

# Package ‘SASmixed’

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**Title** Data Sets from "SAS System for Mixed Models

**Version** 1.0-5

**Description** Data sets and sample lmer analyses corresponding to the examples in Littell, Milliken, Stroup and Wolfinger (1996), ``SAS System for Mixed Models'', SAS Institute.

**Depends** R (>= 2.14.0),

**Suggests** lme4, lattice

**LazyData** yes

**License** GPL (>= 2)

**NeedsCompilation** no

**URL** <https://github.com/annahuynhly/SASmixed>

**Repository** CRAN

**Encoding** UTF-8

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Animal *Animal breeding experiment*

**Description**

The Animal data frame has 20 rows and 3 columns giving the average daily weight gains for animals with different genetic backgrounds.

**Format**

This data frame contains the following columns:

**Sire** a factor denoting the sire. (5 levels)

**Dam** a factor denoting the dam. (2 levels)

**AvgDailyGain** a numeric vector of average daily weight gains

**Details**

This appears to be a constructed data set.

**Source**

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 6.4).

**Examples**

```
str(Animal)
```

---

AvgDailyGain	<i>Average daily weight gain of steers on different diets</i>
--------------	---

---

### Description

The AvgDailyGain data frame has 32 rows and 6 columns.

### Format

This data frame contains the following columns:

**Id** the animal number

**Block** an ordered factor indicating the barn in which the steer was housed.

**Treatment** an ordered factor with levels 0 < 10 < 20 < 30 indicating the amount of medicated feed additive added to the base ration.

**adg** a numeric vector of average daily weight gains over a period of 160 days.

**InitWt** a numeric vector giving the initial weight of the animal

**Trt** the Treatment as a numeric variable

### Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 5.3).

### Examples

```
str(AvgDailyGain)
if (require("lattice", quietly = TRUE, character = TRUE)) {
  ## plot of adg versus Treatment by Block
  xyplot(adg ~ Treatment | Block, AvgDailyGain, type = c("g", "p", "r"),
    xlab = "Treatment (amount of feed additive)",
    ylab = "Average daily weight gain (lb.)", aspect = "xy",
    index.cond = function(x, y) coef(lm(y ~ x))[1])
}
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(ordered = "contr.SAS", ordered = "contr.poly"))
  ## compare with output 5.1, p. 178
  print(fm1Adg <- lmer(adg ~ InitWt * Treatment - 1 + (1 | Block),
    AvgDailyGain))
  print(anova(fm1Adg)) # checking significance of terms
  print(fm2Adg <- lmer(adg ~ InitWt + Treatment + (1 | Block),
    AvgDailyGain))
  print(anova(fm2Adg))
  print(lmer(adg ~ InitWt + Treatment - 1 + (1 | Block), AvgDailyGain))
}
```

**Description**

The BIB data frame has 24 rows and 5 columns.

**Format**

This data frame contains the following columns:

**Block** an ordered factor with levels 1 < 2 < 3 < 8 < 5 < 4 < 6 < 7

**Treatment** a treatment factor with levels 1 to 4.

**y** a numeric vector representing the response

**x** a numeric vector representing the covariate

**Grp** a factor with levels 13 and 24

**Details**

These appear to be constructed data.

**Source**

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 5.4).

**Examples**

```
str(BIB)
if (require("lattice", quietly = TRUE, character = TRUE)) {
  xyplot(y ~ x | Block, BIB, groups = Treatment, type = c("g", "p"),
         aspect = "xy", auto.key = list(points = TRUE, space = "right",
         lines = FALSE))
}
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
  ## compare with Output 5.7, p. 188
  print(fm1BIB <- lmer(y ~ Treatment * x + (1 | Block), BIB))
  print(anova(fm1BIB))      # strong evidence of different slopes
  ## compare with Output 5.9, p. 193
  print(fm2BIB <- lmer(y ~ Treatment + x : Grp + (1 | Block), BIB))
  print(anova(fm2BIB))
}
```

---

Bond	<i>Strengths of metal bonds</i>
------	---------------------------------

---

**Description**

The Bond data frame has 21 rows and 3 columns of data on the strength required to break metal bonds according to the metal and the ingot.

**Format**

This data frame contains the following columns:

**pressure** a numeric vector of pressures required to break the bond

**Metal** a factor with levels c, i and n indicating the metal involved (copper, iron or nickel).

**Ingot** an ordered factor indicating the ingot of the composition material.

**Source**

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 1.2.4).

Mendenhall, M., Wackerly, D. D. and Schaeffer, R. L. (1990), *Mathematical Statistics*, Wadsworth (Exercise 13.36).

**Examples**

```
str(Bond)
options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
if (require("lme4", quietly = TRUE, character = TRUE)) {
  ## compare with output 1.1 on p. 6
  print(fm1Bond <- lmer(pressure ~ Metal + (1|Ingot), Bond))
  print(anova(fm1Bond))
}
```

---

Cultivation	<i>Bacterial inoculation applied to grass cultivars</i>
-------------	---

---

**Description**

The Cultivation data frame has 24 rows and 4 columns of data from an experiment on the effect on dry weight yield of three bacterial inoculation treatments applied to two grass cultivars.

**Format**

This data frame contains the following columns:

**Block** a factor with levels 1 to 4

**Cult** the cultivar factor with levels a and b

**Inoc** the inoculant factor with levels con, dea and liv

**drywt** a numeric vector of dry weight yields

**Source**

Littell, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 2.2(a)).

Littel, R. C., Freund, R. J., and Spector, P. C. (1991), *SAS System for Linear Models, Third Ed.*, SAS Institute.

**Examples**

```
str(Cultivation)
xtabs(~Block+Cult, Cultivation)
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
  ## compare with Output 2.10, page 58
  print(fm1Cult <- lmer(drywt ~ Inoc * Cult + (1|Block) + (1|Cult),
    Cultivation))
  print(anova(fm1Cult))
  print(fm2Cult <- lmer(drywt ~ Inoc + Cult + (1|Block) + (1|Cult),
    Cultivation))
  print(anova(fm2Cult))
  print(fm3Cult <- lmer(drywt ~ Inoc + (1|Block) + (1|Cult), Cultivation))
  print(anova(fm3Cult))
}
```

---

Demand

*Per-capita demand deposits by state and year*

---

**Description**

The Demand data frame has 77 rows and 8 columns of data on per-capita demand deposits by state and year.

**Format**

This data frame contains the following columns:

**State** an ordered factor with levels WA < FL < CA < TX < IL < DC < NY

**Year** an ordered factor with levels 1949 < ... < 1959

**d** a numeric vector of per-capita demand deposits

- y** a numeric vector of permanent per-capita personal income
- rd** a numeric vector of service charges on demand deposits
- rt** a numeric vector of interest rates on time deposits
- rs** a numeric vector of interest rates on savings and loan association shares.

### Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 1.2.4).

Feige, E. L. (1964), *The Demand for Liquid Assets: A Temporal Cross-Sectional Analysis.*, Prentice Hall.

### Examples

```
str(Demand)
if (require("lme4", quietly = TRUE, character = TRUE)) {
  ## compare to output 3.13, p. 132
  summary(fm1Demand <-
    lmer(log(d) ~ log(y) + log(rd) + log(rt) + log(rs) + (1|State) + (1|Year),
      Demand))
}
```

---

Genetics

*Heritability data*

---

### Description

The Genetics data frame has 60 rows and 4 columns.

### Format

This data frame contains the following columns:

- Location** a factor with levels 1 to 4
- Block** a factor with levels 1 to 3
- Family** a factor with levels 1 to 5
- Yield** a numeric vector of crop yields

### Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 4.5).

## Examples

```
str(Genetics)
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(ordered = "contr.SAS", ordered = "contr.poly"))
  summary(fm1Gen <- lmer(Yield ~ Family + (1|Location/Block), Genetics))
}
```

---

 HR

*Heart rates of patients on different drug treatments*


---

## Description

The HR data frame has 120 rows and 5 columns of the heart rates of patients under one of three possible drug treatments.

## Format

This data frame contains the following columns:

**Patient** an ordered factor indicating the patient.

**Drug** the drug treatment - a factor with levels a, b and p where p represents the placebo.

**baseHR** the patient's base heart rate

**HR** the observed heart rate at different times in the experiment

**Time** the time of the observation

## Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 3.5).

## Examples

```
str(HR)
if (require("lattice", quietly = TRUE, character = TRUE)) {
  xyplot(HR ~ Time | Patient, HR, type = c("g", "p", "r"), aspect = "xy",
    index.cond = function(x, y) coef(lm(y ~ x))[1],
    ylab = "Heart rate (beats/min)")
}
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(ordered = "contr.SAS", ordered = "contr.poly"))
  ## linear trend in time
  print(fm1HR <- lmer(HR ~ Time * Drug + baseHR + (Time|Patient), HR))
  print(anova(fm1HR))
  ## Not run:
  fm2HR <- update(fm1HR, weights = varPower(0.5)) # use power-of-mean variance
  summary(fm2HR)
  intervals(fm2HR) # variance function does not seem significant
  anova(fm1HR, fm2HR) # confirm with likelihood ratio
```

```
## End(Not run)
print(fm3HR <- lmer(HR ~ Time + Drug + baseHR + (Time|Patient), HR))
print(anova(fm3HR))
## remove Drug term
print(fm4HR <- lmer(HR ~ Time + baseHR + (Time|Patient), HR))
print(anova(fm4HR))
}
```

---

IncBlk

*An unbalanced incomplete block experiment*

---

## Description

The IncBlk data frame has 24 rows and 4 columns.

## Format

This data frame contains the following columns:

**Block** an ordered factor giving the block

**Treatment** a factor with levels 1 to 4

**y** a numeric vector

**x** a numeric vector

## Details

These data are probably constructed data.

## Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 5.5).

## Examples

```
str(IncBlk)
```

---

 Mississippi

*Nitrogen concentrations in the Mississippi River*


---

### Description

The Mississippi data frame has 37 rows and 3 columns.

### Format

This data frame contains the following columns:

**influent** an ordered factor with levels 3 < 5 < 2 < 1 < 4 < 6

**y** a numeric vector

**Type** a factor with levels 1 2 3

### Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 4.2).

### Examples

```
str(Mississippi)
if (require("lattice", quietly = TRUE, character = TRUE)) {
  dotplot(drop(influent:Type) ~ y, groups = Type, Mississippi)
}
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
  ## compare with output 4.1, p. 142
  print(fm1Miss <- lmer(y ~ 1 + (1|influent), Mississippi))
  ## compare with output 4.2, p. 143
  print(fm1MLMiss <- update(fm1Miss, REML=FALSE))
  ## BLUP's of random effects on p. 142
  ranef(fm1Miss)
  ## BLUP's of random effects on p. 144
  print(ranef(fm1MLMiss))
#intervals(fm1Miss)      # interval estimates of variance components
## compare to output 4.8 and 4.9, pp. 150-152
print(fm2Miss <- lmer(y ~ Type+(1|influent), Mississippi, REML=TRUE))
print(anova(fm2Miss))
}
```

---

 Multilocation

*A multilocation trial*


---

## Description

The Multilocation data frame has 108 rows and 7 columns.

## Format

This data frame contains the following columns:

**obs** a numeric vector

**Location** an ordered factor with levels B < D < E < I < G < A < C < F < H

**Block** a `factor` with levels 1 to 3

**Trt** a factor with levels 1 to 4

**Adj** a numeric vector

**Fe** a numeric vector

**Grp** an `ordered` factor with levels B/1 < B/2 < B/3 < D/1 < D/2 < D/3 < E/1 < E/2 < E/3 < I/1 < I/2 < I/3 < G/1 < G/2 < G/3 < A/1 < A/2 < A/3 < C/1 < C/2 < C/3 < F/1 < F/2 < F/3 < H/1 < H/2 < H/3

## Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 2.8.1).

## Examples

```
str(Multilocation)
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
  ### Create a Block %in% Location factor
  Multilocation$Grp <- with(Multilocation, Block:Location)
  print(fm1Mult <- lmer(Adj ~ Location * Trt + (1|Grp), Multilocation))
  print(anova(fm1Mult))
  print(fm2Mult <- lmer(Adj ~ Location + Trt + (1|Grp), Multilocation), corr=FALSE)
  print(fm3Mult <- lmer(Adj ~ Location + (1|Grp), Multilocation), corr=FALSE)
  print(fm4Mult <- lmer(Adj ~ Trt + (1|Grp), Multilocation))
  print(fm5Mult <- lmer(Adj ~ 1 + (1|Grp), Multilocation))
  print(anova(fm2Mult))
  print(anova(fm1Mult, fm2Mult, fm3Mult, fm4Mult, fm5Mult))
  ### Treating the location as a random effect
  print(fm1MultR <- lmer(Adj ~ Trt + (1|Location/Trt) + (1|Grp), Multilocation))
  print(anova(fm1MultR))
  fm2MultR <- lmer(Adj ~ Trt + (Trt - 1|Location) + (1|Block), Multilocation)
  ## Warning (not error ?!): Convergence failure in 10000 iter %% __FIXME__
  print(fm2MultR)# does not mention previous conv.failure %% FIXME ??
```

```
print(anova(fm1MultR, fm2MultR))
## Not run:
confint(fm1MultR)

## End(Not run)
}
```

---

PBIB

*A partially balanced incomplete block experiment*

---

### Description

The PBIB data frame has 60 rows and 3 columns.

### Format

This data frame contains the following columns:

**response** a numeric vector

**Treatment** a factor with levels 1 to 15

**Block** an ordered factor with levels 1 to 15

### Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 1.5.1).

### Examples

```
str(PBIB)
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
  ## compare with output 1.7 pp. 24-25
  print(fm1PBIB <- lmer(response ~ Treatment + (1|Block), PBIB))
  print(anova(fm1PBIB))
}
```

---

Semi2

*Oxide layer thicknesses on semiconductors*

---

## Description

The Semi2 data frame has 72 rows and 5 columns.

## Format

This data frame contains the following columns:

**Source** a factor with levels 1 and 2

**Lot** a factor with levels 1 to 8

**Wafer** a factor with levels 1 to 3

**Site** a factor with levels 1 to 3

**Thickness** a numeric vector

## Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 4.4).

## Examples

```
str(Semi2)
xtabs(~Lot + Wafer, Semi2)
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
  ## compare with output 4.13, p. 156
  print(fm1Semi2 <- lmer(Thickness ~ 1 + (1|Lot/Wafer), Semi2))
  ## compare with output 4.15, p. 159
  print(fm2Semi2 <- lmer(Thickness ~ Source + (1|Lot/Wafer), Semi2))
  print(anova(fm2Semi2))
  ## compare with output 4.17, p. 163
  print(fm3Semi2 <- lmer(Thickness ~ Source + (1|Lot/Wafer) + (1|Lot:Source),
                        Semi2))
  ## This is not the same as the SAS model.
}
```

---

Semiconductor	<i>Semiconductor split-plot experiment</i>
---------------	--

---

**Description**

The Semiconductor data frame has 48 rows and 5 columns.

**Format**

This data frame contains the following columns:

**resistance** a numeric vector

**ET** a factor with levels 1 to 4 representing etch time.

**Wafer** a factor with levels 1 to 3

**position** a factor with levels 1 to 4

**Grp** an ordered factor with levels 1/1 < 1/2 < 1/3 < 2/1 < 2/2 < 2/3 < 3/1 < 3/2 < 3/3 < 4/1 < 4/2 < 4/3

**Source**

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 2.2(b)).

**Examples**

```
str(Semiconductor)
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
  print(fm1Semi <- lmer(resistance ~ ET * position + (1|Grp), Semiconductor))
  print(anova(fm1Semi))
  print((fm2Semi <- lmer(resistance ~ ET + position + (1|Grp), Semiconductor)))
  print(anova(fm2Semi))
}
```

---

SIMS	<i>Second International Mathematics Study data</i>
------	--

---

**Description**

The SIMS data frame has 3691 rows and 3 columns.

**Format**

This data frame contains the following columns:

**Pretot** a numeric vector giving the student's pre-test total score

**Gain** a numeric vector giving gains from pre-test to the final test

**Class** an ordered factor giving the student's class

**Source**

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (section 7.2.2)

Kreft, I. G. G., De Leeuw, J. and Var Der Leeden, R. (1994), “Review of five multilevel analysis programs: BMDP-5V, GENMOD, HLM, ML3, and VARCL”, *American Statistician*, **48**, 324–335.

**Examples**

```
str(SIMS)
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
  ## compare to output 7.4, p. 262
  print(fm1SIMS <- lmer(Gain ~ Pretot + (Pretot | Class), data = SIMS))
  print(anova(fm1SIMS))
}
```

---

 TeachingI

*Teaching Methods I*


---

**Description**

The TeachingI data frame has 96 rows and 7 columns.

**Format**

This data frame contains the following columns:

**Method** a factor with levels 1 to 3

**Teacher** a factor with levels 1 to 4

**Gender** a factor with levels f and m

**Student** a factor with levels 1 to 4

**score** a numeric vector

**Experience** a numeric vector

**uTeacher** an ordered factor with levels

**Source**

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 5.6).

**Examples**

```
str(TeachingI)
```

---

TeachingII	<i>Teaching Methods II</i>
------------	----------------------------

---

**Description**

The TeachingII data frame has 96 rows and 6 columns.

**Format**

This data frame contains the following columns:

**Method** a factor with levels 1 to 3

**Teacher** a factor with levels 1 to 4

**Gender** a factor with levels f and m

**IQ** a numeric vector

**score** a numeric vector

**uTeacher** an ordered factor with levels

**Source**

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 5.7).

**Examples**

```
str(TeachingII)
```

---

WaferTypes	<i>Data on different types of silicon wafers</i>
------------	--

---

**Description**

The WaferTypes data frame has 144 rows and 8 columns.

**Format**

This data frame contains the following columns:

**Group** a factor with levels 1 to 4

**Temperature** an ordered factor with levels 900 < 1000 < 1100

**Type** a factor with levels A and B

**Wafer** a numeric vector

**Site** a numeric vector

**delta** a numeric vector

**Thick** a numeric vector

**uWafer** an ordered factor giving a unique code to each group, temperature, type and wafer combination.

**Source**

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 5.8).

**Examples**

```
str(WaferTypes)
```

---

Weights

*Data from a weight-lifting program*

---

**Description**

The Weights data frame has 399 rows and 5 columns.

**Format**

This data frame contains the following columns:

**strength** a numeric vector

**Subject** a factor with levels 1 to 21

**Program** a factor with levels CONT (continuous repetitions and weights), RI (repetitions increasing) and WI (weights increasing)

**Subj** an ordered factor indicating the subject on which the measurement is made

**Time** a numeric vector indicating the time of the measurement

**Source**

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 3.2(a)).

**Examples**

```
str(Weights)
if (require("lme4", quietly = TRUE, character = TRUE)) {
  options(contrasts = c(unordered = "contr.SAS", ordered = "contr.poly"))
  ## compare with output 3.1, p. 91
  print(fm1Weight <- lmer(strength ~ Program * Time + (1|Subj), Weights))
  print(anova(fm1Weight))
  print(fm2Weight <- lmer(strength ~ Program * Time + (Time|Subj), Weights))
  print(anova(fm1Weight, fm2Weight))
  ## Not run:
  intervals(fm2Weight)
  fm3Weight <- update(fm2Weight, correlation = corAR1())
  anova(fm2Weight, fm3Weight)
  fm4Weight <- update(fm3Weight, strength ~ Program * (Time + I(Time^2)),
    random = ~Time|Subj)
```

```
summary(fm4Weight)
anova(fm4Weight)
intervals(fm4Weight)

## End(Not run)
}
```

---

WWheat

*Winter wheat*

---

### Description

The WWheat data frame has 60 rows and 3 columns.

### Format

This data frame contains the following columns:

**Variety** an ordered factor with 10 levels

**Yield** a numeric vector of yields

**Moisture** a numeric vector of soil moisture contents

### Source

Littel, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996), *SAS System for Mixed Models*, SAS Institute (Data Set 7.2).

### Examples

```
str(WWheat)
```

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