VAGC_grad_Problem5.2.2.wxm

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A short development document for Geometric Algebra with wxMaxima
just to test some calculus functions within the GAwxM environment,
contains...
Initialization
Loading of functions (intrinsic and GA specific)
Pseudoscalar definition (specifies the space dimension) and
Calculation of the inverse pseudoscalar used to generate the dual of a multivector
Enumeration of the standard basis for the specified dimension

Problem 5.2.2, VAGC page 62 for the multivector gradient
Exercise 5.6d, page 59

Initialization

```
(%i47) 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$
```

Problem 5.2.2
VAGC page 62

```
(%i13) Clst:[c1,c2,c3,0,0,0,0]$
       Alst:[a1,a2,a3,0,0,0,0]$

(%i15) eJ:allblds$
```

form the coordinate vector, c and the constant vector, a from the list of coefficients

```
(%i16) lenlst:2^Plen-1$
       c:0$
       a:0$
       for j:1 thru lenlst do
       block(c:c+Clst[j]*eJ[j],
       a:a+Alst[j]*eJ[j])$
```

form the function, F(x)=xa in Problem 5.2.2a

```
(%i20) F(c):=c&*a$
       F:ev(F(c))$
       ldisplay(c,F)$

  (%t22) c=c3*{e3}+c2*{e2}+c1*{e1}
  (%t23)/R/ F=(a3-{e2,e3}*a2-{e1,e3}*a1)*c3+({e2,e3}*a3+a2-{e1,e2}*a1)*c2+
({e1,e3}*a3+{e1,e2}*a2+a1)*c1

(%i24) Fstr:"F"$
       gradF:mvgrad(Fstr,Clst)$
       ldisplay(gradF)$

  (%t26) gradF={e3}&*(d/(d*c3)*F)+{e2}&*(d/(d*c2)*F)+{e1}&*(d/(d*c1)*F)

(%i27) lhs:ev(gradF,diff);

(%o27)/R/ 3*a1*{e1}+3*a3*{e3}+3*a2*{e2}
```

confirm that the evaluated gradF is the same as the value given in the Problem

```
(%i28) n:Plen$
       rhs:n*a$
       is(equal(lhs,rhs));

(%o30) true
```

form the function, F(x)=x.a in Problem 5.2.2b

```
(%i31) F(c):=c&.a$
       F:ev(F(c))$
       ldisplay(F)$

  (%t33)/R/ F=a3*c3+a2*c2+a1*c1

(%i34) lhs:ev(gradF,diff);

(%o34)/R/ a1*{e1}+a3*{e3}+a2*{e2}

(%i35) rhs:a$
       is(equal(lhs,rhs));

(%o36) true
```

form the function, F(x)=x^a in Problem 5.2.2b cont.

```
(%i37) F(c):=c&^a$
       F:ev(F(c))$
       ldisplay(F)$

  (%t39)/R/ F=(-{e2,e3}*a2-{e1,e3}*a1)*c3+({e2,e3}*a3-{e1,e2}*a1)*c2+
({e1,e3}*a3+{e1,e2}*a2)*c1

(%i40) lhs:ev(gradF,diff);

(%o40)/R/ 2*a1*{e1}+2*a3*{e3}+2*a2*{e2}

(%i41) rhs:(n-1)*a$
       is(equal(lhs,rhs));

(%o42) true
```

As an extra, Exercise 5.6d, page 59

```
(%i43) F(c):=log(normod(c))$
       F:ev(F(c))$
       ldisplay(F)$

  (%t45) F=log(c3^2+c2^2+c1^2)/2
```

grad(ln(|x|) = x/(|x|^2)

```
(%i46) lhs:ev(gradF,diff);

(%o46)/R/ (c1*{e1}+{e3}*c3+{e2}*c2)/(c3^2+c2^2+c1^2)
```

Created with wxMaxima.