

# Package: metaggR (via r-universe)

October 9, 2024

**Type** Package

**Title** Calculate the Knowledge-Weighted Estimate

**Version** 0.3.0

**Description** According to a phenomenon known as ``the wisdom of the crowds," combining point estimates from multiple judges often provides a more accurate aggregate estimate than using a point estimate from a single judge. However, if the judges use shared information in their estimates, the simple average will over-emphasize this common component at the expense of the judges' private information. Asa Palley & Ville Satopää (2021) ``Boosting the Wisdom of Crowds Within a Single Judgment Problem: Selective Averaging Based on Peer Predictions" <[https://papers.ssrn.com/sol3/Papers.cfm?abstract\\_id=3504286](https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=3504286)> proposes a procedure for calculating a weighted average of the judges' individual estimates such that resulting aggregate estimate appropriately combines the judges' collective information within a single estimation problem. The authors use both simulation and data from six experimental studies to illustrate that the weighting procedure outperforms existing averaging-like methods, such as the equally weighted average, trimmed average, and median. This aggregate estimate -- know as ``the knowledge-weighted estimate" -- inputs a) judges' estimates of a continuous outcome (E) and b) predictions of others' average estimate of this outcome (P). In this R-package, the function `knowledge_weighted_estimate(E,P)` implements the knowledge-weighted estimate. Its use is illustrated with a simple stylized example and on real-world experimental data.

**License** GPL-2

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Calorie_Counts	<i>Data: Calorie Counts</i>
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## Description

Palley and Satopää (2021) conducted an experiment where participants were presented with 36 different pictures of food from different restaurants and were asked to estimate the total number of calories in these dishes. Each response involves three steps:

1. **Initial Estimates:** On the first screen the participant was presented with a picture of a meal and asked *How many calories do you think are in this meal?*
2. **Predictions of Others:** On the second screen the participant saw the same picture, was reminded of their previous estimate, and given the statement: *We will be showing this picture to other participants as well. Just as we did with you, we will ask them how many calories they believe are in this meal.* The participant was then asked to predict *How many calories do you think that others will guess on average?*

3. **Final Estimates:** On the third screen the participant saw the same picture again and was asked *After having reflected on others, what is your own final best estimate of the number of calories in this meal?*

### Usage

E\_CALORIES\_INITIAL

E\_CALORIES\_FINAL

P\_CALORIES

THETA\_CALORIES

ID\_CALORIES

### Format

E\_CALORIES\_INITIAL is a list of the judges' initial estimates of the calorie counts in each of the 36 meals. Specifically, the  $j$ th element is a vector of the judges' initial estimates of the calories in the  $j$ th meal.

E\_CALORIES\_FINAL is a list of the judges' final estimates of the calorie counts in each of the 36 meals. Specifically, the  $j$ th element is a vector of the judges' final estimates of the calories in the  $j$ th meal.

P\_CALORIES is a list of the judges' predictions of others. Specifically, the  $j$ th element is a vector of the judges' predictions of other judges' average estimate of the number of calories in the  $j$ th meal.

THETA\_CALORIES is a vector of the true calorie counts in each of the 36 meals. Specifically, the  $j$ th element is the true calorie count in the  $j$ th meal.

ID\_CALORIES is a list of the judges' identification numbers in each of the 36 meals. Specifically, the  $j$ th element is a vector of identification numbers of judges' who gave responses for the  $j$ th meal. These values make it possible to track a judge across questions.

**Remark.** The elements of each list correspond to the same meal. Specifically, the  $j$ th elements of THETA\_CALORIES, E\_CALORIES\_INITIAL, E\_CALORIES\_FINAL, P\_CALORIES, and ID\_CALORIES represent the true calories, initial estimates, final estimates, the predictions of others, and identification numbers of the  $j$ th meal.

### Source

Asa Palley and Ville Satopää. "Boosting the Wisdom of Crowds Within a Single Judgment Problem: Selective Averaging Based on Peer Predictions." [https://papers.ssrn.com/sol3/Papers.cfm?abstract\\_id=3504286](https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=3504286)

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Coin\_Flips

*Data: Coin Flips*

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### Description

Palley and Soll (2019) recruited individuals on Amazon Mechanical Turk and asked them to estimate the proportion of heads in 100 flips of a biased two-sided coin. The probability of heads was unknown to the participants, who were told that it could be anywhere between 1% and 99%. Before responding, each judge was shown a sample of flips that all judges saw (shared information) and another sample of flips that was only seen by that individual or by a subset of judges (private information). Three information structures were considered:

1. **Symmetric:** All judges saw their own unique sample of flips. There are a total of 72 judgment tasks under this condition.
2. **Nested:** Some judges saw only the shared sample while others saw an additional common sample. There are a total of 24 judgment tasks under this condition.
3. **Nested-Symmetric:** Some judges saw only the shared sample while others saw their own additional sample of flips. There are a total of 24 judgment tasks under this condition.

### Usage

E\_COINS\_SYMMETRIC

E\_COINS\_NESTED

E\_COINS\_NESTED\_SYMMETRIC

P\_COINS\_SYMMETRIC

P\_COINS\_NESTED

P\_COINS\_NESTED\_SYMMETRIC

THETA\_COINS\_SYMMETRIC

THETA\_COINS\_NESTED

THETA\_COINS\_NESTED\_SYMMETRIC

ID\_COINS\_SYMMETRIC

ID\_COINS\_NESTED

ID\_COINS\_NESTED\_SYMMETRIC

**Format**

E\_COINS\_SYMMETRIC is a list of the judges' estimates of the proportion of heads in 100 flips of a biased two-sided coin under the Symmetric condition. Specifically, the  $j$ th element is a vector of the judges' estimated proportions in the  $j$ th task.

E\_COINS\_NESTED is a list of the judges' estimates of the proportion of heads in 100 flips of a biased two-sided coin under the Nested condition. Specifically, the  $j$ th element is a vector of the judges' estimated proportions in the  $j$ th task.

E\_COINS\_NESTED\_SYMMETRIC is a list of the judges' estimates of the proportion of heads in 100 flips of a biased two-sided coin under the Nested-Symmetric condition. Specifically, the  $j$ th element is a vector of the judges' estimated proportions in the  $j$ th task.

P\_COINS\_SYMMETRIC is a list of the judges' predictions of other judges' average estimate of the proportion of heads in 100 flips of a biased two-sided coin under the Symmetric condition. Specifically, the  $j$ th element is a vector of the judges' predictions of others in the  $j$ th task.

P\_COINS\_NESTED is a list of the judges' predictions of other judges' average estimate of the proportion of heads in 100 flips of a biased two-sided coin under the Nested condition. Specifically, the  $j$ th element is a vector of the judges' predictions of others in the  $j$ th task.

P\_COINS\_NESTED\_SYMMETRIC is a list of the judges' predictions of other judges' average estimate of the proportion of heads in 100 flips of a biased two-sided coin under the Nested-Symmetric condition. Specifically, the  $j$ th element is a vector of the judges' predictions of others in the  $j$ th task.

THETA\_COINS\_SYMMETRIC is a vector of the actual proportions of heads under the Symmetric condition. Specifically, the  $j$ th element is the actual proportion of heads in the  $j$ th task.

THETA\_COINS\_NESTED is a vector of the actual proportions of heads under the Nested condition. Specifically, the  $j$ th element is the actual proportion of heads in the  $j$ th task.

THETA\_COINS\_NESTED\_SYMMETRIC is a vector of the actual proportions of heads under the Nested-Symmetric condition. Specifically, the  $j$ th element is the actual proportion of heads in the  $j$ th task.

ID\_COINS\_SYMMETRIC is a list of the judges' identification numbers in the judgment tasks under the Symmetric condition. Specifically, the  $j$ th element is a vector of identification numbers of judges' who participated in estimating the proportion of heads in the  $j$ th task. These values make it possible to track a judge across judgment tasks.

ID\_COINS\_NESTED is a list of the judges' identification numbers in the judgment tasks under the Nested condition. Specifically, the  $j$ th element is a vector of identification numbers of judges' who participated in estimating the proportion of heads in the  $j$ th task. These values make it possible to track a judge across judgment tasks.

ID\_COINS\_NESTED\_SYMMETRIC is a list of the judges' identification numbers in the judgment tasks under the Nested-Symmetric condition. Specifically, the  $j$ th element is a vector of identification numbers of judges' who participated in estimating the proportion of heads in the  $j$ th task. These values make it possible to track a judge across judgment tasks.

**Remark.** The elements of each list correspond to the same meal. For instance, the  $j$ th elements of THETA\_COINS\_SYMMETRIC, E\_COINS\_SYMMETRIC, P\_COINS\_SYMMETRIC, and ID\_COINS\_SYMMETRIC represent the true proportion, estimates, the predictions of others, and identification numbers associated with the  $j$ th task under the Symmetric condition.

### Source

Asa Palley and Jack Soll. "Extracting the Wisdom of Crowds When Information Is Shared."  
doi: [10.1287/mnsc.2018.3047](https://doi.org/10.1287/mnsc.2018.3047)

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General\_Knowledge\_Statements

*Data: General Knowledge Statements*

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### Description

Martinie et al. (2020) recruited individuals on Amazon Mechanical Turk and asked them to provide subjective probabilities of whether various general science statements from U.S. grade school were true or false. Problems were classified into five levels of difficulty, with level 1 being the easiest and level 5 being the most difficult. For example, one easy problem (level 1) presented the statement *Omnivores only eat meat*, whereas one difficult problem (level 5) presented the statement *Sound waves and electromagnetic waves are examples of longitudinal waves*.

The full data have been split into 5 groups based on the difficulty the questions.

1. E\_GK\_1 to E\_GK\_5: A list of the judges' estimates of the probabilities that the statements are true.
2. P\_GK\_1 to P\_GK\_5: A list of the judges' predictions of others' average probability estimates.
3. ID\_GK\_1 to ID\_GK\_5: A list of the judges' identification numbers. These values make it possible to track a judge across different judgment tasks.
4. THETA\_GK\_1 to THETA\_GK\_5: Actual outcomes showing whether the statements are true (1) or not (0).

The final number in the name of the data set indicates the associated difficulty level. For instance, E\_GK\_5 holds the probability estimates of the most difficult questions, THETA\_GK\_1 holds actual outcomes for the easiest questions, and so on. The elements of each list correspond to the same question. For instance, the  $j$ th elements of THETA\_GK\_1, E\_GK\_1, P\_GK\_1, and ID\_GK\_1 give the true outcome, vector of probability estimates, vector of predictions of other judges' average probability estimates, and vector of identification numbers of the  $j$ th question with difficulty level 1.

### Usage

E\_GK\_1

E\_GK\_2

E\_GK\_3

E\_GK\_4

E\_GK\_5

P\_GK\_1

P\_GK\_2

P\_GK\_3

P\_GK\_4

P\_GK\_5

THETA\_GK\_1

THETA\_GK\_2

THETA\_GK\_3

THETA\_GK\_4

THETA\_GK\_5

ID\_GK\_1

ID\_GK\_2

ID\_GK\_3

ID\_GK\_4

ID\_GK\_5

**Format**

E\_GK\_1 holds judges' estimates of the outcome. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 1. The  $j$ th element is a vector of the judges' estimates of the probability that the  $j$ th statement is true.

E\_GK\_2 holds judges' estimates of the outcome. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 2. The  $j$ th element is a vector of the judges' estimates of the probability that the  $j$ th statement is true.

E\_GK\_3 holds judges' estimates of the outcome. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 3. The  $j$ th element is a vector of the judges' estimates of the probability that the  $j$ th statement is true.

E\_GK\_4 holds judges' estimates of the outcome. Specifically, it holds a list of 100 elements, one

per general knowledge statement with difficulty level 4. The  $j$ th element is a vector of the judges' estimates of the probability that the  $j$ th statement is true.

E\_GK\_5 holds judges' estimates of the outcome. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 5. The  $j$ th element is a vector of the judges' estimates of the probability that the  $j$ th statement is true.

P\_GK\_1 holds judges' predictions of other judges' average estimate of the outcome. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 1. The  $j$ th element is a vector of the judges' predictions of others' average estimate of the probability that the  $j$ th statement is true.

P\_GK\_2 holds judges' predictions of other judges' average estimate of the outcome. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 2. The  $j$ th element is a vector of the judges' predictions of others' average estimate of the probability that the  $j$ th statement is true.

P\_GK\_3 holds judges' predictions of other judges' average estimate of the outcome. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 3. The  $j$ th element is a vector of the judges' predictions of others' average estimate of the probability that the  $j$ th statement is true.

P\_GK\_4 holds judges' predictions of other judges' average estimate of the outcome. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 4. The  $j$ th element is a vector of the judges' predictions of others' average estimate of the probability that the  $j$ th statement is true.

P\_GK\_5 holds judges' predictions of other judges' average estimate of the outcome. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 5. The  $j$ th element is a vector of the judges' predictions of others' average estimate of the probability that the  $j$ th statement is true.

THETA\_GK\_1 is a vector of 100 elements, one per general knowledge statement with difficulty level 1. The  $j$ th element shows whether the  $j$ th general statement is true (1) or false (0).

THETA\_GK\_2 is a vector of 100 elements, one per general knowledge statement with difficulty level 2. The  $j$ th element shows whether the  $j$ th general statement is true (1) or false (0).

THETA\_GK\_3 is a vector of 100 elements, one per general knowledge statement with difficulty level 3. The  $j$ th element shows whether the  $j$ th general statement is true (1) or false (0).

THETA\_GK\_4 is a vector of 100 elements, one per general knowledge statement with difficulty level 4. The  $j$ th element shows whether the  $j$ th general statement is true (1) or false (0).

THETA\_GK\_5 is a vector of 100 elements, one per general knowledge statement with difficulty level 5. The  $j$ th element shows whether the  $j$ th general statement is true (1) or false (0).

ID\_GK\_1 holds judges' identification numbers. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 1. The  $j$ th element is a vector of numbers identifying the judges who provides responses for the  $j$ th statement. These values make it possible to track a judge across questions.



ID\_GK\_2 holds judges' identification numbers. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 2. The  $j$ th element is a vector of numbers identifying the judges who provides responses for the  $j$ th statement. These values make it possible to track a judge across questions.

ID\_GK\_3 holds judges' identification numbers. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 3. The  $j$ th element is a vector of numbers identifying the judges who provides responses for the  $j$ th statement. These values make it possible to track a judge across questions.

ID\_GK\_4 holds judges' identification numbers. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 4. The  $j$ th element is a vector of numbers identifying the judges who provides responses for the  $j$ th statement. These values make it possible to track a judge across questions.

ID\_GK\_5 holds judges' identification numbers. Specifically, it holds a list of 100 elements, one per general knowledge statement with difficulty level 5. The  $j$ th element is a vector of numbers identifying the judges who provides responses for the  $j$ th statement. These values make it possible to track a judge across questions.

### Source

Marcellin Martinie, Tom Wilkenin, and Piers D. L. Howe. "Using meta-predictions to identify experts in the crowd when past performance is unknown" <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0232058>

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get\_influence\_scores *Calculate the Influence Scores*

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### Description

This function computes and plots the influence scores described in *Palley & Satopää (2021): Boosting the Wisdom of Crowds Within a Single Judgment Problem: Weighted Averaging Based on Peer Predictions*. The current version of the paper is available at [https://papers.ssrn.com/sol3/Papers.cfm?abstract\\_id=3504286](https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=3504286)

### Usage

```
get_influence_scores(E, P, plotIt = FALSE, cutoff = 7/2)
```

### Arguments

E	Vector of $J \geq 6$ estimates of the outcome.
P	Vector of $J \geq 6$ predictions of others. The values must be in the same order as the estimates in E. Specifically, for all $j = 1, \dots, J$ , $E[j]$ and $P[j]$ give the $j$ th judge's estimate and prediction of others, respectively.
plotIt	A boolean value. If TRUE, then the function call produces two side-by-side plots:

1. Left plot: This is a scatter plot of the judges' estimates against the judges' implied predictions of others. This plot includes regression lines both with (solid black) and without (dashed red) the exceptionally influential judges. All exceptionally influential judges are shown in red. The knowledge-weighted estimate is shown both with (black square) and without (red circle) exceptionally influential judges.
2. Right plot: This shows the judges' influence scores. All exceptionally influential judges are shown in red. The dashed horizontal line represents the threshold, defined as the user-defined `cutoff` value  $\times$  the interquartile range of all influence scores.

For more information on the plots, see the Electronic Companion of *Palley & Satopää (2021): Boosting the Wisdom of Crowds Within a Single Judgment Problem: Weighted Averaging Based on Peer Predictions* at [https://papers.ssrn.com/sol3/Papers.cfm?abstract\\_id=3504286](https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=3504286).

`cutoff` A positive scalar describing the cutoff value for the outlier-robust knowledge-weighted estimate. The outlier-robust version calculates the influence scores for all judges. Each influence score is then compared against `cutoff`  $\times$  the interquartile range of all influence scores. If a judge's influence score is above this quantity, then that judge is deemed exceptionally influential. This parameter only has an effect if `plotIt` has been set to TRUE.

## Value

$J$  vector of influence scores. Intuitively, the influence score of a judge represents the amount by which the knowledge-weighted estimate would change if that judge was removed from the crowd. Judges with an exceptionally high influence should be inspected. As a default cutoff value, the authors recommend  $7/2$  times the interquartile range of the individual judges' influence scores.

## Examples

```
# Illustration on the Three Gorges Dam Example in Palley & Satopää (2021):

# The original example with 6 judges is augmented with a 7th judge with an extreme response.
# Judges' estimates:
E2 = c(50, 134, 206, 290, 326, 374, 1000)
# Judges' predictions of others
P2 = c(26, 92, 116, 218, 218, 206, 400)

# The influence score of the 7th judge is much higher than the other judges' scores.
# This judge's response should be inspected and potentially excluded from
# the final knowledge-weighted estimate.
get_influence_scores(E2,P2)
```

**Description**

Palley and Soll (2019) recruited volunteers passing through the student union to estimate the total price of 10 different bundles of nonperishable grocery items. Examples of items include a bottle of 190 Lil Critters Gummy Vites Sour Complete multivitamins (\$10.93), a 5-oz. can of Wild Planet wild albacore tuna in extra virgin olive oil (\$4.19), and an 11 oz. bag of Stauffer's Animal Crackers (\$1.00).

**Usage**

E\_GROCERIES

P\_GROCERIES

THETA\_GROCERIES

ID\_GROCERIES

**Format**

E\_GROCERIES is a list of the judges' estimates of the prices in each of the 10 bundles of groceries. Specifically, the  $j$ th element is a vector of the judges' estimates of the price of the  $j$ th bundle.

P\_GROCERIES is a list of the judges' predictions of others. Specifically, the  $j$ th element is a vector of the judges' predictions of other judges' average estimate of the price of the  $j$ th bundle.

THETA\_GROCERIES is a vector of the prices of the 10 bundles of groceries. Specifically, the  $j$ th element is the actual price of the  $j$ th bundle.

ID\_GROCERIES is a list of the judges' identification numbers in the judgment tasks. Specifically, the  $j$ th element is a vector of identification numbers of judges' who participated in estimating the price of the  $j$ th bundle. These values make it possible to track a judge across judgment tasks.

**Remark.** The elements of each list correspond to the same judgment task. Specifically, the  $j$ th elements of THETA\_GROCERIES, E\_GROCERIES, P\_GROCERIES, and ID\_GROCERIES represent the true price, estimates, the predictions of others, and identification numbers associated with the  $j$ th bundle.

**Source**

Asa Palley and Jack Soll. "Extracting the Wisdom of Crowds When Information Is Shared." doi: [10.1287/mnsc.2018.3047](https://doi.org/10.1287/mnsc.2018.3047)

---

knowledge\_gap                      *Calculate the Knowledge Gap*

---

### Description

This function computes the knowledge gap described in *Palley & Satopää (2021): Boosting the Wisdom of Crowds Within a Single Judgment Problem: Weighted Averaging Based on Peer Predictions*. The current version of the paper is available at [https://papers.ssrn.com/sol3/Papers.cfm?abstract\\_id=3504286](https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=3504286)

### Usage

```
knowledge_gap(E, P, alpha)
```

### Arguments

E	Vector of $J \geq 5$ estimates of the outcome.
P	Vector of $J \geq 5$ predictions of others. The values must be in the same order as the estimates in E. Specifically, for all $j = 1, \dots, J$ , E[j] and P[j] give the $j$ th judge's estimate and prediction of others, respectively.
alpha	Vector of $J \geq 5$ weights. The alpha[j] element is the weight assigned to E[j]. The weights can be any values in the real line as long as they sum to 1.

### Value

A singular value representing the knowledge gap. This represents the expected distance between the weighted combination of the judges' estimates, where the weights have been given by alpha, and the optimal aggregate estimate called the Global Posterior Expectation (GPE).

### Examples

```
# Illustration on the Three Gorges Dam Example in Palley & Satopää (2021):

# Judges' estimates:
E = c(50, 134, 206, 290, 326, 374)
# Judges' predictions of others
P = c(26, 92, 116, 218, 218, 206)

# First find the knowledge-weights that minimize the knowledge gap:
alpha = knowledge_weights(E,P)
knowledge_gap(E,P, alpha)

# Small perturbations increase the knowledge gap:
alpha_per = alpha
alpha_per[1] = alpha_per[1] + 0.001
alpha_per[2] = alpha_per[2] - 0.001
knowledge_gap(E,P, alpha_per)
```

---

knowledge\_weighted\_estimate  
*Knowledge-Weighted Estimate*

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## Description

This function computes the knowledge-weighted estimate from *Palley & Satopää (2021): Boosting the Wisdom of Crowds Within a Single Judgment Problem: Weighted Averaging Based on Peer Predictions*. The current version of the paper is available at [https://papers.ssrn.com/sol3/Papers.cfm?abstract\\_id=3504286](https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=3504286).

## Usage

```
knowledge_weighted_estimate(  
  E,  
  P,  
  cutoff = 7/2,  
  remove_inf = FALSE,  
  no_inf_check = FALSE  
)
```

## Arguments

- |              |   |
|--------------|---|
| E            | Vector of $J$ estimates of the outcome. If influence scores are calculated (i.e., <code>no_inf_check</code> is <code>FALSE</code> ), then the function call requires $J \geq 6$ ; else the knowledge-weighted estimate requires at least $J \geq 5$ judges.   |
| P            | Vector of $J$ predictions of others. The values must be in the same order as the estimates in E. Specifically, for all $j = 1, \dots, J$ , <code>E[j]</code> and <code>P[j]</code> give the $j$ th judge's estimate and prediction of others, respectively.   |
| cutoff       | A positive scalar describing the cutoff value for the outlier-robust knowledge-weighted estimate. The outlier-robust version calculates the influence scores for all judges (see <code>get_influence_scores</code> function). Each influence score is then compared against <code>cutoff</code> x the interquartile range of all influence scores. If a judge's influence score is above this quantity, then that judge is deemed exceptionally influential. By default, the influence scores are checked and a warning is given if an exceptionally influential judge is found. To turn off this feature, set <code>no_inf_check</code> to <code>TRUE</code> . |
| remove_inf   | A boolean value. If <code>TRUE</code> , then all exceptionally influential judges are removed before the knowledge-weighted estimate is calculated. If <code>FALSE</code> , then the knowledge-weighted estimate is calculated based on the responses of all $J$ judges.  |
| no_inf_check | A boolean value. If <code>TRUE</code> , then the influence scores are not calculated at any point. This can be helpful to speed up calculations. However, the authors recommend checking for influential judges each time the knowledge weighted estimate is applied.   |

**Value**

A singular value representing the knowledge-weighted estimate

**Examples**

```
# Illustration on the Three Gorges Dam Example in Palley & Satopää (2021):

# Judges' estimates:
E1 = c(50, 134, 206, 290, 326, 374)
# Judges' predictions of others
P1 = c(26, 92, 116, 218, 218, 206)

# Knowledge-weighted estimate is 329.305
knowledge_weighted_estimate(E1,P1)

# The original example with 6 judges is augmented with a 7th judge with an extreme response.
# Judges' estimates:
E2 = c(50, 134, 206, 290, 326, 374, 1000)
# Judges' predictions of others
P2 = c(26, 92, 116, 218, 218, 206, 400)

# Knowledge-weighted estimate is 630.0491
# The function call warns of exceptionally influential judges.
knowledge_weighted_estimate(E2,P2)

# Calculate the knowledge-weighted estimate without influence score checking.
knowledge_weighted_estimate(E2,P2, no_inf_check = TRUE)

# Calculate the influence scores of the judges.
# This reveals that the 7th judge is highly influential.
get_influence_scores(E2,P2)

# Calculate the outlier-robust knowledge-weighted estimate.
# This removes all highly influential judges, namely judge 7 in this simple example,
# and returns the knowledge-weighted estimate of the remaining judges' estimates.
# This estimate aligns with the original 329.305
knowledge_weighted_estimate(E2,P2, remove_inf = TRUE)
```

---

knowledge\_weights

*Calculate the Weights that Minimize the Knowledge Gap*

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**Description**

This function computes the weighted used in the knowledge-weighted estimate of *Palley & Satopää (2021): Boosting the Wisdom of Crowds Within a Single Judgment Problem: Weighted Averaging Based on Peer Predictions*. The current version of the paper is available at [https://papers.ssrn.com/sol3/Papers.cfm?abstract\\_id=3504286](https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=3504286)

**Usage**

```
knowledge_weights(E, P)
```

**Arguments**

E                    Vector of  $J \geq 5$  estimates of the outcome.  
P                    Vector of  $J \geq 5$  predictions of others. The values must be in the same order as the estimates in E. Specifically, for all  $j = 1, \dots, J$ , E[j] and P[j] give the  $j$ th judge's estimate and prediction of others, respectively.

**Value**

$J \times 1$  vector of weights that minimizes the knowledge gap and lead to the knowledge-weighted estimate.

**Examples**

```
# Illustration on the Three Gorges Dam Example in Palley & Satopää (2021):

# Judges' estimates:
E = c(50, 134, 206, 290, 326, 374)
# Judges' predictions of others
P = c(26, 92, 116, 218, 218, 206)

# Weights used in the knowledge-weighted estimate:
alpha = knowledge_weights(E,P)

# Knowledge-weighted estimate is 329.3266
t(alpha) %*% E

# Alternatively, the knowledge-weighted estimate can be calculated using
# the knowledge_weighted_estimate() function. This returns 329.305, which
# is slightly different from the above result. The difference arises because
# knowledge_weighted_estimate() improves stability by standardizing the
# judges' responses before aggregating them.
knowledge_weighted_estimate(E,P)
```

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NCAA\_Basketball

*Data: NCAA Basketball*


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**Description**

Palley and Soll (2019) recruited participants through ClearVoice Research and Amazon Mechanical Turk to estimate the probability that one team or the other would win various games in the 2014, 2015, and 2016 NCAA Division I Men's Basketball Tournaments. The responses for the Round of 64 games and Round of 16 games are treated separately because the Round of 64 games happen at the start of the tournament and often involve heavily mismatched teams (e.g., a 1 seed versus a 16 seed) while Round of 16 games typically involve more evenly matched teams, with implied betting market probabilities closer to 50%.

**Usage**

E\_NCAA\_R64

E\_NCAA\_R16

P\_NCAA\_R64

P\_NCAA\_R16

THETA\_NCAA\_R64

THETA\_NCAA\_R16

ID\_NCAA\_R64

ID\_NCAA\_R16

**Format**

E\_NCAA\_R64 is a list of the judges' estimates of the probability that the given team wins in Round of 64. Specifically, the  $j$ th element is a vector of the judges' estimated probability in the  $j$ th game.

E\_NCAA\_R16 is a list of the judges' estimates of the probability that the given team wins in Round of 16. Specifically, the  $j$ th element is a vector of the judges' estimated probability in the  $j$ th game.

P\_NCAA\_R64 is a list of the judges' predictions of other judges' average probability that the given team wins in Round of 64. Specifically, the  $j$ th element is a vector of the judges' predictions of the other judges' average probabilities in the  $j$ th game.

P\_NCAA\_R16 is a list of the judges' predictions of other judges' average probability that the given team wins in Round of 16. Specifically, the  $j$ th element is a vector of the judges' predictions of the other judges' average probabilities in the  $j$ th game.

THETA\_NCAA\_R64 is a vector of the actual outcomes of the games in the Round of 64. Specifically, the  $j$ th element is the actual outcome of  $j$ th game in Round of 64.

THETA\_NCAA\_R16 is a vector of the actual outcomes of the games in the Round of 16. Specifically, the  $j$ th element is the actual outcome of  $j$ th game in Round of 16.

ID\_NCAA\_R64 is a list of the judges' identification numbers in the judgment tasks associated with the Round of 64 games. Specifically, the  $j$ th element is a vector of identification numbers of judges' who participated in estimating the probability of a given team winning the  $j$ th game of Round of 64. These values make it possible to track a judge across judgment tasks.

ID\_NCAA\_R16 is a list of the judges' identification numbers in the judgment tasks associated with the Round of 16 games. Specifically, the  $j$ th element is a vector of identification numbers of judges' who participated in estimating the probability of a given team winning the  $j$ th game of Round of 16. These values make it possible to track a judge across judgment tasks.



**Remark.** The elements of each list correspond to the same game. Specifically, the  $j$ th elements of THETA\_NCAA\_R16, E\_NCAA\_R16, P\_NCAA\_R16, and ID\_NCAA\_R16 represent the true outcome, estimates, the predictions of others, and identification numbers associated with the  $j$ th game in the Round of 16.

**Source**

Asa Palley and Jack Soll. "Extracting the Wisdom of Crowds When Information Is Shared."  
doi: [10.1287/mnsc.2018.3047](https://doi.org/10.1287/mnsc.2018.3047)

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