Generating Language with Personality

François Maîresse
University of Sheffield
March 2007

ART Module on Dialogue Systems

Outline

- A bit of personality psychology
- Why do we need language variation?
- Linguistic markers of personality
- Generating language with personality
- Evaluation
- Continuous variation: statistical modelling
- Conclusion
Personality Psychology

- Personality

  *The complex of all the attributes — behavioural, temperamental, emotional and mental — that characterize a unique individual.*

- Do personality traits exist?
- Created to maintain an illusion of consistency in the world?

→ Find the most essential independent traits
  - Lexical Hypothesis
    - Important traits are encoded in the language (Allport & Odbert, 1936)
    - Participants describe people using a pool of adjectives
    - Factor analysis

The Big Five Personality Traits

- Factor analysis → 5 dimensions (Norman, 1963)
  - Extraversion
    - Sociability, assertiveness vs. quietness
  - Emotional stability
    - Calmness vs. neuroticism, anxiety
  - Agreeableness
    - Kindness vs. unfriendliness
  - Conscientiousness
    - Need for achievement, organization vs. impulsiveness
  - Openness to experience
    - Imagination, insight vs. conventionality
Individual Differences in Language

- Example (Mehl et al. 2006)

<table>
<thead>
<tr>
<th>Introvert</th>
<th>Extravert</th>
</tr>
</thead>
<tbody>
<tr>
<td>I don’t know man, it is fine I was just saying I don’t know.</td>
<td>Oh, this has been happening to me a lot lately. Like my phone will ring. It won’t say who it is. It just says call. And I answer and nobody will say anything. So I don’t know who it is.</td>
</tr>
<tr>
<td>I was just giving you a hard time, so. I don’t know.</td>
<td>Okay. I don’t really want any but a little salad.</td>
</tr>
<tr>
<td>I will go check my e-mail.</td>
<td></td>
</tr>
<tr>
<td>I said I will try to check my e-mail, ok.</td>
<td></td>
</tr>
</tbody>
</table>

- 96 participants recorded for 2 days
- Filled a personality questionnaire

Language and Personality

- Linguistic markers of extraversion (Furnham, 1990)
  - Talk more, faster, louder and more repetitively
  - Fewer pauses and hesitations
  - Lower type/token ratio
  - Less formal, more references to context (Heylighen & Dewaele, 2002)
  - More positive emotion words (Pennebaker & King, 1999)
    - E.g. happy, pretty, good

- Emotional instability (Pennebaker & King, 1999)
  - 1st person singular pronouns
  - Negative emotion words

- Conscientiousness (Pennebaker & King, 1999)
  - Fewer negations and negative emotion words

- Low but significant correlations
Motivation for Linguistic Variation

- Different tasks require different languages
  - Intelligent tutoring system
    - Extravert, agreeable, conscientious
  - Store
    - Agreeable and extravert (persuasive)
  - Critical information provider
    - Conscientious, not extravert, not agreeable (no politeness)
  - Video games
  - Psychotherapy

- Frustration with repetitiveness in dialogue systems
  - Assumption: preference for human-like behaviour

- Developer’s implicit style unlikely to be optimal

Personality Generation at the University of Sheffield

- PERSONAGE
  - Information presentation in the restaurant domain
  - Focus on extraversion
    - Most important dimension
    - Most visible dimension
  - Two goals
    - Generate extreme extravert and introvert personality
    - Generate personality on a continuous scale

- Can individual differences observed in general studies be recognised
  - In a very specific domain?
  - Within a single utterance?
Overview of PERSONAGE’s Framework

- Develop initial generator
  1. Identify personality markers from psychological studies
  2. Map those markers to NLG decisions
  3. Generate utterances covering the full parameter range

- Train the generator
  1. Judges rate the output with a standard personality test
  2. Compute feature values for each utterance
     - Based on the generator’s actual decisions and the literature
  3. Train a statistical model to predict the judge’s ratings from the features

- Generating language given personality parameters
  - **Direct generation**: interpolate between parameter values associated with both ends of the personality dimension
  - **Overgenerate and rank**: use the statistical model to rank randomly generated utterances

Variation in the NLG Pipeline Architecture
PERSONAGE’S Architecture

Restaurant attributes
Parameter values

Content Planner

Syntactic Structure Selection

Aggregation

Syntactic Structure Transformation

Lexical Choice

Realization

Output utterance

<table>
<thead>
<tr>
<th>NLG modules</th>
<th>Intervent findings</th>
<th>Extracted findings</th>
<th>Parameter</th>
<th>Info</th>
<th>Extra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context selection and structure</td>
<td>Negative type</td>
<td>Many topics</td>
<td>RESTATEMENTS</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td></td>
<td>Problem talk, dissatisfaction</td>
<td>Think out loud</td>
<td>REPETITIONS</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Syntactic selection</td>
<td>Few self-references</td>
<td>Many articles</td>
<td>CONTENT POLARITY</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td></td>
<td>Elaborated constructions</td>
<td>Few articles</td>
<td>EXPRESSION POLARITY</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td></td>
<td>Many articles</td>
<td>Many self-references</td>
<td>CLAIM POLARITY</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Aggregation Operations</td>
<td>Few words per sentence clause</td>
<td>Few words per sentence clause</td>
<td>CONCESSIONS</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td></td>
<td>Many unfilled pauses</td>
<td>Few unfilled pauses</td>
<td>CONSTRUCTION</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Syntactic transformations</td>
<td>Many nouns, adjectives, propositions (explicit)</td>
<td>Few nouns, adjectives, propositions (explicit)</td>
<td>HEDGE VARIATION</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td></td>
<td>Many questions</td>
<td>Few questions</td>
<td>HEDGE REPETITION</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td></td>
<td>Many noun words</td>
<td>Few noun words</td>
<td>MARTIQUET INTERJ allotement</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td></td>
<td>Few words</td>
<td>Few words</td>
<td>BAD collocation</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Lexical choice</td>
<td>Few positive emotion words</td>
<td>Many positive emotion words</td>
<td>MANY PREPOSITIONS</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td></td>
<td>Many negative emotion words</td>
<td>Few negative emotion words</td>
<td>MANY POLARITY PARAMETERS</td>
<td>low</td>
<td>low</td>
</tr>
</tbody>
</table>
Phase 1: Content Planning and Aggregation

**Content Plan Tree**

- Assert-reco-best
- Assert-reco-service
- Assert-reco-food-quality
- Assert-reco-price

- Justify
- Index

**Sentence Plan Tree**

- CW-SINCE-NS-justify
- CW-CONJUNCTION-inferr
- WITH-NS-inferr
- CW-CONJUNCTION-inferr

- Assert-reco-cuisine
- Assert-reco-service
- Assert-reco-price
- Assert-reco-food-quality

**Content Planner**
- Content item selection
- Relation insertion
- Content item ordering

**Aggregation**
- Selection of clause combining operations

### Generation Decisions: Content Planning

- **Verbosity**
  - Content items selection, e.g. food quality, price, service, etc.

- **Choice of content based on polarity**
  - Zagat scalar ratings, e.g. food = 2/5, service = 5/5

- **Insertion of restatements/repetitions**
  - Small generation dictionary
  - WordNet based paraphrasing, e.g. “the food is awful, terrible”

- **Concession of content items with different polarity**
  - E.g. “Even if Wok Mania has awful food, it’s cheap”

- **Position of positive content**
Generation Decisions:
Aggregation operations

- Many ways to combine information
- Inferences
  - Relative clauses, e.g. “X, which has good food, is …”
  - Conjunctions
  - Period, etc.
- Concessions
  - “Even if X has awful food, …”
  - “Although X has awful food, …”
- Restatements
  - Comma, e.g. “X has awful food, it has bad food”
  - Merge, e.g. “X has awful food, bad food”
- Generation parameter define probability of selection

Phase 2:
Syntactic Template Selection

- Generation dictionary
  - Content item → Syntactic Structures
Phase 3: Syntactic Transformation

- Sequential modifications of the syntactic tree
  - Subject implicitness
    - “X has awful food” → “The food is awful”
  
- Negation insertion
  - WordNet antonyms of adjectives
    - “X has good food” → “X doesn’t have bad food”
  
- Hedge insertion
  - Downtoners: “kind of”, “quite”, “It seems that”, “around”, etc.
  - Fillers: “err…”, “I mean”, “like”
  - Acknowledgments: “right”, “I see”, “well”, “yeah”
  - Emphasizers: “really”, “basically”, “you know”, exclamation, etc.

- Tag question insertion
  - “X has good food, doesn’t it?”

Example of Syntactic Transformation

- Negation insertion
  - “X has awful food” → “X doesn’t have good food”
Phase 4: Lexical Choice

- Need to choose from WordNet synonyms
- Each word is associated to a point in a feature space
  - E.g. word frequency of use, word size, etc.
  - Machine-readable dictionary
- Select the closest synonym to the input target values

![Feature Space Diagram]

PERSONAGE Example Outputs

- Recommendation for John’s Pizzeria
  - Extravert:
    “I am sure you would like John’s Pizzeria, it’s one of my favourite places. It’s cheap. Even if the atmosphere is just bad, it has really good food.”
  - Introvert:
    “Well, I mean, John’s Pizzeria is the only restaurant that is any good.”
Extreme Personality Generation

- Generate either extravert or introvert language
- Use parameter settings from the psychology literature

Evaluation: can people recognise both types of language?
- 3 human judges rated 80 outputs
  - Fill short personality questionnaire for every utterance
    - Extraversion score between 1 (introvert) and 7 (extravert)
  - 2 input parameter sets → 2 types of utterances
    - 40 introvert utterances vs. 40 extravert

<table>
<thead>
<tr>
<th>Rating</th>
<th>Introvert</th>
<th>Extravert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraversion</td>
<td>2.96</td>
<td>5.98</td>
</tr>
<tr>
<td>Naturalness</td>
<td>4.93</td>
<td>5.78</td>
</tr>
</tbody>
</table>

- If binary classification of output: ~ 90% accuracy

Predefined Parameter Sets

![Chart showing utterance count against extraversion rating for introvert and extravert]
Correlational Analysis

- What makes an utterance extraverted?
- Parameters can be refined based on correlation between generation decision and ratings
- Significant positive correlations (p < .05)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Correlation</th>
<th>Naturalness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbose</td>
<td>0.30</td>
<td>0.09</td>
</tr>
<tr>
<td>Concessions</td>
<td>0.28</td>
<td>0.15</td>
</tr>
<tr>
<td>Aggregation: justify - period</td>
<td>0.27</td>
<td>0.16</td>
</tr>
<tr>
<td>Hedge: exclamation</td>
<td>0.21</td>
<td>-0.02</td>
</tr>
<tr>
<td>Lexicon: Maximum BNC Frequency</td>
<td>0.19</td>
<td>0.07</td>
</tr>
<tr>
<td>Aggregation: restate - conjunction</td>
<td>0.15</td>
<td>-0.13</td>
</tr>
<tr>
<td>Aggregation: infer - merge</td>
<td>0.15</td>
<td>0.09</td>
</tr>
<tr>
<td>Negative Content Items</td>
<td>0.14</td>
<td>-0.02</td>
</tr>
<tr>
<td>Use of First Person in Claim</td>
<td>0.13</td>
<td>0.14</td>
</tr>
<tr>
<td>Neutral Content</td>
<td>0.12</td>
<td>-0.08</td>
</tr>
<tr>
<td>Restatements</td>
<td>0.12</td>
<td>-0.01</td>
</tr>
<tr>
<td>Hedge: it seems that</td>
<td>0.12</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Correlational Analysis

- Significant negative correlations (p < .05)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Correlation</th>
<th>Naturalness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregation: Contrast - period however</td>
<td>-0.23</td>
<td>-0.09</td>
</tr>
<tr>
<td>Hedge: err</td>
<td>-0.22</td>
<td>0.02</td>
</tr>
<tr>
<td>Lexicon: Imageability</td>
<td>-0.22</td>
<td>0.18</td>
</tr>
<tr>
<td>Lexicon: Number of Syllables</td>
<td>-0.20</td>
<td>0.07</td>
</tr>
<tr>
<td>Lexicon: Number of Phonemes</td>
<td>-0.20</td>
<td>0.03</td>
</tr>
<tr>
<td>Positive Content</td>
<td>-0.19</td>
<td>0.07</td>
</tr>
<tr>
<td>Content Polarity</td>
<td>-0.18</td>
<td>0.06</td>
</tr>
<tr>
<td>Aggregation: Justify - with</td>
<td>-0.18</td>
<td>-0.17</td>
</tr>
<tr>
<td>Lexicon: Age of Acquisition</td>
<td>-0.18</td>
<td>0.80</td>
</tr>
<tr>
<td>Aggregation: Contrast - period on the other hand</td>
<td>-0.15</td>
<td>-0.03</td>
</tr>
<tr>
<td>Hedge: sort of</td>
<td>-0.13</td>
<td>-0.07</td>
</tr>
<tr>
<td>Hedge: just have</td>
<td>-0.13</td>
<td>0.02</td>
</tr>
<tr>
<td>Hedge: right</td>
<td>-0.12</td>
<td>-0.03</td>
</tr>
<tr>
<td>Hedge: kind of</td>
<td>-0.11</td>
<td>-0.03</td>
</tr>
<tr>
<td>Negation Insertion</td>
<td>-0.10</td>
<td>-0.14</td>
</tr>
</tbody>
</table>
Generate Variation on a Continuous Scale

- Goal: produce language close to an arbitrary input personality value

- Two approaches
  - Direct generation through parameter interpolation
    - Interpolation between extreme parameter settings
    - Pros: faster approach
    - Demo: recommend-2.avi
  - Trainable language generation
    - Overgenerate and rank

Overgenerate and Rank

- Input personality score e.g. 2.5 out of 7
- Statistical Regression/Ranking Model
  - Estimates scores from features, e.g. verbosity, hedges
  - Closest estimate, utterance 2: “Err… this restaurant’s not as bad the others.”
Making NLG Trainable

- Where do we get the ranking model from?
  - Train the statistical model from a source of language
  - The ratings can reflect anything we want to control
    - Utterance quality
    - Perceived personality

### Data Collection

- Text 1 \(\rightarrow\) Rating 1
- Text 2 \(\rightarrow\) Rating 2
- ... Text n \(\rightarrow\) Rating n

### Feature Extraction

- Text 1 \(\rightarrow\) Feature vector 1
- Text 2 \(\rightarrow\) Feature vector 2
- ... Text n \(\rightarrow\) Feature Vector n

### Dataset

- Features + rating pairs

### Function Approximation

- Find 'simple' F such as \(F(\text{feature vector}) = \text{rating}\)
  - Can be learned statistically!
    - E.g. neural networks, decision tree

### Statistical Model

- F(new features) = rating estimate

---

What Features to Use?

- N-grams: HALogen (Langkilde, 2002)
  - Only takes consecutive surface words into account (bigrams, trigrams)
  - N gram will never model deep relations in a sentence, like information restatements or specific content structure

- Deeper linguistic features: SPoT (Walker et al. 02)
  - Syntactic configurations
  - Content organisation
  - Features reflecting generation decisions
Why Trainable NLG?

- Producing hand crafted rule is time consuming
- Requires less linguistic expertise
- Makes it less domain dependent
  - Different sources of data for different domain
- Can use other features than generation decisions
  - e.g. word count, dictionaries, syntactic features
- Regression models model a continuous function
  - Appropriate for linguistic variation!

Statistical Models of Personality Perception

- Source of data: 3 judges rate 120 random utterances
- Feature based on generation decisions
- Results for predicting extraversion
  - Best model: Support Vector Machines
  - Correlation between rating and prediction \( r = 0.5 \)
  - Average prediction error on a scale from 1 to 7
    absolute error = 0.9
- E.g. regression tree model
**Conclusion**

- Learned about trainable language generation
- Focus on generating language with personality
- Integration in a dialogue system?
  - Acoustic parameters crucial
    - Introvert 🎧
      
      "Because Azuri Cafe's price is around 14 dollars, it isn’t err... as bad as the others."
    
    - Extravert 🎧
      
      "Let's see what we can find on Azuri Cafe. Yeah, it's one of my favourite places. Its price is 14 dollars, it's cheap, the atmosphere is poor though and it's a kosher and vegetarian place. Even if the service is bad, actually, this restaurant has good food."
  
- Personality affects every aspects of language production