# Integrating Syntactic and Semantic Annotation of Biomedical Text

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# Contributors

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## Other

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# Goal

- Information Extraction from the biomedical literature, particularly Medline
  - Enzyme Inhibition Relations

    Expression of CYP3A11 and PXR was suppressed by inactivation of HNF4alpha

    customer: GlaxoSmithKline
  - Mutation/Malignancy Relations

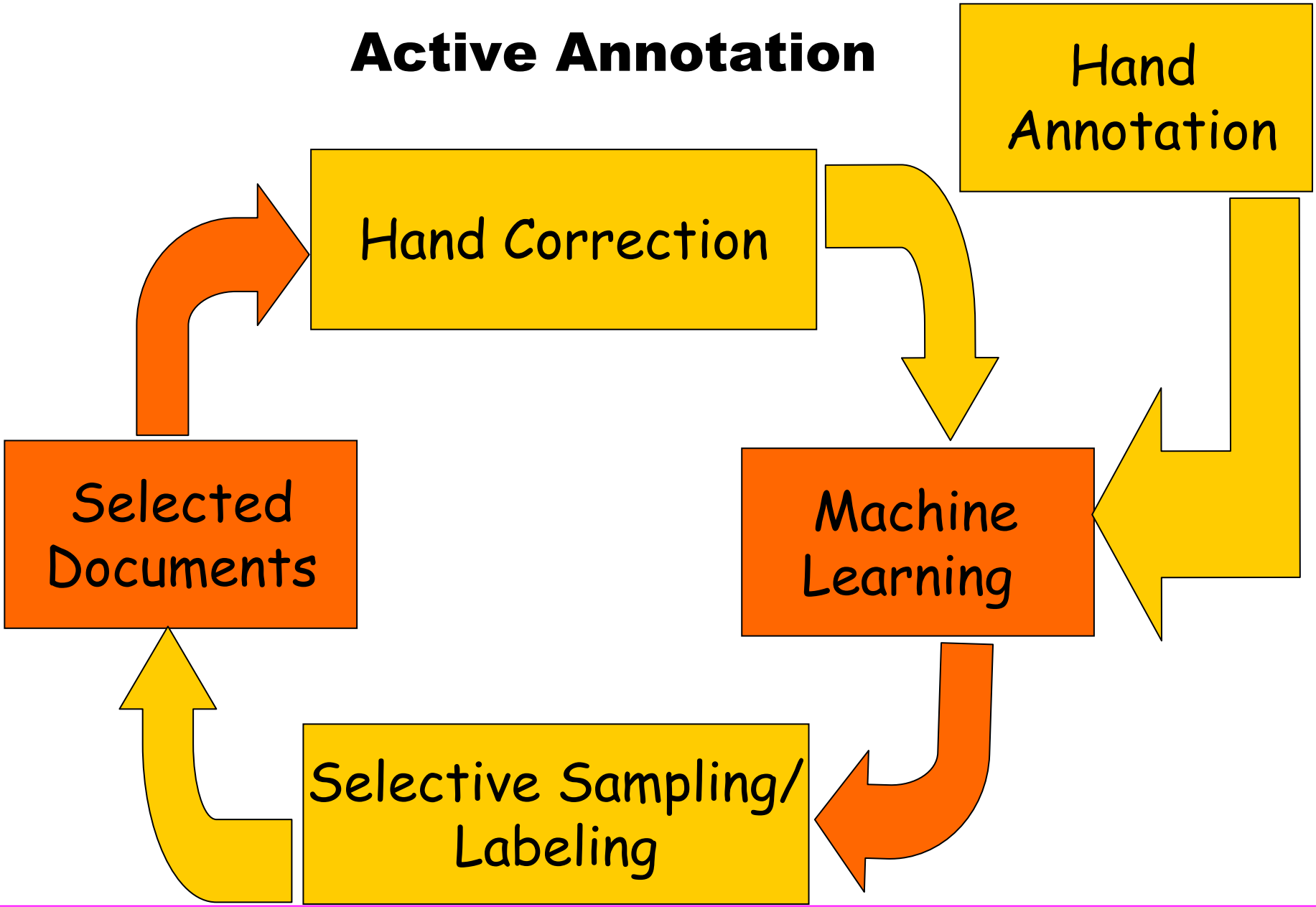
    Ki-ras mutations were detected in 17.2% of the adenomas.

    customer: eGenome
- Annotate 1-10K abstracts for each domain

# Approach to Information Extraction

- Phase 1:
  - Develop definitions and ontologies
  - Annotate data according to definitions
- Phase 2: Train corpus-based algorithms exploiting various annotation:
  - Parsing
  - Predicate-argument analysis
  - Reference resolution
- Phase 3: "Active Annotation"

# Active Annotation



# Challenge: Diversity in Expression

1. "Activation of the C-Ki-ras genes by point mutations in codons 12 or 13..."
2. "Point mutations in codons 12 and 13 activated C-Ki-ras"
3. "Point mutations in codons 12 and 13 were activators of C-Ki-ras gene"

Want to populate a factbank with:

activation(C-Ki-ras, point mutation in codon 12)

activation(C-Ki-ras, point mutation in codon 13)

# Approaches to Handling Diversity

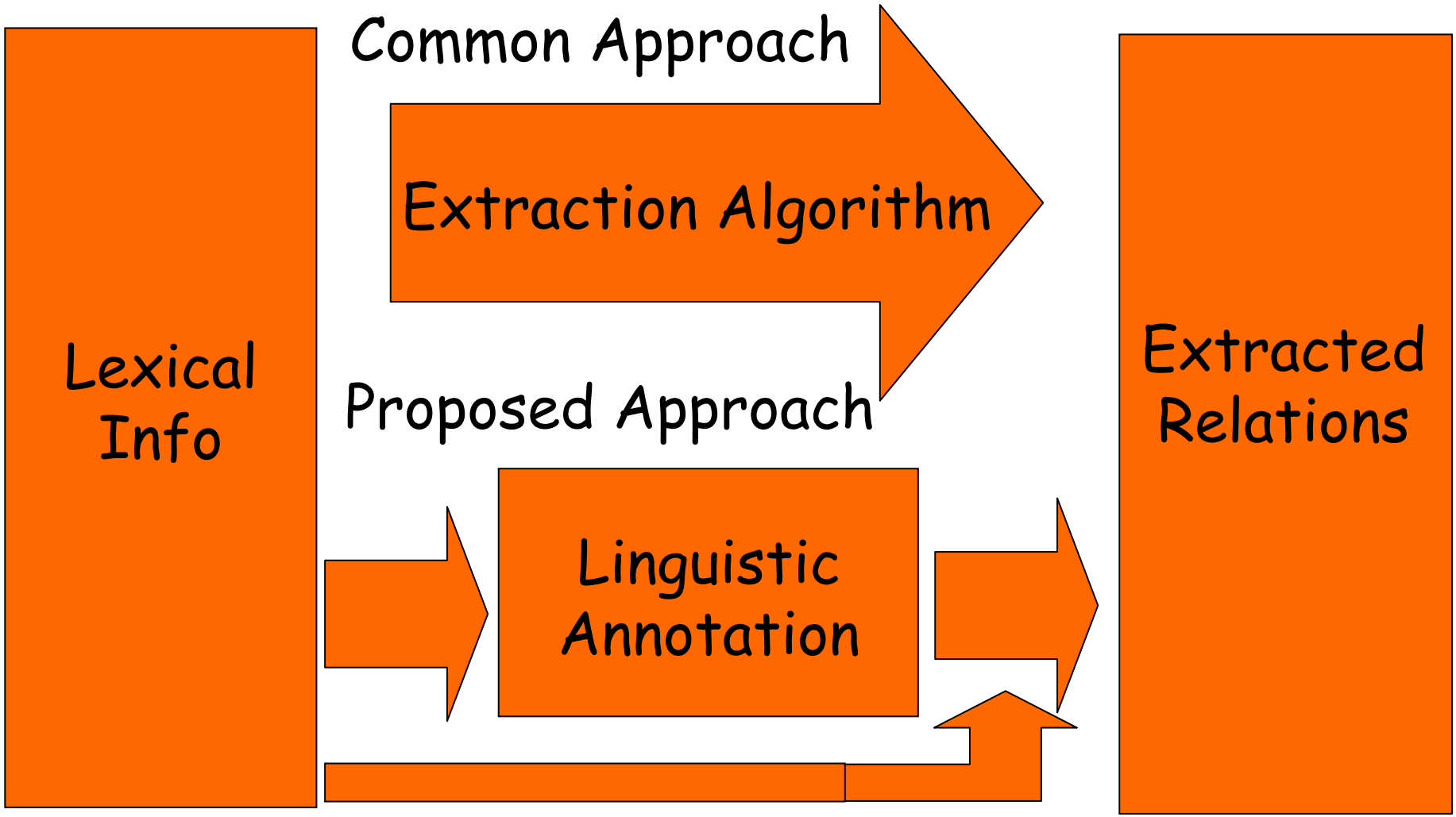
- Current Approach is to either:
  - Hand build extraction patterns to cover all variant expressions

    **or**

  - Annotate **lots** of data to get examples of variant expressions (for machine learning)
- Proposed Approach:

  Linguistic analysis of the sentences

# Information Extraction Approaches



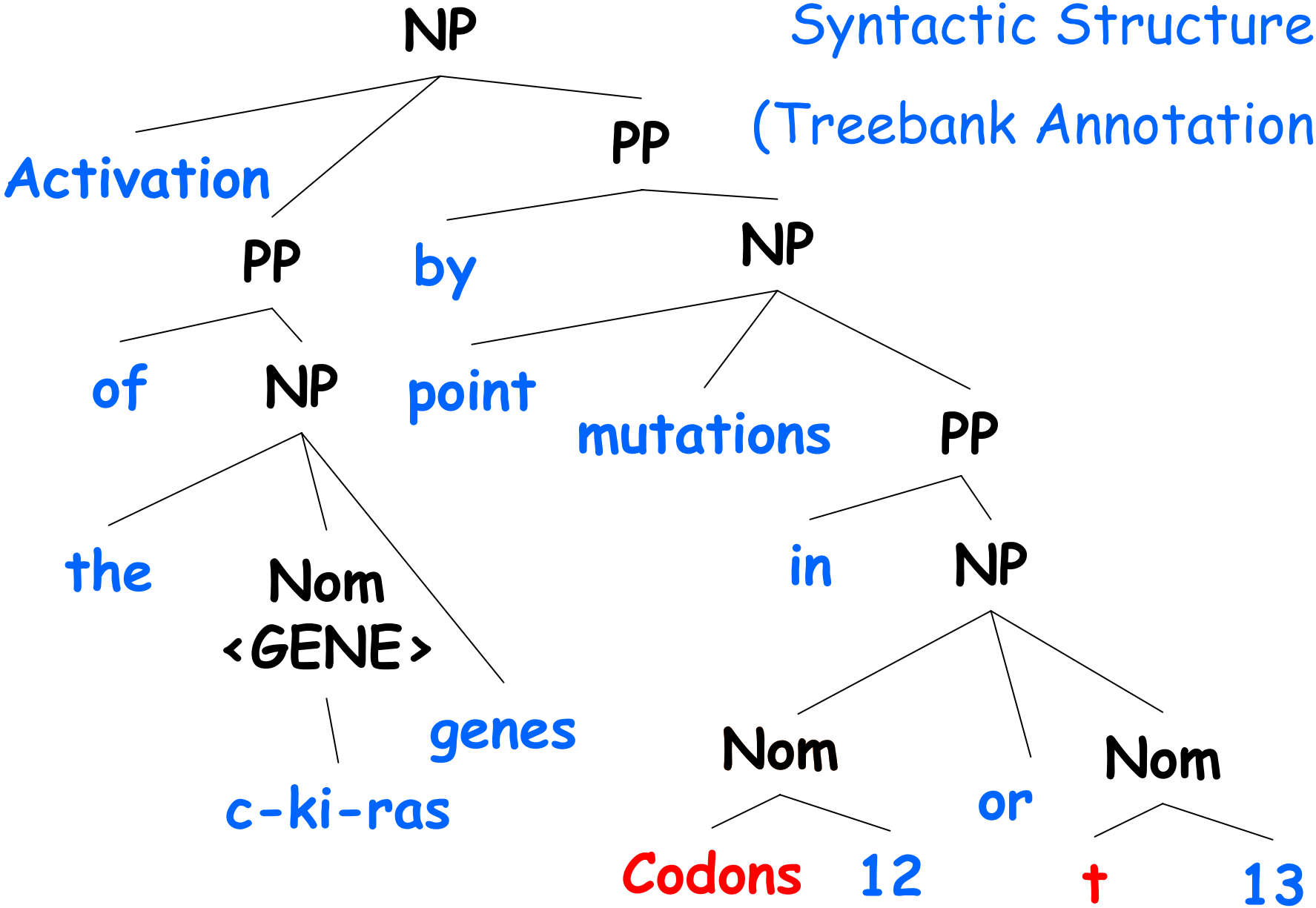
# Our Annotation Effort

**Together for the first time…**

Annotations include:

- Treebank (Syntax)
- Probank (predicate-argument structure)
- Entities (genes, malignancies)
- Reference and Coreference
- Factbanking (end goal)

# Syntactic Structure (Treebank Annotation)



# More Examples of Coordination

- "the ortho and meta positions"
  - (= the ortho positions and meta positions)
- "PLC and cytochrome P450 arachidonate epoxygenase activity"
  - (= PLC arachidonate epoxygenase activity and cytochrome P450 arachidonate…)
- "enhanced CYP2C9 expression and 11,12 EET production"
  - (= enhanced CYP2C9 expression and enhanced 11,12 EET production)

# Predicate-Argument Annotation: Propbank

- "Point mutations in codons 12 and 13 were activators of C-K-ras genes"
- "Activation of the C-K-ras genes by point mutations in Codons 12 or 13..."
- Predicate-Argument Structure (Propbank):
  - REL: activation
    activatee: c-ki-ras genes
    activator: point mutations in codons 12 or 13
  - REL: mutations
    type: point
    position(s): Codons 12 or 13

# Why Combine Treebank and Propbank?

- Treebank indicates constituents
  - subject, verb, direct object, etc.
- Propbank indicates roles of constituents
  - "agent," "theme," "quantification", etc.
  - inhibitor, inhibitee, inhibition rate
- Prior work combines Treebank/Propbank for financial text IE:

  (Surdeneau et al., 2003, Gildea and Palmer, 2002)

# Entity Annotation

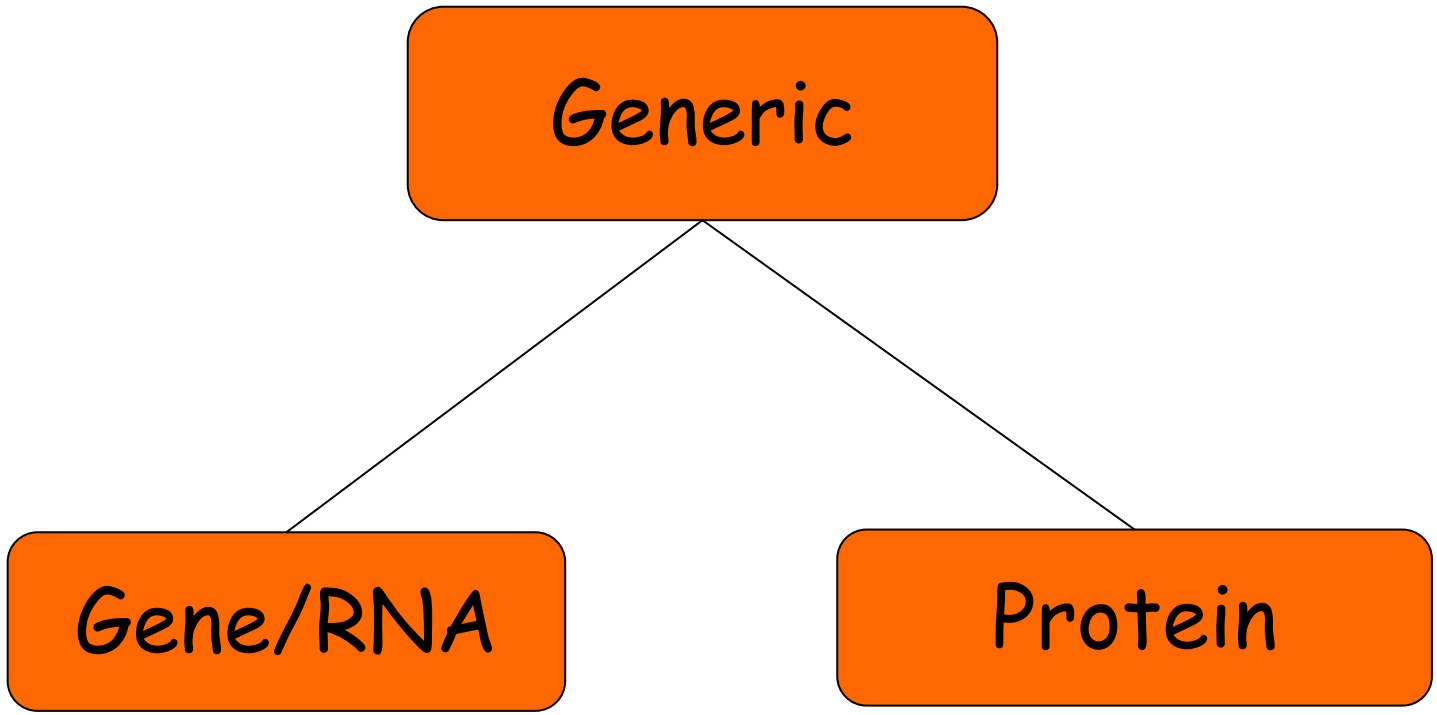
- Entities we annotate include:

  "gene", "protein", "substance", "malignancy"

- Metonymy Issues:
  - is a reference a gene or a protein?
  - We use subtypes, following ACE conference convention
  - Gene is broken in to three categories:

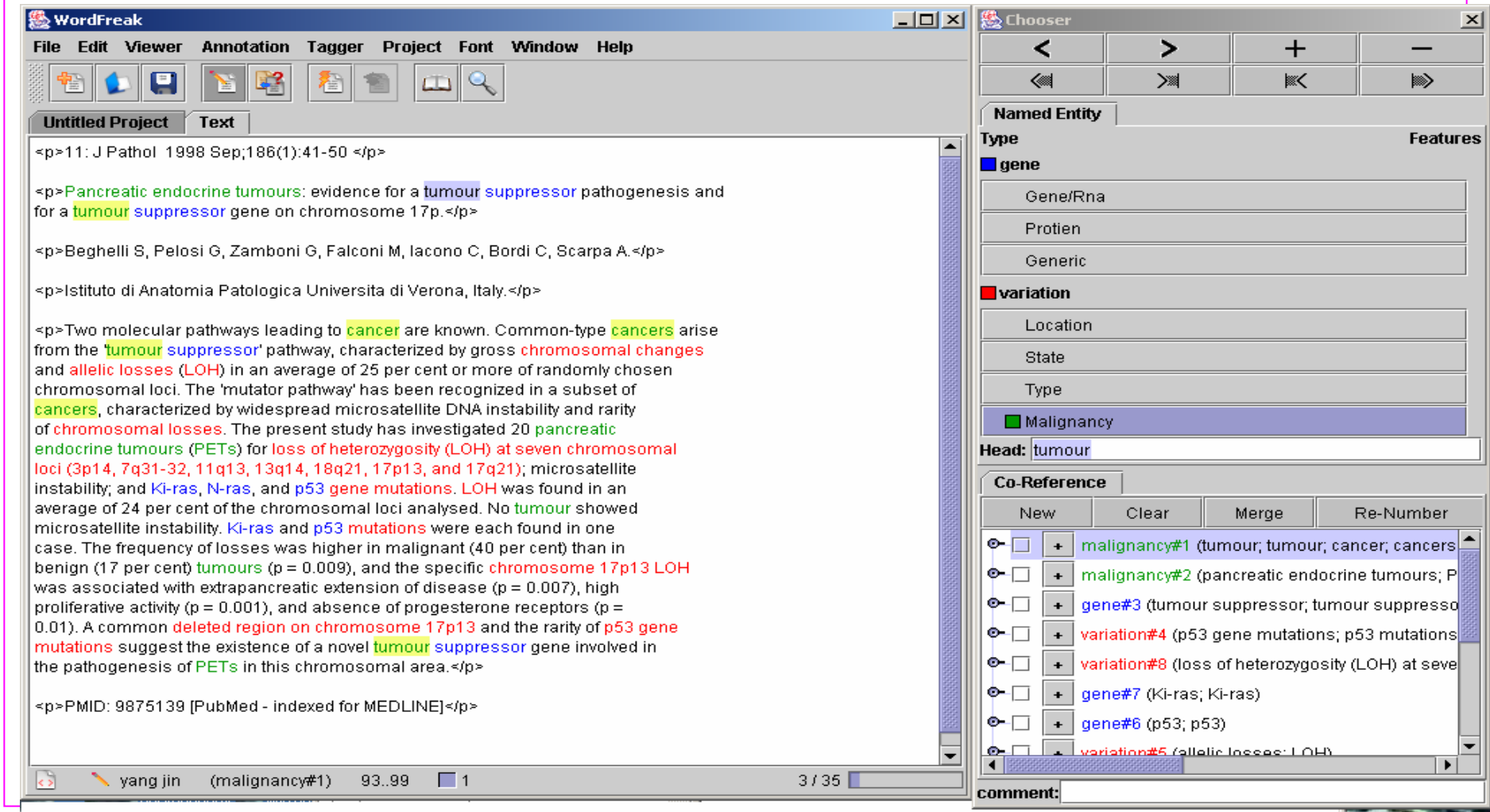
    "Generic," "Gene/RNA" and "Protein"

# The Gene Entity



# WordFreak Annotation Tool

Morton, Lacivita, Pancoast: www.annotation.org



# Reference and Co-reference Annotation

- Co-reference is an equivalence relation
- subtypes prevent nonsense in a co-ref graph

Example of reference types:

"K-Ras is a member of the Ras family of Oncogenes. The protein form is actively expressed in…"

class-membership(K-Ras, Ras family)

anaphor(K-Ras_protein, protein form)

# Current Activities

- In Progress:
  - Entity Annotation of "Gene," "Chemical," "Malignancy," "genetic variation," etc.
  - POS annotation
  - Training Treebank Syntactic Annotators
- Starting Up:
  - Start coreference annotation
  - Build our first entity tagging models

# Some Projected Milestone Dates

- January 2004 -

  Entity tagging and coreference on oncology domain complete. We publish:

  - annotation guidelines
  - data
  - baseline statistical taggers

- May 2004 -

  First draft syntactic analysis of oncology domain

(1-10K Medline abstracts)

# Some Annotation Projects and Related Research

- GENIA Project and U Tokyo Work:
  http://www-tsujii.is.s.u-tokyo.ac.jp/GENIA
- Pasta system and Sheffield Work:
  http://nlp.shef.ac.uk/research/areas/bio.html
- GENIES system and Columbia/CUNY Work
- Modeling Linguistic Phenomenon:
  - Ray/Craven, IJCAI-2001
  - Pustejovsky et al. 2003

# The End.

# Some Examples Follow

# Reference and Co-reference

- Our reference subtypes are:
  - Acronyms (definitions and linkages)
  - Anaphor (such as pronouns)
  - Classes versus their members
  - "Is-a" relation,

    i.e. "{CYP450}, {an enzyme} found in…"
  - Standardized database reference

# Complex Coordination Example

Inhibition of CB -52 and -101 metabolism

Note coordination of "CB" and also "metabolism"!

The sentence above can be represented as:

Inhibition of CB-52 metabolism and CB-101 metabolism)