

Supplemental Natural Language Processing (NLP) Algorithm Material

Task 1 (automated detection of diabetic retinopathy screening and treatment):

Dictionary Creation: A set of target terms were created by a domain expert to indicate the presence of diabetes mellitus, diabetic retinopathy staging and complications, diabetic retinopathy treatments, diabetic retinopathy examination findings, and counseling related to diabetes mellitus. This was done through an iterative process based on review of the development set to maximize true positives and minimize false positives and false negatives.

Text Processing: Notes were separated into two types based on structured metadata: problem list notes and progress notes.

Rule Creation: The target terms were divided into groups based on specificity of the search terms for diabetic retinopathy screening and treatment and ranked in priority for the search.

1. The first search was for diabetic retinopathy staging and complications (e.g., proliferative diabetic retinopathy, juxtafoveal edema) or counseling related to diabetes mellitus (e.g., blood sugar control). (82.1% of notes were labeled using this search parameter)
2. The second search was for a generic mention of diabetes mellitus (e.g., diabetes) combined with a diabetic retinopathy examination finding (e.g., neovascularization, exudates). (2.1%)
3. The last search, only applicable to problem list notes, was for diabetes mellitus related International Classification of Diseases (ICD) code (see Supplemental Table 1) combined with a diabetic retinopathy treatment (e.g., avastin). (15.8%)

Rule-based NLP Method: The output was a binary label indicating if the note addressed diabetic retinopathy screening or treatment.

Task 2 (provider recommended follow-up):

Dictionary Creation: A set of target terms and character patterns were created by a domain expert to flag the section of the ophthalmology provider note that is likely to be preceded by or followed by the return time interval recommendation. This was done through an iterative process based on qualitative review of the development set.

Text Processing: Text processing was tailored to the specific type of note analyzed (progress note and problem list notes).

For problem list notes, notes were searched for the target term list and character patterns according to the following priority: 1) the last 85 characters of the note, and then 2) the entire note. If this initial search did not return a recommended follow-up, then the last search was for a number followed by a date type in the 3) last 15 characters of the note (6.4% of problem list notes were labeled using this search parameter).

For progress notes, 10 characters before and 50 characters after mentions of diabetic retinopathy screening and treatment related terms (outlined in Task 1) were searched first. This criterion was selected after manual review of the development set notes to

optimize search results. If this search did not return a recommended follow-up, then the note was searched as described above.

Rule Creation: The target term list and character patterns were divided into eight groups based on where the return recommendation timeframe was likely to appear, whether before or after the term. The search range varied as a function of the target term. The groups were also ranked in priority for the search based on specificity of the term.

1. Return to clinic keywords: e.g. “return” in 3 months, “rtc” 4 weeks, “ret” to clinic in 2 days (38.1%, the proportion of notes labeled using this target term and search parameter)
2. Follow-up keywords: e.g. “followup” with me, “f/u” in 8 days (27.7%)
3. Dilation keywords: e.g. “dil” 6mo, repeat “dfe” in 2 weeks, “dilation” due in 6 months, annual “dilated fundus exam” (10.00%)
4. After keywords: The terms that contain the follow-up time after its occurrence e.g. “monitor” in 6 months, “monitor every” 4 weeks (9.2%)
5. Ambiguous "return" keywords: e.g. come “back in” 2 weeks, “repeat in” 2 days, “recheck in” 5 days, “re-evaluate” in 5 weeks, “see me” in 6 weeks (5.2%)
6. Medication keywords: e.g. “Eylea” due in another 4 weeks, “Lucentis”, “Avastin” (3.4%)
7. Before keywords: The terms that contain the follow-up time before its occurrence e.g. 6mo “with testing”, 1 year “testing hvf”, 6mo and “sooner if worse” (<0.1%)
8. Appointment keywords: e.g. “appointment” in 6mo, “evaluation” annually, another “examination” in 1 year, “examine” again in 4 weeks, “next visit” in 6 months (<0.1%)

Rule-based NLP Method: The output was a numeric (e.g., 4-6) and date type (e.g., day, week, month, year) for the recommended follow-up timeframe when available, and otherwise a null value.

Python scripts for both tasks are available at: <https://github.com/wilson3090/NLP-for-Patient-Notes>