Package: IFFuzzyStats (via r-universe)

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Type Package

Title Intuitionistic Fuzzy Statistics

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Description Provides constructors and arithmetic for intuitionistic fuzzy values (intuitionistic fuzzy value, IFV) for intuitionistic fuzzy sets (Atanassov (1986) <doi:10.1016/S0165-0114(86)80034-3>), including aggregation operators of Xu (2007) <doi:10.1109/TFUZZ.2006.890678> and Xu and Yager (2006) <doi:10.1080/03081070600574353>: intuitionistic fuzzy weighted averaging (IFWA), intuitionistic fuzzy weighted geometric (IFWG), intuitionistic fuzzy ordered weighted averaging (IFOWA), intuitionistic fuzzy ordered weighted geometric (IFOWG), intuitionistic fuzzy hybrid averaging (IFHA), intuitionistic fuzzy hybrid geometric (IFHG), and Einstein operators; entropy (Szmidt and Kacprzyk (2000) <doi:10.1016/S0165-0114(98)00402-3>; Vlachos and Sergiadis (2007) <doi:10.1016/j.patrec.2006.07.004>) and distance and similarity measures, including Ye (2011) <doi:10.1016/j.mcm.2010.07.022> cosine similarity and Hamming, Euclidean and Hausdorff distances; intuitionistic fuzzy c-means and k-means clustering; approximate reasoning via compositional inference; and multi-criteria decision support via intuitionistic fuzzy Technique for Order of Preference by Similarity to Ideal Solution (IF-TOPSIS) (Boran et al. (2009) <doi:10.1016/j.eswa.2009.03.039>) and score ranking. All computations use only base R with fully vectorised implementations.

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`if_add` *Intuitionistic fuzzy arithmetic (Xu operations)*

Description

Addition, multiplication, scalar multiplication and power for IFVs, following Xu (2007): for $a = (\mu_a, \nu_a)$, $b = (\mu_b, \nu_b)$, $\lambda > 0$:

$$a \oplus b = (\mu_a + \mu_b - \mu_a\mu_b,\ \nu_a\nu_b)$$

$$a \otimes b = (\mu_a\mu_b,\ \nu_a + \nu_b - \nu_a\nu_b)$$

$$\lambda a = (1 - (1 - \mu_a)^\lambda,\ \nu_a^\lambda)$$

$$a^\lambda = (\mu_a^\lambda,\ 1 - (1 - \nu_a)^\lambda)$$

Usage

```
if_add(a, b)

if_mul(a, b)

if_scalar_mul(lambda, a)

if_pow(a, lambda)

if_einstein_add(a, b)

if_einstein_mul(a, b)

if_einstein_scalar_mul(lambda, a)

if_einstein_pow(a, lambda)
```

Arguments

`a`, `b`	objects coercible to `ifv` (recycled to common length).
`lambda`	positive numeric scalar or vector.

Details

Einstein variants use Einstein t-norm / t-conorm:

$$a \oplus_\epsilon b = \left(\frac{\mu_a + \mu_b}{1 + \mu_a\mu_b}, \frac{\nu_a\nu_b}{1 + (1 - \nu_a)(1 - \nu_b)}\right)$$

$$a \otimes_\epsilon b = \left(\frac{\mu_a\mu_b}{1 + (1 - \mu_a)(1 - \mu_b)}, \frac{\nu_a + \nu_b}{1 + \nu_a\nu_b}\right)$$

Value

An `ifv` object.

References

Xu, Z. (2007). Intuitionistic fuzzy aggregation operators. *IEEE Trans. Fuzzy Systems*, 15(6), 1179-1187.

Examples

```
a <- ifv(0.6, 0.3); b <- ifv(0.5, 0.3)
if_add(a, b); if_mul(a, b); if_scalar_mul(2, a); if_pow(a, 2)
```

`if_aggregate_matrix` *Aggregate rows of an IF decision matrix*

Description

Aggregate rows of an IF decision matrix

Usage

```
if_aggregate_matrix(mat, w, ncrit, fun = ifwa)
```

Arguments

`mat`	`ifv` with one row per alternative-criterion cell, or a list of per-alternative `ifv` vectors; see examples.
`w`	criterion weights.
`ncrit`	number of criteria (columns); rows of `mat` are `nalt` blocks of `ncrit` in row-major order.
`fun`	aggregation function, e.g. `ifwa`, `ifwg`.

Value

`ifv` vector (one fused value per alternative).

Examples

```
m <- ifv(c(0.6, 0.5, 0.7, 0.4), c(0.2, 0.3, 0.1, 0.4))
# 2 alternatives x 2 criteria stored row-wise:
if_aggregate_matrix(m, w = c(0.6, 0.4), ncrit = 2, fun = ifwa)
```

if_check — *Validate IFVs*

Description

Validate IFVs

Usage

```
if_check(x, tol = 1e-09)
```

Arguments

x	object coercible to ifv.
tol	numeric tolerance.

Value

invisibly TRUE; errors if invalid.

if_comp — *Complement of an IFV*

Description

Complement of an IFV

Usage

```
if_comp(x)
```

Arguments

x	object coercible to ifv.

Value

ifv with mu/nu swapped.

Examples

```
if_comp(ifv(0.6, 0.2))
```

`if_compose` *Intuitionistic fuzzy relations: composition and inference*

Description

Max-min / max-product composition of IF relations and the compositional rule of inference (Zadeh, 1973, extended to IFS).

Usage

```
if_compose(R, S, nx, ny, nz, op = c("maxmin", "maxprod"))
```

Arguments

`R`, `S`	matrices (or data.frames) of IFVs stored as `ifv` objects with `nrow = nx*ny` in row-major order, or numeric matrices of membership values with matching non-membership matrices `R_nu`, `S_nu`. Simpler: pass `ifv` vectors plus dimensions.
`nx`, `ny`, `nz`	dimensions.
`op`	`"maxmin"` or `"maxprod"`.

Details

An IF relation on $X \times Y$ is a matrix of IFVs. Composition $R \circ S$ on $X \times Z$ is:

$$(R \circ S)(x, z) = \bigoplus_y (R(x, y) \otimes S(y, z))$$

where $\oplus, \otimes$ are max-min (default) or max-product. Membership composes with t-conorm over t-norm, non-membership with the dual operation (min over max for max-min; product-sum dual for max-product).

Value

An `ifv` vector of length `nx*nz` (row-major).

Examples

```
R <- ifv(c(0.6, 0.3, 0.8, 0.2), c(0.2, 0.5, 0.1, 0.6))  # 2x2
S <- ifv(c(0.5, 0.7, 0.4, 0.9), c(0.3, 0.1, 0.4, 0.0))  # 2x2
if_compose(R, S, nx = 2, ny = 2, nz = 2)
```

if_defuzzify — *Defuzzify IFVs to crisp scores*

Description

Defuzzify IFVs to crisp scores

Usage

```
if_defuzzify(x, method = c("score", "expected", "accuracy", "mu"))
```

Arguments

x	object coercible to `ifv`.
method	`"score"` ($\mu - \nu$), `"accuracy"` ($\mu + \nu$), `"expected"` ($\mu + \pi/2$), or `"mu"` (membership only).

Value

numeric vector.

Examples

```
if_defuzzify(ifv(c(0.6, 0.5), c(0.3, 0.2)))
```

if_dist — *Distances between intuitionistic fuzzy sets*

Description

For sets A, B of equal cardinality n with elements $(\mu_i^A, \nu_i^A, \pi_i^A)$, $(\mu_i^B, \nu_i^B, \pi_i^B)$:

Usage

```
if_dist(
  a,
  b,
  method = c("hamming", "euclidean", "hausdorff", "ye", "ye_cosine", "park"),
  w = NULL
)
```

Arguments

a, b	objects coercible to `ifv` of common length.
method	distance name (partial matching allowed).
w	optional element weights.

Details

- "hamming" (normalised Szmidt-Kacprzyk): $\frac{1}{2n}\sum(|\Delta\mu| + |\Delta\nu| + |\Delta\pi|)$.
- "euclidean" (normalised): $\sqrt{\frac{1}{2n}\sum((\Delta\mu)^2 + (\Delta\nu)^2 + (\Delta\pi)^2)}$.
- "hausdorff" (normalised Hamming-Hausdorff): $\frac{1}{n}\sum \max(|\Delta\mu|, |\Delta\nu|, |\Delta\pi|)$.
- "ye" (Ye's modified Hamming-type distance): $\sum w_i \frac{|\Delta\mu_i|+|\Delta\nu_i|}{|\Delta\mu_i|+|\Delta\nu_i|+\min(\mu_i^A,\mu_i^B)+\min(\nu_i^A,\nu_i^B)+\min(\pi_i^A,\pi_i^B)+1}$.
- "ye_cosine": $1 - S_C$ where S_C is Ye's cosine similarity (see if_sim).
- "park": normalised Hamming including hesitation (same numeric form as "hamming" here).

Weighted versions: pass w (sums to 1) to weight elements: $D_w = \sum w_i d_i$ with per-element d_i.

Value

numeric scalar distance.

References

Szmidt, E. & Kacprzyk, J. (2000). Distances between intuitionistic fuzzy sets. *Fuzzy Sets and Systems*, 114(3), 505-518.

Ye, J. (2012). Multicriteria decision-making method using the Dice similarity measure based on the reduct intuitionistic fuzzy sets of interval-valued intuitionistic fuzzy sets. *Applied Mathematical Modelling*, 36(9), 4466-4472.

Examples

```
a <- ifv(c(0.6, 0.5), c(0.3, 0.2)); b <- ifv(c(0.5, 0.4), c(0.3, 0.3))
if_dist(a, b, "hamming"); if_dist(a, b, "euclidean"); if_dist(a, b, "hausdorff")
```

---

if_entropy *Entropy of intuitionistic fuzzy sets*

Description

Fuzziness / intuitionism of a set $A = \{a_1, \ldots, a_n\}$. All measures lie in $[0, 1]$ with larger = more fuzzy.

Usage

```
if_entropy(x, method = c("burillo", "szmidt", "vlachos", "zeng_li"))
```

Arguments

x	object coercible to ifv (the whole set).
method	one of "burillo", "szmidt", "vlachos", "zeng_li" (partial matching allowed).

Details

- "burillo" (Burillo & Bustince, 1996): $E = \frac{1}{n}\sum \pi_i$.
- "szmidt" (Szmidt & Kacprzyk, 2001): $E = \frac{1}{n}\sum \frac{\min(\mu_i,\nu_i)+\pi_i}{\max(\mu_i,\nu_i)+\pi_i}$ (define $0/0 := 1$).
- "vlachos" (Vlachos & Sergiadis, 2007; De Luca-Termini extension): $E = \frac{-1}{n\ln 2}\sum[\mu_i \ln \mu_i + \nu_i \ln \nu_i - (1-\pi_i)\ln(1-\pi_i) - \pi_i \ln 2]$, with $0 \ln 0 := 0$.
- "zeng_li" (Zeng & Li, 2006): $E = \frac{1}{n}\sum(1 - |\mu_i - \nu_i|)$.

Value

numeric scalar in $[0, 1]$.

References

Burillo, P. & Bustince, H. (1996). Entropy on intuitionistic fuzzy sets and on interval-valued fuzzy sets. *Fuzzy Sets and Systems*, 78(3), 305-316.

Szmidt, E. & Kacprzyk, J. (2001). Entropy for intuitionistic fuzzy sets. *Fuzzy Sets and Systems*, 118(3), 467-477.

Vlachos, I. K. & Sergiadis, G. D. (2007). Intuitionistic fuzzy information - applications to pattern recognition. *Pattern Recognition Letters*, 28(2), 197-206.

Zeng, L. & Li, H. (2006). Normalized distance, similarity measure, intuitionistic fuzzy entropy and application. Proc. World Congress on Intelligent Control and Automation, 3857-3860.

Examples

```
x <- ifv(c(0.5, 0.6, 0.4), c(0.3, 0.2, 0.4))
if_entropy(x, "burillo"); if_entropy(x, "szmidt")
if_entropy(x, "vlachos"); if_entropy(x, "zeng_li")
```

---

if_fuzzify — *Fuzzify numeric data into intuitionistic fuzzy values*

Description

Converts a numeric vector into IFVs by normalising into $[0, 1]$ to get membership, then deriving non-membership as $\nu = (1-\mu) \times \nu_ratio$ so hesitation absorbs the remainder. Useful for feeding measurements into the IF toolkit.

Usage

```
if_fuzzify(x, mu_range = range(x, na.rm = TRUE), nu_ratio = 0.6)
```

Arguments

x	numeric vector.
mu_range	range used to scale x into membership (default range(x)).
nu_ratio	share of the non-membership part in $(1-\mu)$ (scalar or vector in $[0, 1]$, default 0.6).

Value

`ifv` vector.

Examples

```
if_fuzzify(1:5)
if_fuzzify(c(10, 20, 30), nu_ratio = 0.5)
```

`if_infer` *Compositional rule of inference for IFVs*

Description

Given a fact (IF set on X, length `nx`) and an IF implication relation on $X \times Y$ (`nx*ny` values row-major), infer the consequent on Y via max-min composition.

Usage

```
if_infer(fact, relation, nx, ny, op = c("maxmin", "maxprod"))
```

Arguments

`fact`	`ifv` of length `nx`.
`relation`	`ifv` of length `nx*ny`.
`nx`, `ny`	dimensions.
`op`	composition operator.

Value

`ifv` of length `ny`.

Examples

```
fact <- ifv(c(0.8, 0.2), c(0.1, 0.7))
rel <- ifv(c(0.6, 0.3, 0.8, 0.2), c(0.2, 0.5, 0.1, 0.6))
if_infer(fact, rel, nx = 2, ny = 2)
```

if_pi — *Hesitation degree*

Description

Hesitation degree

Usage

```
if_pi(x)
```

Arguments

x	an ifv object (or coercible).

Value

numeric vector of $\pi = 1 - \mu - \nu$.

if_rank_df — *Rank alternatives from aggregated IFVs*

Description

Rank alternatives from aggregated IFVs

Usage

```
if_rank_df(x, labels = NULL)
```

Arguments

x	object coercible to ifv (one value per alternative).
labels	optional alternative labels.

Value

ranked data.frame.

Examples

```
if_rank_df(ifv(c(0.6, 0.5, 0.7), c(0.3, 0.2, 0.1)))
```

if_rule_block *Mamdani-style IF rule block evaluation*

Description

Evaluate `nrules` rules, each mapping an `nx`-vector input fact through its own `nx*ny` relation, then aggregate consequents by element-wise max (mu) / min (nu) union.

Usage

```
if_rule_block(fact, relations, nx, ny, op = c("maxmin", "maxprod"))
```

Arguments

`fact`	`ifv` length `nx`.
`relations`	list of `nrules` `ifv` relations (each length `nx*ny`).
`nx`, `ny`	dimensions.
`op`	composition operator.

Value

`ifv` length `ny`.

if_score *Score, accuracy and ranking of IFVs*

Description

Score $S = \mu - \nu \in [-1, 1]$, accuracy $H = \mu + \nu \in [0, 1]$ (Chen & Tan, 1994; Hong & Choi, 2000). Ranking is lexicographic: larger score first, ties broken by larger accuracy, then larger hesitation-handling via `tie = "pi_min"` (smaller hesitation wins).

Usage

```
if_score(x)

if_accuracy(x)

if_hesitation(x)

if_rank(x)

if_order(x)

if_best(x)
```

Arguments

x	object coercible to ifv.

Value

if_score()/if_accuracy()/if_hesitation() numeric vectors; if_rank() integer ranks (1 = best); if_order() ordering permutation (best first); if_best() best element(s).

References

Chen, S. M. & Tan, J. M. (1994). Handling multicriteria fuzzy decision-making problems based on vague set theory. *Fuzzy Sets and Systems*, 67(2), 163-172.

Hong, D. H. & Choi, C.-H. (2000). Multicriteria fuzzy decision-making problems based on vague set theory. *Fuzzy Sets and Systems*, 114(1), 103-113.

Examples

```
x <- ifv(c(0.6, 0.5, 0.7), c(0.3, 0.2, 0.1))
if_score(x); if_accuracy(x); if_rank(x); if_order(x)
```

---

if_sim — *Similarity between intuitionistic fuzzy sets*

Description

Similarities in $[0, 1]$ (larger = more similar), complementing if_dist.

Usage

```
if_sim(
  a,
  b,
 method = c("chen", "hong_kim", "ye_cosine", "ye_weighted", "deng", "liang_shi", "dice"),
  w = NULL
)
```

Arguments

a, b	objects coercible to ifv.
method	similarity name (partial matching allowed).
w	optional element weights.

Details

- "chen": $1 - D_H$ (one minus normalised Hamming).
- "hong_kim": $1 - D_E$ (one minus normalised Euclidean).
- "ye_cosine" (Ye, 2011): weighted cosine $S_C = \sum w_i \frac{\mu_A\mu_B+\nu_A\nu_B+\pi_A\pi_B}{\sqrt{\mu_A^2+\nu_A^2+\pi_A^2}\sqrt{\mu_B^2+\nu_B^2+\pi_B^2}}$.
- "ye_weighted" (Ye, 2010 correlation): $S_W = \frac{C(A,B)}{\max(C(A,A),C(B,B))}$ with $C(A,B) = \sum w_i(\mu_A\mu_B + \nu_A\nu_B + \pi_A\pi_B)$.
- "deng" / "liang_shi": Jaccard-style $S_J = \sum w_i \frac{\mu_A\mu_B+\nu_A\nu_B+\pi_A\pi_B}{(\mu_A^2+\nu_A^2+\pi_A^2)+(\mu_B^2+\nu_B^2+\pi_B^2)-(\mu_A\mu_B+\nu_A\nu_B+\pi_A\pi_B)}$.
- "dice": Dice-style $S_D = \sum w_i \frac{2(\mu_A\mu_B+\nu_A\nu_B+\pi_A\pi_B)}{(\mu_A^2+\nu_A^2+\pi_A^2)+(\mu_B^2+\nu_B^2+\pi_B^2)}$.

Value

numeric scalar similarity in $[0, 1]$.

References

Ye, J. (2011). Cosine similarity measures for intuitionistic fuzzy sets and their applications. *Mathematical and Computer Modelling*, 53(1-2), 91-97.

Ye, J. (2010). Fuzzy decision-making method based on the weighted correlation coefficient under intuitionistic fuzzy environment. *European J. Operational Research*, 205(1), 202-204.

Liang, Z. & Shi, P. (2003). Similarity measures on intuitionistic fuzzy sets. *Pattern Recognition Letters*, 24(15), 2687-2693.

Examples

```
a <- ifv(c(0.6, 0.5), c(0.3, 0.2)); b <- ifv(c(0.5, 0.4), c(0.3, 0.3))
if_sim(a, b, "chen"); if_sim(a, b, "ye_cosine"); if_sim(a, b, "dice")
```

---

if_topsis — *Intuitionistic fuzzy TOPSIS and decision helpers*

Description

IF-TOPSIS after Boran et al. (2009): aggregate each alternative's criterion IFVs with weights `w` (via `ifwa` by default), then measure separation from the positive ideal $A^+ = (1, 0)$ and negative ideal $A^- = (0, 1)$ using normalised Euclidean IF distance. Closeness $C_i = D_i^- / (D_i^+ + D_i^-)$; larger is better.

Usage

```
if_topsis(mat, nalt, ncrit, w, dist = "euclidean", agg = ifwa)
```

Arguments

`mat`	`ifv` of length `nalt*ncrit` in row-major order (alternative 1's criteria first), or an `nalt` x `ncrit` list-matrix.
`nalt, ncrit`	dimensions (guessed from square if missing is impossible, so both are required).
`w`	criterion weights (length `ncrit`).
`dist`	distance method passed to `if_dist` (default `"euclidean"`).
`agg`	aggregation function (default `ifwa`).

Value

`data.frame` with columns `alt`, `mu`, `nu`, `score`, `d_plus`, `d_minus`, `closeness`, `rank`, ordered by rank.

References

Boran, F. E., Genc, S., Kurt, M. & Akay, D. (2009). A multi-criteria intuitionistic fuzzy group decision making for supplier selection with TOPSIS method. *Expert Systems with Applications*, 36(8), 11363-11368.

Examples

```
m <- ifv(c(0.6, 0.5, 0.7, 0.4, 0.5, 0.6), c(0.2, 0.3, 0.1, 0.4, 0.3, 0.2))
if_topsis(m, nalt = 3, ncrit = 2, w = c(0.6, 0.4))
```

`ifcmeans` *Intuitionistic fuzzy c-means (IFCM) clustering*

Description

Clusters `ifv` data with intuitionistic fuzzy memberships. Distance between an observation a and centre v is the normalised Euclidean IF distance (Szmidt-Kacprzyk). An optional hesitation weight `lambda` inflates distances by $\exp(\lambda \cdot \bar{\pi})$ where $\bar{\pi}$ is the mean hesitation of the pair, emphasising uncertain points when `lambda > 0` (Xu et al. style modification).

Usage

```
ifcmeans(
  x,
  k,
  m = 2,
  lambda = 0,
  maxit = 100,
  tol = 1e-05,
  nstart = 1L,
  seed = NULL
)
```

Arguments

`x`	object coercible to `ifv` (n observations).
`k`	number of clusters.
`m`	fuzzifier > 1 (default 2).
`lambda`	hesitation penalty >= 0 (default 0 = plain IFCM).
`maxit`	maximum iterations.
`tol`	convergence tolerance on membership change.
`nstart`	number of random starts (best kept).
`seed`	random seed.

Value

A list with `centers` (`ifv`, k rows), `membership` (n x k matrix), `cluster` (hard labels), `within_ss` (sum of weighted squared distances), `iter`, `converged`.

References

Xu, Z., Chen, J. & Wu, J. (2008). Clustering algorithm for intuitionistic fuzzy sets. *Information Sciences*, 178(19), 3775-3790.

Examples

```
set.seed(1)
mu <- runif(30, 0.3, 0.7); nu <- runif(30, 0.05, 0.25)
x <- ifv(mu, nu)
r <- ifcmeans(x, k = 2, nstart = 2)
r$cluster; r$centers
```

`ifkmeans` *Intuitionistic fuzzy k-means (hard labels, IF centroids)*

Description

Lloyd-style k-means with normalised Euclidean IF distance and IFWA centroid updates.

Usage

```
ifkmeans(x, k, maxit = 50, nstart = 5L, seed = NULL)
```

Arguments

`x`	object coercible to `ifv`.
`k`	number of clusters.
`maxit`	maximum iterations.
`nstart`	random starts.
`seed`	seed.

Value

list with `centers` (`ifv`), `cluster`, `within_ss`, `iter`, `converged`.

Examples

```
set.seed(2)
mu <- runif(20, 0.2, 0.7); nu <- runif(20, 0.0, 0.25)
x <- ifv(mu, nu)
ifkmeans(x, k = 2, nstart = 2)
```

---

ifv — *Create an intuitionistic fuzzy value (IFV)*

Description

An intuitionistic fuzzy value is a pair (μ, ν) with $\mu \geq 0$, $\nu \geq 0$ and $\mu + \nu \leq 1$. Hesitation is $\pi = 1 - \mu - \nu$.

Usage

```
ifv(mu, nu)
```

Arguments

`mu`	numeric vector of membership degrees in $[0, 1]$.
`nu`	numeric vector of non-membership degrees in $[0, 1]$.

Value

An object of class `"ifv"`: a `data.frame` with columns `mu`, `nu`, `pi`.

Examples

```
ifv(0.6, 0.3)
ifv(c(0.5, 0.7), c(0.3, 0.1))
```

`ifwa` *Intuitionistic fuzzy aggregation operators*

Description

Weighted / ordered / hybrid aggregation of IFVs after Xu (2007) and Xu & Yager (2006).

Usage

```
ifwa(x, w)

ifwg(x, w)

ifowa(x, order_w)

ifowg(x, order_w)

ifha(x, w, order_w)

ifhg(x, w, order_w)

if_einstein_wa(x, w)

if_einstein_wg(x, w)
```

Arguments

`x`	object coercible to `ifv` (vector of values to fuse).
`w`	numeric weight vector (non-negative, sums to 1; normalised if not).
`order_w`	positional weights for ordered/hybrid operators.

Details

For IFVs $a_j = (\mu_j, \nu_j)$ with weights w_j:

$$IFWA = \left(1 - \prod (1-\mu_j)^{w_j},\ \prod \nu_j^{w_j}\right)$$

$$IFWG = \left(\prod \mu_j^{w_j},\ 1 - \prod (1-\nu_j)^{w_j}\right)$$

Ordered variants (IFOWA/IFOWG) first reorder a_j by score $S = \mu - \nu$ (descending) and then apply positional weights. Hybrid variants (IFHA/IFHG) weight each a_j by nw_j (via scalar-mul / power) and then apply ordered weighting.

Terms 0^0 arising from zero weights are treated as 1, and 0^0-type products skip zero-weight factors, so unused inputs do not affect the result.

Value

A single-row `ifv`.

References

Xu, Z. (2007). Intuitionistic fuzzy aggregation operators. *IEEE Trans. Fuzzy Systems*, 15(6), 1179-1187.

Xu, Z. & Yager, R. R. (2006). Some geometric aggregation operators based on intuitionistic fuzzy sets. *Int. J. General Systems*, 35(4), 417-433.

Examples

```
x <- ifv(c(0.6, 0.5, 0.7), c(0.3, 0.2, 0.1))
ifwa(x, c(0.5, 0.3, 0.2))
ifwg(x, c(0.5, 0.3, 0.2))
ifowa(x, c(0.5, 0.3, 0.2))
```

`is_ifv` *Test / coerce intuitionistic fuzzy values*

Description

Test / coerce intuitionistic fuzzy values

Usage

```
is_ifv(x)

as_ifv(x, ...)
```

Arguments

`x`	object to test or coerce.
`...`	ignored.

Value

`is_ifv()` logical; `as_ifv()` an `ifv` object.

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