Status Analysis: projecting genotype performance into long-term environment discrimination space

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Definition: Status analysis

• Comparison of current year’s environments discrimination space to the long-term discrimination space (DeLacy et al. 2000)

• This definition is extended to include genotype performance:

  A projection of genotype performance from the current year’s results into the long-term environment discrimination space
Definition: Discrimination space

- Average relationships among environments (in the way in which they discriminate among the genotypes grown in them) displayed in a Cartesian space from an ordination analysis (DeLacy et al. 2000)

- Two-types of discrimination space:
  - Single-year discrimination space
  - Long-term discrimination space
BACKGROUND

• Objective of multi-environment trials is to predict long-term genotype performance in farmers’ fields

• Due to the presence of genotype by environment interactions (GE) in any single year, that GE pattern rarely reflects the long-term GE pattern

• It is expected that averaging GE over years will produce a more stable GE pattern
METHODOLOGY

• Obtaining a single-year location discrimination space and the long-term location discrimination space → pattern analysis

• Projecting single-year genotype × location (GL) data into long-term discrimination space → status analysis
Pattern Analysis

• Calculate GL data for each year using ASREML
  ▪ Model: $y = \mu + \text{trials} + \text{design|trials} + G \times L + \epsilon$
  ▪ Location standardised (Fox & Rossielle, 1982)

• Calculate proximity matrix among locations
  ▪ SED as dissimilarity matrix and correlation matrix as similarity matrix
  ▪ Do for each year and then average over years

• Clustering strategy: Ward’s method

• Ordination: Principal Component Analysis
Symbols

\[ n = \text{number of locations in a single-year} \]
\[ m = \text{number of long-term locations} \]
\[ b = \text{number of locations common to both a single-year and the long-term} \]
\[ g = \text{number of genotypes} \]
\[ p = \text{number of principal components} \]
Status Analysis

Based on Singular Value Decomposition equation:

If n=m

\[ X_{g \times n} = U_{g \times p} D_{p \times p} V_{p \times m}^T \]

then

\[ U = X (D V^T)^{-1} \]

\[ = X (V^T)^{-1} D^{-1} \]

\[ = X V D^{-1} \]
If $n \neq m$ and $n \cap m = b$:

$$\text{then } U_{g \times p}^s = X_{g \times b}^s V_{b \times p}^s D_{p \times p}^{-1}$$

Where:

- $U = \text{genotype projection to long-term discrimination space}$
- $D = \text{singular value of long-term discrimination space}$
- $V = \text{long-term discrimination space}$
Example

Elite Wheat Spring Yield Trials (ESWYT)

- One of CIMMYT international nurseries
- 25 years (1979 – 2004, except 1993)
- Grain yield
- 400 locations
- 685 elite lines targeted for high-input irrigated environments
## Number of locations in the first 25 cycle of ESWYT

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<th>ESWYT02</th>
<th>ESWYT03</th>
<th>ESWYT04</th>
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EXAMPLE contd.

• Long-term discrimination space:
  - Cumulative pattern analysis (DeLacy et al. 1996) over 25 years
  - Using locations that were used for a minimum of 5 years

• Results:
  - 6 mega-environments (MEs)
  - Several released cultivars

Substitution of location and genotype grouping
CIMMYT mega-environment classification for spring wheat

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<td>High temperature</td>
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Braun et al. 1996
Pattern analysis of single-year: 1983 - 1984
Pattern analysis of single-year: 1984 - 1985
Pattern analysis of single-year: 1985 - 1986

PC1 (24%)  PC2 (14%)  PC3 (10%)

Australasian Applied Statistics Conference, 12 - 15 July 2011, Palm Cove
Long-term discrimination space
57 locations

Australasian Applied Statistics Conference, 12 - 15 July 2011, Palm Cove
Status Analysis: 1985 – 1986

PC1 and PC2

Single-year

Long-term

PC1 (24%)  PC2 (14%)

PC1 (14%)  PC2 (6%)

Australasian Applied Statistics Conference, 12 - 15 July 2011, Palm Cove
Status Analysis: 1985 – 1986

PC2 and PC3

**Single-year**

**Long-term**

Australasian Applied Statistics Conference, 12 - 15 July 2011, Palm Cove
Summary

- **Discrimination space:**
  - PC1 – reflects average genotype performance
  - PC2 & PC3 – reflects G×E interactions

- **Status analysis:**
  - Project genotypes performance in long-term space including in locations they were not tested
  - Evaluate similarity between current year pattern & long-term GE pattern

- **Long-term discrimination space:**
  - Updated with additional data
  - Re-done when there were major changes in germplasm or test locations
References


