Add fixed effect in BGLR and rrBLUP

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```
library(rrBLUP)
```

```
## Warning: package 'rrBLUP' was built under R version 4.2.3
```

```
M <- matrix(rep(0,200*1000),200,1000)
for (i in 1:200) {
  M[i,] <- ifelse(runif(1000)<0.5,-1,1)
}

#random phenotypes
u <- rnorm(1000)
g <- as.vector(crossprod(t(M),u))
h2 <- 0.5  #heritability
y <- g + rnorm(200,mean=0,sd=sqrt((1-h2)/h2*var(g)))+60

#predict marker effects
ans <- mixed.solve(y,Z=M)  #By default K = I
accuracy <- cor(u,ans$u)

dim(M)
```

```
## [1]  200 1000
```

```
svd= svd(M)
U= svd$u
D=svd$d
V=svd$v

x=U%*%diag(D)%*%t(V)
PC1= x%*%V[,1]
PC2= x%*%V[,2]

X= cbind(1,PC1,PC2)
head(X)
```

```
##      [,1]        [,2]        [,3]
## [1,]    1 -1.89083663  2.45563981
## [2,]    1  4.93523984 -0.35102881
## [3,]    1  6.79277198 -2.29188679
## [4,]    1 -2.75815010  0.02511561
## [5,]    1  0.03431488 -1.76137140
## [6,]    1 -1.35554652 -0.05492886
```

```r
K=A.mat(M)
#predict breeding values with fixed effect
ans <- mixed.solve(y,X=X,K=K)
accuracy <- cor(g,ans$u)
accuracy
```

```
## [1] 0.6853263
```

```r
ans$beta
```

```
## [1] 57.0792708  0.3158774  1.3671500
```

```r
#predict breeding values without fixed effect
ans2 <- mixed.solve(y,K=K)
ans2$beta
```

```
## [1] 57.32911
```

```r
accuracy2 <- cor(g,ans2$u)
accuracy2
```

```
## [1] 0.6878247
```

```r
# RKHS with fixed effect
library(BGLR)
X2= data.frame(PC1=PC1,PC2=PC2)
head(X2)
```

```
##           PC1         PC2
## 1 -1.89083663  2.45563981
## 2  4.93523984 -0.35102881
## 3  6.79277198 -2.29188679
## 4 -2.75815010  0.02511561
## 5  0.03431488 -1.76137140
## 6 -1.35554652 -0.05492886
```

```r
X3=model.matrix(~PC1+PC2,X2)
head(X3)
```

```
##   (Intercept)         PC1         PC2
## 1           1 -1.89083663  2.45563981
## 2           1  4.93523984 -0.35102881
## 3           1  6.79277198 -2.29188679
## 4           1 -2.75815010  0.02511561
## 5           1  0.03431488 -1.76137140
## 6           1 -1.35554652 -0.05492886
```

```
fit= BGLR(

  y=y,
  ETA=list(list(X=X2, model="FIXED"),
           list(K=K,model="RKHS")),
  nIter=20000,
  burnIn=5000,
  verbose=F

)
fit$mu
```

```
## [1] 57.10009
```

```
fit$ETA[[1]]
```

```
## $model
## [1] "FIXED"
##
## $Name
## [1] "ETA_1"
##
## $p
## [1] 2
##
## $colNames
## [1] "PC1" "PC2"
##
## $b
##       PC1       PC2
## 0.2788655 1.3730323
##
## $NamefileOut
## [1] "C:/Users/ddli/OneDrive - Iowa State University/ISU/ISU_study/Quantitative-Genetics-and-R/Quanti
##
## $varB
## [1] 1e+10
##
## $SD.b
##      PC1      PC2
## 1.226677 1.257626
```

```
accuracy3 <- cor(g,fit$yHat)
accuracy3
```

```
## [1] 0.6887394
```

```
# RKHS without fixed effect

fit2= BGLR(
  y=y,
```

```
  ETA=list(list(K=K,model="RKHS")),
  nIter=20000,
  burnIn=5000,
  verbose=F
)
fit2$mu
```

```
## [1] 57.40658
```

```
accuracy4 <- cor(g,fit2$yHat)
accuracy4
```

```
## [1] 0.6896708
```