Desiderata for a theory of meaning

Lecture 3

Hana Filip
… before we really start

• Funny Church Bulletins

1. The Rev. Merriwether spoke briefly, much to the delight of the audience.

2. The concert held in Fellowship Hall was a great success. Special thanks are due to the minister's daughter, who labored the whole evening at the piano, which as usual fell upon her.


4. Bertha Belch, a missionary from Africa will be speaking tonight at Calvary Memorial Church in Racine. Come tonight and hear Bertha Belch all the way from Africa.
… and at the end of this presentation

• You’ll find HOMEWORK 3
due next Monday, September 29.

• By next Monday, you should have read
de Swart: Ch. 3. Connectives, truth and truth conditions.
What we have done so far

• What is semantics?
  – In the most general way, semantics provides an account of how form and meaning are systematically related in an adequate grammar of natural language.
  – It provides a systematic account of semantic intuitions that native speakers have about how words and sentences are related (e.g., synonymy, ambiguity, antonymy, symmetry, hyponymy) and empirical tests that access them.

• What is meaning?
  – The meaning of words cannot be derived from their physical properties,
  – it cannot be reduced to the real-world objects or their perception, and
  – it cannot be reduced to the particular image in my or your mind.

Therefore, the meaning of words is to be derived from the relations between words, concepts and things in the real world.

• Two main approaches to meaning
  – Cognitive, mentalistic
  – Referential, truth-conditional
Today

• Motivation and background for truth-conditional semantics
  – ‘Aboutness’ of language, reference, truth, syntax
  – World, model, domain of discourse
  – Principle of compositionality
  – Toy English example
Referential theories of meaning

• Basic tenet (see Lecture 1):
  MEANING IS REFERENCE TO FACTS OR OBJECTS IN THE WORLD

• Referential theories of meaning are concerned with the relation between linguistic expressions and the world.

• They are motivated by the basic intuition that one of the most important characteristics of natural language expressions is that they are *about* something in the world, they are about something that is external to the concepts in our minds.
Referential theories of meaning

- Saying that natural language expressions are *about* something in the world means that

- natural language expressions have a *representation* or *symbolic* function, i.e., natural language expressions *stand for* things we are talking about.

- Recall (Lecture 1)
  The constitutive rule for linguistic symbols:
  One symbol **X stands for Y** (meaning) in context C, and it does so by some *convention* that is publicly acknowledged.
Referential theories of meaning

• Question: If natural language expressions have a representational function, to what extent are they then similar to or different from other representations of aspects of the world like paintings, maps, scaled down representations of interior designers, etc.?

• Representations like paintings, maps, scaled down representations of interior designers, etc. can be said to be accurate or inaccurate.

• Natural language expressions can be said to be accurate or inaccurate with respect to what they are about or stand for, AND they also convey statements that can be true or false.
Referential theories of meaning

George Washington Crossing the Delaware (December 25, 1776), by Emanuel Leutze, 1851

- This painting is **inaccurate** in so far as historians doubt that George Washington would have been so foolish as to stand up in a small boat while crossing the Delaware.
- The *painting itself* is not true or false.
- The statement “George Washington stood up in his boat while crossing the Delaware” can be **true** or **false**.
- The story the painting tells - a linguistic object - can be **true** or **false**. (Ex. due to Greg Carlson)

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Referential theories of meaning

- Which one of the three boxes has a prize in it?

Possible responses:
- [pointing at the box you choose]
- Utterance: “The prize is in the box in the middle.”

Impossible responses:
- “That’s true” or “That’s false.”
Referential theories of meaning

• Which one of the three boxes has a prize in it?

A says: “The prize is in the box in the middle.”
B responds: “That’s true.” (I.e., the statement of A is true.)

Conclusion
• Objects in and of themselves cannot be true or false.
• Statements (about these objects) can be true or false.
Referential
theories of meaning

• Summary:
  – Natural language expressions can be true or false, unlike other symbolic or representational systems.
  – Natural language expressions have truth/falsity as one of their unique semantic properties.

• Question: What is it that makes it possible for natural language expressions to be associated with truth or falsity?

• An important ingredient is syntax: the study of how words combine with one another to form larger constituents, up to the level of a sentence.
Referential theories of meaning

• Focusing on words in isolation as the symbols of language would not make language that much different from other signs.
• The fact that words combined in larger meaningful expressions that can be true or false, rather than words and their associated meanings alone, constitutes the central characteristic of language, and the characteristics that semantics tries to explain.

In what follows we will explore the connection between
• Truth/Falsity (related to ‘aboutness’ of language) and
• Syntax
Referential theories of meaning

- Truth/Falsity (related to ‘aboutness’ of language) & Syntax

Example: interjection *Ouch!* vs. statement *That hurts bad!*

interjection *Ouch!*
- is meaningful, it indicates pain, and possibly frustration
- BUT it is not ABOUT the pain and frustration, it does not stand for the pain and frustration

statements *That hurts bad!* or *I am now in severe pain* or …
- are ABOUT pain
- **stand for** pain in context C, and they do so by some convention that is publicly acknowledged.
Referential theories of meaning

- Truth/Falsity (related to ‘aboutness’ of language) & Syntax

interjection *Ouch*! lacks

- *aboutness*
- *syntax*, i.e., it does not combine with other words to give coherent meanings for a whole

*Ouch* cannot function as a part of a sentence

* Bill said that *ouch*.
* If *ouch*, then go see a doctor.
* *Ouch* when I bend my wrist.
* Any time when *ouch* you should take an aspirin.
Referential theories of meaning

- Truth/Falsity (related to ‘aboutness’ of language) & Syntax

Statement *That hurts bad!* has the properties of
- aboutness
- syntax

*That hurts bad!* can function as a part of another statement

*Bill said that that hurts bad.*
*If that hurts bad, then go see a doctor.*
*That hurts bad when I bend my wrist.*
*Any time when that hurts bad you should take an aspirin.*

All of the above statements can be true or false.
Referential theories of meaning

- statements vs. sentences

Question: Is the following sentence true or false?

This house used to be blue.

You cannot answer this question, because you have no knowledge about when the sentence was uttered, the circumstances in which it was uttered, i.e., which house the speaker was pointing at, etc.

To actually assign truth or falsity, you must have the knowledge of the circumstances of a particular event = a STATEMENT = an utterance of a sentence. You need to know the designations of the pragmatically-oriented words like this, which can shift from statement to statement.
Referential theories of meaning

- **sentences**
  - are not localized in time and space
  - do not vary in dependence on time and space

- **statements**
  - are particular events = utterances of sentences
  - are localized in time and space

sentence: *Apples are red.*

Homer says: “Apples are red.”
Marge says: “Apples are red.”
Lisa says: “Apples are red.”

statement 1
statement 2
statement 3
Toy English

Model
• a set of individuals
  i.e., our domain of discourse (or universe of discourse)

• a set of truth values: \{t, f\}
• an interpretation function \( I \) that assigns interpretation (or denotation, semantic value) to words in our lexicon
Toy English

Lexicon

- Nouns: *Alan, Betty, Cathy, Dean*
- Adjectives: *fit, grumpy, happy*
- Verbs: *likes, knows, admires*
Toy English

Assignment of interpretation to nouns (here proper names)

I(Alan) = \( a \)  
I(Cathy) = \( c \)

I(Betty) = \( b \)  
I(Dean) = \( d \)

- The name *Alan* is to designate the individual *a* in the model, the bearer of the name *Alan*.
- The name *Betty* is to designate the individual *b* in the model, and so forth.
Assignment of interpretation to adjectives

I(fit) = \{a,b\}
I(happy) = \{a\}
I(grumpy) = \{b,c\}

- Each adjective will designate a set of individuals (just as a common noun like house, and an intransitive verb like exercise, we have discussed previously).
- Intuitively, we regard each member of the set as having the characteristics described by the adjective.
Toy English

Assignment of interpretation to verbs
• the verbs we have in our lexicon are all transitive verbs: like, know, admire
• they are two-place predicates
• their denotations consist of sets that have members that are ordered pairs

• In order characterize the meanings of verbs, we need another technical device: namely, an ordered pair.
  – Suppose that we have a set \{g, h\}. This is the same set as \{h, g\}, after all both have exactly the same members, so they are the same set.
    \{g, h\} = \{h, g\}

  – The ordered pair \(<g,h>\) is different from the ordered pair \(<h,g>\).
    \(<g,h> \neq <h,g>\)

• in mentioning sets, order does not matter
• in mentioning ordered pairs, the order matters
Toy English

Assignment of interpretation to verbs

$I(likes) = \{<a,b>, <c,a>\}$
Assignment of interpretation to verbs

I(knows) = \{<a,b>, <b,c>, <c,a>, <d,a>\}
Toy English

Assignment of interpretation to verbs

\[ I(\text{admires}) = \{<c,d>, <b,d>, <a,c>, <d,d>, <c,a>\} \]
Toy English

Summary: Assignment of interpretation to verbs

I(likes) = \{<a,b>, <c,a>\}
I(knows) = \{<a,b>, <b,c>, <c,a>, <d,a>\}
I(admires) = \{<c,d>, <b,d>, <a,c>, <d,d>, <c,a>\}
Toy English

Summary: Interpretation function
The interpretation function $I$ assigns:

- to each noun (here a proper name) a member of the model,
- to each adjective (and one-place predicates, in general) a subset of the model,
- to each two-place predicate a set of ordered pairs in the model.

This is an implementation of the idea (introduced in Lecture 1) that meaning is taken to reside in relations between linguistic expressions and things in the world. The meaning of an expression is that relation it has to the things in the world. (Referential theories of meaning.)

Here, the ‘world’ is the model and ‘things in the world’ are individuals.
Toy English

• By assigning extensions to predicates, we \textit{carve the model into sets and relations} and also describe in this way a situation or state of affairs. For example, the way the interpretations are assigned to adjectives and verbs, the model describes a situation in which Alan is happy and likes Betty.
**Toy English**

**Assignment of interpretation to adjectives**

- $I(\text{fit}) = \{a, b\}$
- $I(\text{happy}) = \{a\}$
- $I(\text{grumpy}) = \{b, c\}$
Assignment of interpretation to verbs
I(likes) = \{<a,b>, <c,a>\}
Toy English

• When the domain of discourse (the set of individuals) and the choice of semantic values for the lexical items are fully specified, we have a MODEL and we can determine the truth value of any sentence (or better of a proposition expressed by any sentence) relative to this particular model.
• A sentence is true with respect to (a particular) model $M$.
• A semantic theory that assumes the concept of the interpretation of an expression in a model is called model-theoretic semantics.
Toy English

- **Models and model-theory**
  In general, models are abstract structures that we use as auxiliary devices in providing interpretations. This idea comes from model-theory or model-theoretic semantics.

- **Model-theory**
  - was developed as a branch of modern logic that deals with the semantics of formal systems
  - more generally, it is the study of the interpretation of any language, formal (such as first-order predicate logic) or natural, by means of set-theoretic structures
  - provides rules for assigning meaning (truth conditions) to a language
  - an interpretation function is constructed for mapping the symbols and formulae of a language on to elements in the model (interpretation). The semantics of complex expressions in the language is then defined in terms of their parts.
Toy English

- Model-theoretic semantics for natural language presupposes the truth-conditional approach to meaning

**Gottlob Frege (1848-1925)**

1. The *reference* / denotation of a sentence is its truth value: A sentence will designate *t* if true, and *f* if false. (The True and The False, which Frege took to be objects.)

2. To know the meaning of a declarative sentence is to know its truth conditions, i.e., what makes the sentence true. (It is the *sense* of a sentence, according to Frege, we will discuss it later in class.)

3. ‘Frege’s principle’ / the Principle of Compositionality: The meaning of a compound expression is a function of the meaning of its parts and of the syntactic rule by which they are combined.
Toy English

• A slight historical detour on
  Frege’s principle or the principle of compositionality

It is motivated by two main observations (originally made by Frege):

(1) We can express an infinite number of different meanings in natural language. There are infinitely many well-formed sentences of any natural language, and consequently infinitely many syntactically complex linguistic expressions in a language can have linguistic meanings associated with them. However, the means of a natural language, the set of words and the set of syntactic constructions, is fairly limited.

(2) Expressions with arbitrary meaning, like words (which have largely unmotivated, conventionalized meanings), are put in nonarbitrary meaningful combinations or structures.

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Toy English

• A slight historical detour on Frege’s principle or the principle of compositionality

(1) is related to what is known as the ‘productivity’ of language, one of the essential characteristics of human language that the generative grammar of Chomsky tries to capture:

with a limited set of grammar rules and a finite set of terms, humans are able to produce an infinite number of sentences, including sentences no one has ever uttered.

This idea is related to the Rationalist ideas of a priori knowledge and Chomsky also gives credit to Panini (4th century BC Sanskrit grammarian).
Toy English

- specification of the meaning of sentences (a slight historical detour)

Consequence of (1) and (2) for truth-conditional semantics:
- We must specify an infinite number of truth conditions, an infinite number of states of affairs.
- A simple list will therefore not do, just as in syntax, recursive devices will be required. This is simply the semantic analogue of the fact that indefinitely many complex linguistic expressions can be classed as syntactically well-formed by the grammar.
Toy English

• In order to specify the truth conditions of any declarative sentence (even a sentence that has never been formed), we will make the following assumptions:

  – Just as sentences are defined recursively by syntactic rules, taking words (or morphemes) as their basis, so their meanings will be defined recursively from the meanings ascribed to the words and phrases they contain.
  – We will generate an infinite class of truth conditions while putting them in correspondence with natural language sentences, if we take the syntactic generation of each sentence and match each node with its semantic interpretation.
  – The Principle of Compositionality will be our guiding principle, its bottom-up meaning-determination.
Toy English

- General method for implementing the Principle of Compositionality:

We will set up two algebras (sets of symbols and operations over them)
- one syntactic (syntactic formation rules, A) and
- one semantic (semantic formation rules, B) and define structure-preserving mapping (homomorphism) between them.

The goal is to have semantic rules match one-onto-one with syntactic rules, so we have a rule-by-rule compositional semantics (of predicate logic).
Toy English

• General method for implementing the Principle of Compositionality:

There is a homomorphism mapping (a many-to-one mapping) of elements of the syntactic algebra onto elements of the semantic algebra.

• This allows for different syntactic structures to receive the same semantic values, the same interpretation.

\[ S_1 \xrightarrow{\text{Interpretation}} S_2 \]

• We exclude the possibility that a single syntactic structure could receive two different interpretations.
Toy English

• **Rule 1**

Suppose we have a rule of syntax saying $S_0 \rightarrow S_1 \text{ and } S_2$.

Question: What is the interpretation of the whole sentence? It depends on the interpretation of its immediate constituents.

- $S_0$ will be true if $S_1$ is true and $S_2$ is true,
- $S_0$ will be false otherwise. I.e., if either $S_1$ or $S_2$ is false, or both $S_1$ and $S_2$ are false.

$$
\text{Rule 1: } \\
\begin{array}{c}
S_0 \\
\end{array} \\
\begin{array}{c}
S_1 \text{ and } S_2 \\
\end{array} \\
S_0 \rightarrow S_1 \text{ and } S_2 \\
$$

I($S_0$) = t if I($S_1$) = I($S_2$) = t

I($S_0$) = f otherwise

syntactic formation rule  semantic formation rule
**Toy English**

**Rule 2**

Suppose we have a rule of syntax saying $S_0 \rightarrow S_1 \ or \ S_2$.

Question: What is the interpretation of the whole sentence? It depends on the interpretation of its immediate constituents.

- $S_0$ will be false if both $S_1$ and $S_2$ are false,
- $S_0$ will be true, otherwise.

Rule 2:

- $S_0$  
  - $S_1$  
  - $S_2$

$I(S_0) = f$ if $I(S_1) = I(S_2) = f$

$I(S_0) = t$ otherwise

*syntactic formation rule*  
*semantic formation rule*
Toy English

Rule 3: $S \rightarrow NP \rightarrow VP$

$I(S) = t$ if $I(NP)$ is a member of $I(VP)$

$I(S) = f$ if $I(NP)$ is not a member of $I(VP)$.

Example: *Alan is happy* is true just in case Alan is a member of the set of those individuals who are happy.
Rule 4:

\[
\text{NP} \quad \quad \quad I(\text{NP}) = I(w)
\]

\[
\quad w \quad \quad \quad 'w': \text{any word of the appropriate category}
\]
Toy English

Rule 5: $\text{VP} = \text{I(VP)} = \text{the set of first members of ordered pairs in I(V) that have I(NP) as a second member}$

Suppose that our V is *know*, and the direct object NP is filled by the proper name *Alan*. Independently, we already specified that the meaning of *know* is: $I(\text{know}) = \{<a,b>, <b,c>, <c,a>, <d,a>\}$

Since the direct object NP is *Alan*, the meaning of the V in our world is the set of those who know Alan.

In our model, it is the set consisting of Cathy and Dean. Cathy and Dean are the first members of the ordered pairs that have Alan as the second member.
Toy English

Rule 6: \[ V \quad I(V) = I(w) \]

\[ w \quad 'w': \text{any word of the appropriate category} \]
Rule 7: \[ \text{VP} \quad \text{I(VP)} = \text{I(Adj)} \]

\[ \begin{array}{c}
\text{is} \\
\text{Adj}
\end{array} \]
Toy English

Rule 8:

Adj

I(Adj) = I(w)

w

‘w’: any word of the appropriate category
• We begin the interpretation of the sentence *Alan is fit and Cathy admires Dean* from the bottom (see the **Principle of Compositionality**).
• We assign each of the words in this sentence the meanings specified in the lexicon.
• We then replace each word in the tree by its interpretation.
Toy English

Note on syncategorematic words:

• *and, or* and *is* are not in the lexicon. The reason for this is that they have no independent meaning of their own, when standing in isolation.
• Such words are called syncategorematic words.
• Since they are treated as not bearing independent meaning, they are not treated as lexical items of a particular category of its own.
• A word like *fit* is a categorematic word, it has a meaning by itself.
Toy English

We will represent the derivation of the meaning of a sentence in an analysis tree. Every node of an analysis tree is labeled with

• an expression (a word from our vocabulary),
• its syntactic category (S, NP, VP, V, Adj), and
• the name of the rule used in its interpretation.

The derivation steps are highlighted in red.

We also make a simplifying assumption that at each step of derivation, the previous steps in a derivational history are still accessible (‘visible’).
Toy English

We apply Rule 4 (three times), interpreting each NP node:

Rule 4:

\[ I(NP) = I(w) \]

‘w’: any word of the appropriate category
Toy English

We apply rule 6, regarding the interpretation of the V node. I.e., we replace the V node in the tree with $I(\text{admires}) = \{<c,d>, <b,d>, <a,c>, <d,d>, <c,a>\}$

Rule 6: 

\[ V \quad I(V) = I(w) \]

\[ w \quad 'w': \text{any word of the appropriate category} \]
Toy English

Let us now apply Rule 8, regarding the interpretation of the Adjective node. I.e., we replace the Adj node in the tree with \( I(\text{fit}) = \{a,b\} \)

Rule 8: \[ \text{Adj} \rightarrow \text{I}(\text{w}) \]

\( \text{w} \) : any word of the appropriate category
Toy English

Let us now apply Rule 7, interpreting the VP node with the interpretation of Adj

Rule 7:

$$I(\text{VP}) = I(\text{Adj})$$

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Toy English

• Let us now assign an interpretation to the VP in the second conjunct. In accordance with

Rule 5: $\text{VP}$

$I(\text{VP}) = \text{the set of first members of ordered pairs in } I(V) \text{ that have } I(\text{NP}) \text{ as a second member}$

• we are looking for the set of those who admire Dean, i.e., we take the set representing the meaning of $\textit{admire}$. This amounts to finding all the pairs that have $d$ as a second member, and then pick all the first members of these ordered pairs:

$\{<c,d>, <b,d>, <a,c>, <d,d>, <c,a>\}$

hence, the meaning of the VP $\textit{admire Dean}$ is the set $\{b, c, d\}$
• Let us now assign an interpretation to the VP in the second conjunct. In accordance with

Rule 5:

\[ I(VP) = \text{the set of first members of ordered pairs in } I(V) \text{ that have } I(NP) \text{ as a second member} \]

\[ S_0, R1: t \]

\[ S_1, R3: t \]

\[ S_2, R3: t \]

\[ Allan, NP, R4: a \text{ is } \text{fit, VP, R7: } \{a,b\} \]

\[ fit, \text{Adj R8: } \{a,b\} \]

\[ Alan \text{ is fit} \]

\[ Cathy, NP, R4: c \text{ admires Dean, VP, R5: } \{b,c,d\} \]

\[ admires, V, R6: \{<c,d>, <b,d>, <a,c>, <d,d>, <c,a>\} \]

\[ Dean, NP, R4: d \]

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**Toy English**

We apply Rule 3 to the first conjunct. We see that $a$ is indeed a member of the set \{a,b\}, so the interpretation of the first S is $t$:

Rule 3: $S$

- $I(S) = t$ if $I(NP)$ is a member of $I(VP)$
- $I(S) = f$ if $I(NP)$ is not a member of $I(VP)$

We apply Rule 3 to the first conjunct. We see that $a$ is indeed a member of the set \{a,b\}, so the interpretation of the first S is $t$:  

- $S_0$, R1: $t$
- $S_1$, R3: $t$
- $S_2$, R3: $t$

$S_1$, R3: $t$

- Allan, NP, R4: a
- is, VP, R7: \{a,b\}
- fit, Adj R8: \{a,b\}

- Alan, is, fit
- and

$S_2$, R3: $t$

- Cathy, NP, R4: c
- admires, Dean, VP, R5: \{b,c,d\}
- admires, V, R6: \{<c,d>, <b,d>, <a,c>, <d,d>, <c,a>\}

- Cathy, admires
- and

- Dean, NP, R4: d
- Dean
Toy English

We apply Rule 3 to the second conjunct. We see that c is indeed a member of the set \{b, c, d\}, so the interpretation of the second S is \(t\):

\[
\begin{align*}
\text{Rule 3:} & \quad S \\
\text{NP} & \quad \text{VP} \\
\text{I(S) = t} & \quad \text{if I(NP) is a member of I(VP)} \\
\text{I(S) = f} & \quad \text{if I(NP) is not a member of I(VP).}
\end{align*}
\]
We may now apply Rule 1 for the entire sentence.

Rule 1:

\[ I(S_0) = t \text{ if } I(S_1) = I(S_2) = t \]
\[ I(S_0) = f \text{ otherwise} \]

Since the interpretations of both conjuncts are \( t \), the interpretation of the whole \( S_0 \) is \( t \), as well.

Allan, NP, R4: a  is fit, VP, R7: \{a,b\}

fit, Adj R8: \{a,b\}

Alan  is  fit

Cathy, NP, R4: c

admires, V, R6: \{<c,d>, <b,d>, <a,c>, <d,d>, <c,a>\}

Dean, NP, R4: d

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Conclusion:

Our rules of interpretation specify that the sentence *Alan is fit and Cathy admires Dean* is true with respect to the model we have.
1. **Assuming the above simple fragment of English (Toy English), answer the following questions:**

Question I: What claim are we making here about the relationship between *admiring* and *liking*?

Question II: We are making a somewhat strange claim about the meaning of *knows*. What is it?
Homework 3

Due September 29

Question III: What are the interpretations for the sentences below?
Draw a tree diagram for each allowed by the few syntactic rules found above, and assign interpretations to all the nodes. Instead of drawing a new tree every time you apply a rule, you may work with just one tree diagram, and working bottom-up write the interpretation for each node immediately next to it.

a. Betty is happy.
b. Dean admires Alan or Betty is grumpy.
c. Cathy knows Alan and Alan likes Betty.
2. **Funny Church Bulletins.**

Drawing on your knowledge of relations among words and sentences, and the influence of extra-linguistic pragmatic factors on the interpretation of words and sentences (discussed in lecture 2 and in de Swart Chapter 1 and 2), try to explain in as precise terms as possible what is the source of oddity (and hence of the funny effect) in the following sentences.

You should identify whether the oddity/funny effect is due to lexical ambiguity, structural ambiguity, unintended coreferentiality, etc.

a. Don't let worry kill you - let the church help.

b. Wednesday the ladies liturgy will meet. Mrs. Johnson will sing "Put me in my little bed accompanied by the pastor."

c. At the evening service tonight, the sermon topic will be "What is Hell?" Come early and listen to our choir practice.

d. The pastor would appreciate it if the ladies of the congregation would lend him their electric girdles for the pancake breakfast next Sunday morning.

e. Eight new choir robes are currently needed, due to the addition of several new members and to the deterioration of some older ones.

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