

# Subject index

## A

- Aalen–Nelson estimate ..... see Nelson–Aalen estimate
- accrual ..... 348–358
  - exponential ..... 350, 351, 354–358
  - period ..... 349–354, 356, 357
  - uniform ..... 350–354, 358
- additive-hazards model ..... 20
- administrative censoring ..... 336, 339, 348, 349, 355
- AFT metric
  - definition ..... 16, 19, 20, 232, 239–241
  - relation to PH metric ..... 241–244
  - specification ..... 233
- Akaike information criterion ..... 278, 281–282, 317
- allocation of subjects ..... 334–335, 338, 340
- analysis time ..... 24–27, 52–55
- at-risk table ..... 105–107

## B

- bathtub hazard ..... 8
- Bayesian information criterion ..... 282
- Bonferroni adjustment ..... 204
- bootstrap, variance estimation ..... 165
- boundary effects ..... see kernel smoothing, boundary bias
- boundary kernels method ..... 115
- Breslow approximation for tied failures ..... 150–151
- Breslow test ..... see Wilcoxon test
- BRR, variance estimation ..... 165

## C

- cancer data ..... 170–171

- casewise deletion ..... see listwise deletion
- categorical variables ..... 178–180, 309
- censored-normal regression .....
  - ..... see regression models, censored normal
- censoring ..... 29–30
  - administrative .. see administrative censoring
  - interval ..... 32–33
  - left ..... 34
  - loss to follow-up ..... see loss to follow-up
  - right ..... see right-censoring
- ci ..... 92
- clustered data ..... 157–158, 198–199, 325–326, 358
- competing risks ..... 365–391
- complete case analysis ..... see listwise deletion
- concordance, measures ..... 222–223
- conditional logistic regression ..... see regression models, conditional logistic
- confidence bands, plot ..... 107
- confidence interval for
  - cumulative hazard function ..... 109
  - estimated coefficients ..... 186
  - hazard ratio ..... 133
  - mean survival time ..... 119–120
  - median survival time ..... 118–119
  - survivor function ..... 96
- contingency table ..... 123–124
- Cox regression .. see regression models, Cox
- Cox–Snell residuals ..... 219–222, 284, 294–295
- cubic splines ..... 185

- cumulative
- distribution function
    - conditional.....9
    - estimation.....see empirical distribution function
    - generalized gamma ..... 276
    - loglogistic.....273
    - lognormal.....269
    - relation to cumulative hazard..9
    - relation to survivor function...7
    - standard normal.....269
    - Weibull ..... 9, 265
  - hazard count data interpretation..13–15
  - hazard function
    - baseline.....135–137, 139, 143, 145, 155–156, 161, 172
    - conditional.....9
    - estimation....107–113, 135–137, 155–156, 161, 291–294
    - exponential.....247
    - Gompertz ..... 267
    - goodness of fit.....219–222
    - Nelson–Aalen estimate ..... see Nelson–Aalen estimate
    - plot ..... 102, 142, 295–300
    - relation to survivor function...8
    - Weibull.....257
  - incidence function.....367–368, 372–375, 382–389
  - subhazard function.....383
- D**
- date format ..... 48–50
  - delayed entry.....12, 34–35, 38, 62–64, 86, 97–99, 104, 105, 245, 293
    - generation of ..... 11–12
  - delta method ..... 133
  - density function ..... 16, 287, 288
    - conditional.....9
    - for censored data.....31
    - relation to cumulative hazard....9
    - relation to likelihood ..... 21, 245
    - relation to survivor function.....7
    - Weibull ..... 9
- E**
- effect size ..... 335, 337, 347, 356, 359
    - determination ..... 359–360
    - specification.....338, 356
  - efficient score residuals.....223–228
  - Efron approximation for tied failures ..151
  - empirical distribution function..99–101
  - enduring variables.....41, 47, 75
  - estat concordance** ..... 222–223
  - estat phtest** ..... 206–209
  - Euler’s constant ..... 255, 265, 288
  - exponential regression ... see regression models, exponential
  - extended mean ..... 120
  - extreme-value distribution.....see Gumbel distribution
- F**
- failure function ..... see cumulative distribution function
  - fixed effects.....199
  - FMI ..... 174–175
  - follow-up period ..... 29, 349–353, 356, 357, 359
  - fracpoly, stcox** ..... 183–185
  - fraction missing information ... see FMI
  - fractional polynomials....182–185, 206
    - multivariable ..... 185, 218–219
  - frailty models
    - shared ..... 156–164, 169, 199–200, 324–331
    - unshared ..... 311–324
- G**
- gamma function ..... 16, 255, 265, 276, 287, 288

- gaps ..... 35–36, 38, 39, 67–70, 77, 83, 86–87, 99–101, 245, 284, 293, 298–300  
generalized gamma regression ..... see regression models, generalized gamma  
Gompertz regression ..... see regression models, Gompertz  
goodness of fit ..... 219–223  
Greenwood's standard error ..... 96  
Gumbel distribution ..... 255, 265
- H**  
Harrell's  $C$  statistic ..... 222  
hazard  
cause-specific ..... 366–367, 369–372, 375–381  
contribution ..... 113, 135, 139, 141, 143, 145  
cumulative ..... see cumulative hazard function  
function  
baseline ..... 19, 129–131, 134–135, 139–141, 152, 163–164, 234–236, 239  
bathtub ..... 8  
conditional ..... 9  
cumulative ..... see cumulative hazard function  
definition ..... 7–8  
estimation ..... 113–117, 135, 139–141, 163–164, 284, 291–294  
examples of ..... 9  
exponential ..... 247  
Gompertz ..... 267  
lognormal ..... 271  
modeling ..... 19–24, 156, 177–197, 301–331  
plot ..... 102, 142, 163–164, 295–300  
test ..... 124  
Weibull ..... 9, 257  
log relative ..... 135, 183–189  
metric ..... see PH metric
- hazard, *continued*  
rate ..... 8, 13, 15–16  
ratio ..... 130–134, 143, 160, 192, 234, 333, 338, 340, 344, 347, 356, 359, 361, 364  
confidence interval for ..... 133  
estimation ..... 284  
interpretation in frailty models .. ..... 321  
standard error of ..... 132–133  
test ..... 133, 339  
relative ..... 135, 183  
heterogeneity  
modeling ..... 310–312  
test for ..... 317–324  
hip-fracture data  
description of ..... 82–89  
sample size for ..... 333–335  
hypothesis  
alternative ..... 133, 345, 346  
null ..... 124, 133, 158, 207, 337, 339, 343, 345, 346
- I**  
imputation ..... see multiple imputation  
incomplete gamma function ..... 276  
indicator variables ..... see categorical variables  
influence diagnostics  
Cox–Snell residuals ..... see Cox-Snell residuals  
deviance residuals ..... see deviance residuals  
DFBETA ..... 223–225  
efficient score residuals ..... see efficient score residuals  
likelihood displacement values ..... 225–226  
LMAX ..... 225–227  
instantaneous variables ..... 41, 47, 54, 63  
interaction terms ..... 186–189  
interval regression ..... see regression models, interval  
interval-censoring ..... 32–33

interval-truncation ..... see gaps  
**intreg** ..... 2, 233

**J**  
 jackknife, variance estimation ..... 165

**K**  
 Kaplan–Meier estimate ..... 5, 93–122, 126, 138–139, 141, 210–212, 230, 342  
 kernel smoothing ..... 113–117, 139–141  
     boundary bias ..... 115–116  
 Kidney data ..... 156–164, 312–316

**L**  
 left-censoring ..... 34  
 left-truncation ..... see delayed entry  
 likelihood displacement values .....  
     ... see influence diagnostics,  
     likelihood displacement values  
 likelihood function  
     for censored data ..... 31, 32  
     for parametric models ..... 245–246  
     for truncated data ..... 35, 36  
     partial ..... see partial likelihood  
     penalized .. see penalized likelihood  
 likelihood-ratio test ..... 159, 279–280,  
     321, 322, 327  
 linearization, variance estimation .. 165  
**linktest** ..... 203–204  
 listwise deletion ..... 169–170  
**LMAX** .. see influence diagnostics, LMAX  
 log-rank test ..... 5, 123–124, 214, 334,  
     337, 345, 347, 361  
     power of ..... 338, 345, 364  
     sample size for ..... see sample size,  
         for the log-rank test  
 log-time metric ..... see AFT metric  
**logistic** ..... 3  
 logistic regression ..... see regression  
     models, logistic  
 loss to follow-up ..... 348–349, 355–358,  
     see withdrawal  
**lrtest** ..... 279–280  
 lung cancer data ..... 166

**M**  
 Mantel–Cox test ..... see log-rank test  
**MAR** ..... 170–172  
 marginal effects ..... 188, 190  
 martingale residuals ..... 214–218, 285  
 maximum likelihood estimation .. 20–21,  
     31–35, 38, 146–147, 231, 245–246  
 maximum pseudolikelihood estimators ..... 165  
**MCAR** ..... 170–172  
 mean survival time  
     definition ..... 16–17  
     estimation ... 91–92, 117, 119–122,  
         284–289  
 median survival time  
     definition ..... 16–17  
     estimation ... 93, 117–119, 284–291  
**mfp** ..... 185, 218  
**mi** ..... 170–175  
     **mi estimate** ..... 170, 173–175  
     **mi impute** ..... 170–173  
     **mi register** ..... 172  
     **mi set** ..... 172  
 Mill’s ratio ..... 7  
 missing at random ..... see MAR  
 missing completely at random ..... see  
     MCAR  
 missing data .. see multiple imputation  
 missing not at random ..... see MNAR  
**MNAR** ..... 171  
 multiple failures ... 59–62, 157–158, 316  
     generation of ..... 12  
 multiple imputation  
     Cox model ..... 169–175  
     multiple-myeloma data .. 336–337, 339,  
         341, 342, 345, 359

**N**  
 Nelson–Aalen estimate ..... 5, 107–113,  
     138–139, 141, 172, 220–222  
 nested models ..... 278–281  
**NHANES I** ..... 166  
**NHEFS** ..... 166

- nonparametric analysis ..... 5, 91–128
  - censoring ..... 96–97
  - truncation ..... 97–101
- null hypothesis .... see hypothesis, null
- number of events ... 334–335, 338, 340, 345–347, 350, 361
- number-at-risk table .. see at-risk table
  
- O**
- OLS regression .. see regression models, OLS
- one-sided test...338, 340–341, 347, 359
- outliers, identification .... see influence diagnostics
- overdispersion.....see heterogeneity
  
- P**
- parametric analysis ..... 2, 229–244
  - censoring ..... 31–32
  - likelihood function ..... 21, 31, 38
  - truncation ..... 35–36
- partial likelihood ..... 146
- penalized likelihood.....161
- percentiles.....10, 117–119
- PH metric
  - definition ..... 20, 232–239
  - relation to AFT metric....241–244
  - specification ..... 233
- piecewise constant model.....
  - ..... see regression models, piecewise constant
- piecewise exponential model.....
  - ..... see regression models, piecewise exponential
- power ..... 335, 337, 338, 345
  - by simulation ..... 358
  - curve.....360, 364
  - definition ..... 337
  - determination ..... 343, 359–360
  - relation to number of events.. 335, 338
- predict** ... 135–145, 155–156, 160–162, 283–295
- primary sampling units ..... 166
- Probability Integral Transform ..... 10
  
- probability weights ..... 164
- product limit estimate ..... see Kaplan–Meier estimate
- proportional hazards regression....see regression models, Cox
- proportional-hazards assumption
  - graphical assessment.....209–212
  - test of.....206–209
- pweights**.....165
  
- Q**
- quantile function ..... 9–12
- Weibull ..... 11
  
- R**
- random effects ..... 156, 160, 199
- random number generator ..... 11
- random-effects models ..... see frailty models, shared
- recurrent events...see multiple failures
- regress**.....1, 233, 347
- regression models
  - censored normal ..... 2, 233
  - conditional logistic ..... 4, 197
  - Cox ..... 4, 6, 21–24, 128–229, 234–238, 241, 254, 345
    - power analysis for ..... 359–360
    - sample size for..see sample size, for Cox model
  - exponential...20, 24, 247–256, 341
    - sample size for..see sample size, for exponential survival
  - generalized gamma ..... 276–278
  - Gompertz ..... 234, 266–269
  - interval ..... 233
  - logistic ..... 3
  - loglogistic ..... 273–275
  - lognormal ..... 269–272
  - OLS ..... 1–2, 21
  - piecewise constant...254, 328, 331
  - piecewise exponential....264, 296, 328–331, 354
  - Weibull.....234, 256–266
  - regression splines ..... 185

relative risk model.....see regression models, Cox  
 repeated failures .. see multiple failures  
**reshape** ..... 41, 45  
 residuals  
     Cox–Snell residuals..219–222, 284,  
         294–295  
     deviance residuals ..... 212, 285  
     efficient score residuals ... 223–228  
     martingale residuals..214–218, 285  
     scaled Schoenfeld residuals...206–  
         209  
     Schoenfeld residuals ..... 206–209  
 restricted mean.....119  
 Reye’s syndrome data, description..213  
 right-censoring ..... 30–31, 52, 57–58,  
     96–97, 245  
 right-truncation.....36  
 risk score ..... see hazard, log relative

**S**

sample size  
     for complex survival study ... 354–  
         359  
     for Cox model ..... 345–348  
     for exponential survival .. 341–345,  
         353–354  
     for the log-rank test.....337–341,  
         352–353  
     notion of ..... 335  
 sampling  
     complex survey ..... 164–166, 198  
         simple random ..... 164  
     scaled Schoenfeld residuals .... 206–209  
 Schoenfeld residuals.....206–209  
 semiparametric analysis .. 3–5, 128–175  
     censoring ..... 31–33  
     likelihood function.....21, 39  
     truncation ..... 35–36  
 significance level ..... 333, 337–338  
**simulate**.....14  
 simulation ..... 12  
 snapshot data.....40–44  
**snapspan** ..... 43–46  
 Somers’  $D$  rank correlation ..... 223

splines, cubic ..... 185  
 stacked cumulative incidence plot..387–  
     388  
 standard error  
     adjusting for clustering .. 157–158,  
         200  
     adjusting for survey design ... 165,  
         167, 168  
     delta method ..... 132–133  
     of cumulative hazard function  
         log-transformed estimate ... 109  
         Nelson–Aalen estimate.....109  
     of dispersion parameter ..... 265  
     of estimated coefficients..132–133,  
         161  
     of hazard ratio ..... 132–133  
     of linear predictor ..... 284  
     of mean survival time ..... 119  
     of median survival time ..... 118  
     of survivor function  
         Kaplan–Meier estimate ..... 96  
         loglog-transformed estimate .. 96  
         robust ..... 158, 279, 325–326  
**stci** ..... 117–122  
**stcompet** ..... 373  
**stcox** ..... 345, 389  
     `efron` ..... 151  
     `exactm` ..... 149, 193  
     `exactp` ..... 150, 193, 197  
     `nohr` ..... 130, 132, 133, 181  
     `shared()` .. 159, 160, 162, 163, 199  
     `strata()` ..... 154, 155, 169, 200  
     `tvc()` ..... 191–193, 204–205  
     `vce()` ..... 158, 168, 198, 381  
**stcoxkm** ..... 209–212  
**stcrreg** ..... 382–388  
     `compete()` ..... 384  
     `noshr` ..... 384  
**stcurve** ... 142, 163, 295–300, 376–378  
     `cif` ..... 384–385  
**stdescribe** ..... 73, 77–78  
**stfill** ..... 73, 80–82  
**stjoin** ..... 195  
**stpepemori** ..... 373–375  
**stphplot** ..... 209–212

- stpower**.....334–336, 338, 348–351, 360–362
  - cox**.....347–349, 351, 359
  - exponential**...342–345, 348–351, 353, 358, 363
    - dialog box of..355–358, 362–363
  - logrank**.....334, 337, 339, 340, 343–345, 347–353, 364
    - table.....361–362
- stratification
  - Cox models .....152–156, 199–200
  - nonparametric tests .....126–128
  - parametric models.....307–310
  - survey data.....see survey data, stratification
- streg**
  - ancillary()** .....301–306
  - anc2()**.....301
  - dist()**.....233
  - frailty()**.....320, 322, 326, 327
  - nohr** .....238, 247, 341
  - strata()**.....307–310
  - time**.....265
  - vce()**.....325
- streset**.....73
- sts**.....91
  - sts generate**.....172
  - sts generate**.....110, 139, 203, 221, 352
  - sts graph**.....102–107, 109, 122, 341
  - sts list**....95, 99, 101–102, 108, 352
  - sts test**.....122–128, 214
- stset**....44, 47–71, 165, 167, 171, 197, 336, 341, 345, 352
  - analysis time .....52–55
  - enter()** .....62–64
  - exit()** .....59–62
  - failure()**.....57–58
  - id()**.....65–66
  - PROBABLE ERROR** .....65, 73–76
  - time0()** .....67–70
  - variables defined by.....55–56
- stssplit**...193–197, 205, 249, 256, 260, 315, 328
- stvary**.....73, 78–80
- subhazard function.....382–383
- subjects-at-risk table .. see at-risk table
- successive difference replication, variance estimation .....165
- survey data
  - clustering .....164, 198
  - Cox model .....164–169
  - stratification .....164, 198
  - variance estimation .....165
- survival data
  - declaring .....see **stset**
  - modeling .....1–6, 91–93
  - power analysis for .....333–364
  - recording .....37–46
  - summaries.....77–78
- survivor function
  - baseline ... 135, 137–139, 143, 155, 161–163
  - conditional.....9, 12, 284
  - definition.....7
  - estimation.....93–101, 135, 155, 161–163, 284, 291–294
  - exponential .....247, 255
  - generalized gamma.....277
  - Gompertz.....267
  - Kaplan–Meier estimate .....see Kaplan–Meier estimate
  - loglogistic.....273
  - lognormal.....270
  - plot .....102–107, 142, 295–300
  - relation to cumulative hazard....8
  - test.....122–128, 214
  - Weibull.....9, 257, 265
- svyset**.....165–166, 198, 200
- svy:** **stcox** .....166–168, 198, 200

**T**

## test

- likelihood-ratio .....see likelihood-ratio test
- log-rank.....see log-rank test

- test, *continued***
  - nonparametric stratification . . . . .
    - . . . . . see stratification, nonparametric tests
  - proportional-hazards assumption.. . . . .
    - . . . . . see proportional-hazards assumption
  - Wald. . . . . see Wald test
  - Wilcoxon . . . . . see Wilcoxon test
  - tied failure times . . . . . 33, 148–151
  - time at risk . . . . . see analysis time
  - time-varying coefficients . . . . . 190
  - time-varying covariates. . . . . . . . .
    - . . . . . 25, 84, 185, 189–197, 231, 241–244, 246, 248, 291, 300
  - tobit** . . . . . 233
  - truncation . . . . . 34
    - interval . . . . . see gaps
    - left . . . . . see delayed entry
    - right . . . . . 36
  - two-sided test . . . . . 338, 340–341
  - type I error
    - probability of. . . . . see significance level
  - type II error
    - probability of. . . . . 337–338, 360
- U**
  - uniform distribution . . . . . 10, 33, 354
- V**
  - variables
    - categorical. . . . . 178–180, 309
    - enduring. . . . . 41, 47, 75
    - indicator. . . . . see categorical variables
    - instantaneous . . . . . 41, 47, 54, 63
- W**
  - Wald test . . . . . 133, 182, 258, 278–280, 303–305, 310, 317, 346, 359
  - Weibull
    - failure times
      - generation of . . . . . 10–12
      - functions of. . . . . 9, 257
      - mean and median of. . . . . 16