

Package: BayesSurveillance (via r-universe)

July 12, 2026

Type Package

Title Bayesian Surveillance Methods for Healthcare Performance Monitoring

Version 0.1.0

Description Provides Bayesian surveillance methods for prospective monitoring of healthcare performance, patient safety, and clinical quality indicators. The package implements beta-binomial monitoring for binary outcomes, gamma-Poisson monitoring for count outcomes, posterior predictive alert probabilities, risk-adjusted surveillance, early-warning signal rules, simulation tools, and graphical summaries. Methods are motivated by risk-adjusted monitoring and healthcare surveillance frameworks including Steiner et al. (2000) [doi:10.1093/biostatistics/1.4.441](https://doi.org/10.1093/biostatistics/1.4.441), Spiegelhalter et al. (2003) [doi:10.1002/sim.1546](https://doi.org/10.1002/sim.1546), Cook et al. (2011) [doi:10.1136/bmjqs.2008.031831](https://doi.org/10.1136/bmjqs.2008.031831), and Neuburger et al. (2017) [doi:10.1136/bmjqs-2016-005667](https://doi.org/10.1136/bmjqs-2016-005667).

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Encoding UTF-8

Roxygen list(markdown = TRUE)

RoxygenNote 7.3.3

Depends R (>= 4.2.0)

Imports stats, ggplot2, pROC, rlang

Suggests testthat (>= 3.0.0),

Config/testthat/edition 3

Repository <https://zerish12.r-universe.dev>

Date/Publication 2026-06-10 08:51:20 UTC

RemoteUrl <https://github.com/zerish12/bayessurveillance>

RemoteRef HEAD

RemoteSha 8035269f37e07deb003e5792e3cf96b0b8a5a174

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alert_probability	<i>Bayesian Alert Probability</i>
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Description

Bayesian Alert Probability

Usage

alert_probability(posterior_probability, threshold = 0.95)

Arguments

- posterior_probability
Numeric vector of posterior probabilities.
- threshold
Alert threshold.

Value

Logical vector indicating alerts.

bayes_factor_alert	<i>Approximate Bayes Factor Alert</i>
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Description

Approximate Bayes Factor Alert

Usage

```
bayes_factor_alert(posterior_prob, prior_prob = 0.5, threshold = 3)
```

Arguments

posterior_prob	Posterior probability of deterioration.
prior_prob	Prior probability of deterioration.
threshold	Bayes factor threshold.

Value

Data frame with Bayes factor and alert.

bayesian_cusum	<i>Bayesian CUSUM Surveillance</i>
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Description

Bayesian CUSUM Surveillance

Usage

```
bayesian_cusum(observed, expected, threshold = 5, reset = TRUE)
```

Arguments

observed	Observed outcomes.
expected	Expected outcomes.
threshold	CUSUM alert threshold.
reset	Logical; reset CUSUM at zero.

Value

A data frame with Bayesian CUSUM statistics.

bayesian_ewma	<i>Bayesian EWMA Surveillance</i>
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Description

Bayesian EWMA Surveillance

Usage

```
bayesian_ewma(observed, expected, lambda = 0.2, threshold = 3)
```

Arguments

observed	Observed outcomes.
expected	Expected outcomes.
lambda	EWMA smoothing parameter.
threshold	Alert threshold.

Value

A data frame with EWMA statistics.

bayesian_funnel_plot	<i>Bayesian Funnel Plot Data</i>
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Description

Bayesian Funnel Plot Data

Usage

```
bayesian_funnel_plot(observed, expected, level = 0.95)
```

Arguments

observed	Observed events.
expected	Expected events.
level	Credible interval level.

Value

A data frame for funnel plot construction.

beta_binomial_monitor *Bayesian Beta-Binomial Monitoring for Binary Outcomes*

Description

Bayesian Beta-Binomial Monitoring for Binary Outcomes

Usage

```
beta_binomial_monitor(y, n, alpha_prior = 1, beta_prior = 1, threshold = 0.95)
```

Arguments

y	Number of observed events at each time point.
n	Number of patients/cases at each time point.
alpha_prior	Prior alpha parameter.
beta_prior	Prior beta parameter.
threshold	Alert threshold for posterior probability.

Value

A data frame with posterior estimates and alert status.

calibration_surveillance
Calibration Summary for Surveillance Predictions

Description

Calibration Summary for Surveillance Predictions

Usage

```
calibration_surveillance(observed, predicted, groups = 10)
```

Arguments

observed	Binary observed outcomes.
predicted	Predicted risks.
groups	Number of calibration groups.

Value

Calibration table.

`create_research_figures`*Create Research-Quality Surveillance Figures*

Description

Saves high-resolution example figures to `man/figures`.

Usage

```
create_research_figures(output_dir = "man/figures")
```

Arguments

`output_dir` Directory where figures are saved.

Value

Invisibly returns saved file paths.

`early_warning_signal` *Early-Warning Signal Rule*

Description

Early-Warning Signal Rule

Usage

```
early_warning_signal(probability, threshold = 0.95, consecutive = 1)
```

Arguments

`probability` Posterior or predictive probability.
`threshold` Alert threshold.
`consecutive` Number of consecutive signals required.

Value

Logical vector indicating alerts.

expected_events	<i>Calculate Expected Events</i>
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Description

Calculate Expected Events

Usage

```
expected_events(risk, group = NULL)
```

Arguments

risk	Predicted patient-level risks.
group	Optional grouping variable.

Value

Expected event totals.

o_minus_e	<i>Observed Minus Expected Statistic</i>
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Description

Observed Minus Expected Statistic

Usage

```
o_minus_e(observed, expected)
```

Arguments

observed	Observed outcomes.
expected	Expected outcomes.

Value

Data frame with O-E statistics.

plot_surveillance	<i>Plot Surveillance Results</i>
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Description

Plot Surveillance Results

Usage

```
plot_surveillance(data, y = "posterior_mean")
```

Arguments

data	Data frame returned by a surveillance function.
y	Column name to plot.

Value

A ggplot object.

poisson_gamma_monitor	<i>Bayesian Gamma-Poisson Monitoring for Count Outcomes</i>
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Description

Bayesian Gamma-Poisson Monitoring for Count Outcomes

Usage

```
poisson_gamma_monitor(  
  y,  
  exposure,  
  shape_prior = 1,  
  rate_prior = 1,  
  threshold = 0.95  
)
```

Arguments

y	Observed counts.
exposure	Exposure or expected counts.
shape_prior	Prior gamma shape.
rate_prior	Prior gamma rate.
threshold	Alert threshold.

Value

A data frame with posterior rate estimates and alerts.

posterior_predictive	<i>Posterior Predictive Probability</i>
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Description

Posterior Predictive Probability

Usage

```
posterior_predictive(  
  observed,  
  predicted,  
  sd_pred,  
  direction = c("higher", "lower")  
)
```

Arguments

observed	Observed value.
predicted	Predicted or expected value.
sd_pred	Predictive standard deviation.
direction	Direction of concern: "higher" or "lower".

Value

Posterior predictive tail probability.

risk_adjusted_cusum	<i>Risk-Adjusted CUSUM</i>
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Description

Risk-Adjusted CUSUM

Usage

```
risk_adjusted_cusum(observed, expected, threshold = 5)
```

Arguments

observed	Observed outcomes.
expected	Expected outcomes.
threshold	Alert threshold.

Value

Risk-adjusted CUSUM results.

risk_adjusted_ewma	<i>Risk-Adjusted EWMA</i>
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Description

Risk-Adjusted EWMA

Usage

```
risk_adjusted_ewma(observed, expected, lambda = 0.2, threshold = 3)
```

Arguments

observed	Observed outcomes.
expected	Expected outcomes.
lambda	EWMA smoothing parameter.
threshold	Alert threshold.

Value

Risk-adjusted EWMA results.

risk_adjusted_monitor	<i>Risk-Adjusted Observed Minus Expected Monitoring</i>
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Description

Risk-Adjusted Observed Minus Expected Monitoring

Usage

```
risk_adjusted_monitor(observed, expected, threshold = 3)
```

Arguments

observed	Observed outcomes.
expected	Expected outcomes.
threshold	Alert threshold for cumulative O-E statistic.

Value

A data frame with O-E statistics and alerts.

roc_surveillance	<i>ROC Evaluation for Surveillance Alerts</i>
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Description

ROC Evaluation for Surveillance Alerts

Usage

```
roc_surveillance(truth, score)
```

Arguments

truth	Binary true outcome.
score	Numeric risk or alert score.

Value

A list containing ROC object and AUC.

simulate_surveillance_data	<i>Simulate Healthcare Surveillance Data</i>
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Description

Simulate Healthcare Surveillance Data

Usage

```
simulate_surveillance_data(  
  n_time = 50,  
  patients_per_time = 100,  
  baseline_risk = 0.05,  
  change_point = NULL,  
  risk_multiplier = 1.5  
)
```

Arguments

n_time	Number of time points.
patients_per_time	Number of patients per time point.
baseline_risk	Baseline event probability.
change_point	Time point where risk changes.
risk_multiplier	Risk multiplier after change point.

Value

A simulated surveillance data frame.

summary.BayesSurveillance
<i>Summarise BayesSurveillance Results</i>

Description

Summarise BayesSurveillance Results

Usage

```
## S3 method for class 'BayesSurveillance'  
summary(object, ...)
```

Arguments

- object A surveillance result data frame.
- ... Additional arguments.

Value

Summary information.

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