz\right)+\{e1\}\&*\left(\frac{d}{d*x1}*fxyz\right)$$

part c) grad(f) = 2x

```
(%i24)  gradf:ev(gradF,diff)$
        ldisplay(gradf)$

(%t25)/R/ gradf=2*x1*{e1}+2*x2*{e2}+2*x3*{e3}
```

N.B. the gradient gives non-unit normals to level surfaces of scalar functions

Created with wxMaxima.