Colour Feature Extraction for Computer-Aided Art Therapy

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Presentation Outline

1. Objective
   • System framework for psychotherapy

2. Methods
   • Colour analysis
   • Psychological colour measure

3. Experiment and results
   • Using clinical data

4. Summary and future work
Mental therapy

- Assessments of mental state
- Features of drawings
- Subjective judgements
- Numerical values

Client → Therapist

- Drawing therapy
- Cognitive behavioural therapy
- Clinical treatments
- Diagnosis, etc.

Drawings
Computer-aided art/drawing therapy

Drawings

Client

By computer

Image analysis
- Region
- Color

Objectives of quantities

Features of drawings

By computer

Applications
- AI, etc.

Clinical treatments

Therapist

Assessments of mental state

Numerical values

Cognitive behavioural therapy

By computer

Drawing therapy
Focus in this study

- Client's works: pastel drawings
- Features to see in mental therapy: the use of colour in the drawing
  What colour is the drawing?
Colour analysis of pastel drawings

1. Extracting a drawing region

2. Determining a representative colour of the extracted region

3. Evaluating the representative colour in terms of colour psychology
Step 1: Extracting a drawing region

- Segmentation into a drawing region and blank regions
- Aiming at excluding blanks from colour analysis
- Methods depend on drawing properties.
- For pastel drawings, by Kato and Kimoto, 2015
Step 2: Determining a representative colour

- Reducing the number of colours in the drawing region
- Using a colour clustering method (k++ means)
- Making a function of the area ratio $r$, $m(r)$, that gives the mean colour over $r$ of the entire area

  - Cluster $\text{CL}_i = \{ \text{pixels } R_i, \text{ centroid colour } C_{t_i} \}_{i=1...N}$
  - By accumulating $|R_i|$ and re-averaging $C_{t_i}$ in descending order of $|R_i|$, $m(r)$ is obtained.
Step 3: Psychological measure for colours

- Based on psychological primary colours
- Def. of a degree of psychological primary (DPP) colour $P$:

$$a(c, P) = \begin{cases} 
1 - \frac{d}{d_0}, & \text{if } d < d_0 \\
0, & \text{if } d \geq d_0
\end{cases}$$

$$0 \leq a(c, P) \leq 1$$

$P_0$: psychological basic colour assumed to be nonemotional

$c$: Colour to be measured

In L*a*b* uniform colour space
Experimental data

- Pastel drawings that a client made every month
- Assessments of the client's mental state: degrees of mental improvement (DMI) values
- 47 drawing and DMI-value pairs for four years
Result of region extraction

- Example

(a) Source image

(b) Extracted drawing region
Result of colour representation

Example

50% of area

100% of area

Mean colour for area ratio

r
Result of psychological colour measure

- Using the psychological measure for the mean colour of 100% area to evaluate four degrees
- Using tentative values for the psychological primary colour: red, green, blue and yellow; and $P_0$
- Results of degree of psychological primary (DPP) colour:
Mental state classifier (1): modelling

- **Dataset:**
  
  \{Drawing, DMI value\} \\
  \downarrow \\
  \{(DPP-red, -green, -blue, -yellow), 3-class mental state\}

- **Classification model:**
  
  Associating one of 3 classes of mental state with each 4-d feature vector

- **Neural network modelling**
Mental state classifier (2): learning

- Supervised machine learning
  - 37 feature vector/class pairs as the training set
  - 10 pairs randomly chosen as the testing set

- Resulting accuracy
  - 1.0 for the training set
  - 0.7 for the testing set
Summary

- A framework of computer-aided art/drawing therapy system: two key points
  - An activity of a client
  - Numerical assessments of the client's mental state

- Psychological colour measure
  - Examined with clinical data
  - Some effectiveness has been proved with the classifier built by supervised machine learning.
Future work

- Fixing the tentative values for the psychological primary colours
- Time-series analysis of clinical data
- Further feature engineering with more clinical data
Any Questions or Comments?

Thank you for your kind attention