

1/13/24 - First team meeting

Attendees: Milan Haruyama, Tabitha O'Malley, David Serfaty

Task List:

- Discussion of Project Vision
- Review for Project Presentation
- Update Scrumwise (Sprint 4)

Sprint 4:

- SRS V4
- SDS V4
- Test Plan V4
- Presentations
- Product Vision
- Software Installation
- User Manual (Installation) V1

Models to be worked on:

- Use Case V5 (Sprint 4)
- Scenarios (Sprint 5)
- DFD V4 (Sprint 4)
- Class Diagram V4 (Sprint 5)
- State Model (Sprint 5)
- CRC (Sprint 4)
 - Hierarchy (Sprint 5)
 - Collaboration Graph (Sprint 5)
 - Subsystems (Sprint 5)

Current Assignments:

Milan - SRS & SDS

David - User Manual (Installation Section)

Tabitha - Test Plan

Full Team - Presentations & Product Vision

Tisha - Software Installation

1/18/24 - First class meeting

Attendees: Milan Haruyama, Tabitha O'Malley, David Serfaty, Adam Gallub

Task List:

- Product Vision
- Overview of current models
- Organize file system/define new numbering system for models
- Start CRC

Models to be worked on:

- CRC

Current Assignments:

- Milan - Product Vision & SRS
- Adam - User Manual
- Tabitha - Models/CRC
- David - Models/CRC

Notes:

- Reorganized and defined file structure
- Began work on CRC
- Reviewed older models
- Contacted Dr. Ochoa for resources and feedback

1/20/24 - Second out-of-class meeting

Attendees: Milan Haruyama, Tabitha O'Malley, David Serfaty, Adam Gallub, Tahmina Tisha

Task List:

- Delete Kaldi - Adam
- Mac Installation - Tisha
 - Setup
 - Email Liu
- Timeline for SRS and SDD - Milan
- Start CRC cards - David/Tabitha
- Product Vision - David/Tabitha
- Starting Installation Process w/ notes - Adam

Models to be worked on:

- CRC

Notes:

- Updated Product Vision
- Helped Adam with Kaldi install
- Helped Tabitha with new PC setup
- Started CRC
 - Began creating and listing keywords

1/22/24 - Third out-of-class meeting

Attendees: Milan Haruyama, Tabitha O'Malley, David Serfaty, Adam Gallub

Task List:

- Discuss Kaldi with Dr. Liu
- Finish Product Vision
- Install Kaldi - Adam
- Go over SDD & SRS

Models to be worked on:

- CRC
- *Class Diagram*

Notes:

- Met with Dr. Liu
- Finished product vision statement
- Went over SDD, will cry

1/23/24 - Second class meeting

Attendees: Milan Haruyama, Tabitha O'Malley, David Serfaty, Tahmina Tisha

Task List:

- Update github README.md
- Go over list of future changes to SDD
- Update Use case diagram
- Update Context diagram
- Update DFD L1

Models to be worked on:

- Use Case
- Context diagram
- DFD L1
- CRC

Notes:

- Markdown is fun
- Updated use case to Dr. Liu's specifications
- Updated SDD to include new Use Case Diagram
- Updated context diagram
- Updated Use cases in SDD
- Updated DFD L1 & L2
- Updated Training DFD L1
- Updated SDD 1.2.1
- Updated SDD 2.2

1/25/24 - Third class meeting

Attendees: Milan Haruyama, Tabitha O'Malley, David Serfaty, Tahmina Tisha, Adam Gallub

Task List:

- CRC (sobbing)
- SDD V4

Models to be worked on:

- CRC

Notes:

- CRC is agony
- Discussing MFC and Viterbi decoder
- AGONY

Pseudocode [\[edit \]](#)

This algorithm generates a path $X = (x_1, x_2, \dots, x_T)$, which is a sequence of states $x_n \in S = \{s_1, s_2, \dots, s_K\}$ that generate the observations $Y = (y_1, y_2, \dots, y_T)$ with $y_n \in O = \{o_1, o_2, \dots, o_N\}$, where N is the number of possible observations in the observation space O .

Two 2-dimensional tables of size $K \times T$ are constructed:

- Each element $T_1[i, j]$ of T_1 stores the probability of the most likely path so far $\hat{X} = (\hat{x}_1, \hat{x}_2, \dots, \hat{x}_j)$ with $\hat{x}_j = s_i$ that generates $Y = (y_1, y_2, \dots, y_j)$.
- Each element $T_2[i, j]$ of T_2 stores \hat{x}_{j-1} of the most likely path so far $\hat{X} = (\hat{x}_1, \hat{x}_2, \dots, \hat{x}_{j-1}, \hat{x}_j = s_i) \forall j, 2 \leq j \leq T$

The table entries $T_1[i, j], T_2[i, j]$ are filled by increasing order of $K \cdot j + i$:

$$T_1[i, j] = \max_k (T_1[k, j-1] \cdot A_{ki} \cdot B_{iy_j}),$$

$$T_2[i, j] = \operatorname{argmax}_k (T_1[k, j-1] \cdot A_{ki} \cdot B_{iy_j}),$$

with A_{ki} and B_{iy_j} as defined below. Note that B_{iy_j} does not need to appear in the latter expression, as it's non-negative and independent of k and thus does not affect the argmax.

Input

- The **observation space** $O = \{o_1, o_2, \dots, o_N\}$.
- the **state space** $S = \{s_1, s_2, \dots, s_K\}$.
- an array of initial probabilities $\Pi = (\pi_1, \pi_2, \dots, \pi_K)$ such that π_i stores the probability that $x_1 = s_i$.
- a sequence of observations $Y = (y_1, y_2, \dots, y_T)$ such that $y_t = o_i$ if the observation at time t is o_i .
- **transition matrix** A of size $K \times K$ such that A_{ij} stores the **transition probability** of transitioning from state s_i to state s_j .
- **emission matrix** B of size $K \times N$ such that B_{ij} stores the probability of observing o_j from state s_i .

Output

- • The most likely hidden state sequence $X = (x_1, x_2, \dots, x_T)$

Explanation

Suppose we are given a [hidden Markov model](#) (HMM) with state space S , initial probabilities π_i of being in the hidden state i and transition probabilities $a_{i,j}$ of transitioning from state i to state j . Say, we observe outputs y_1, \dots, y_T . The most likely state sequence x_1, \dots, x_T that produces the observations is given by the recurrence relations^[10]

$$V_{1,k} = P(y_1 | \pi_k) \cdot \pi_k,$$
$$V_{t,k} = \max_{x \in S} (P(y_t | \pi_k) \cdot a_{x,k} \cdot V_{t-1,x}).$$

Here $V_{t,k}$ is the probability of the most probable state sequence $P(x_1, \dots, x_t, y_1, \dots, y_t)$ responsible for the first t observations that have k as its final state. The Viterbi path can be retrieved by saving back pointers that remember which state x was used in the second equation. Let $\text{Ptr}(k, t)$ be the function that returns the value of x used to compute $V_{t,k}$ if $t > 1$, or k if $t = 1$. Then

$$x_T = \arg \max_{x \in S} (V_{T,x}),$$
$$x_{t-1} = \text{Ptr}(x_t, t).$$

Here we're using the standard definition of [arg max](#).

The complexity of this implementation is $O(T \times |S|^2)$. A better estimation exists if the maximum in the internal loop is instead found by iterating only over states that directly link to the current state (i.e. there is an edge from k to j). Then using [amortized analysis](#) one can show that the complexity is $O(T \times (|S| + |E|))$, where E is the number of edges in the graph.

- Try and understand the viterbi decoder/decoding class
- Progress made on CRC

1/27/24 - Fourth out-of-class meeting

Attendees: Tabitha O'Malley, David Serfaty, Adam Gallub, Milan Haruyama, Tahmina Tisha

Task List:

- Research Viterbi Decoder
- Research HMM
- Research GMM
- Work on CRC

Models to be worked on:

- CRC

Notes:

- Math is cringe
- Fourier Transforms are overly complicated
- GMM is a myth
- Creation of [Kaldi Math document](#)
- Kaldi user docs are unreadable garbage

1/29/24 - Fifth out-of-class meeting

Attendees: Tabitha O'Malley, David Serfaty, Milan Haruyama, Adam Gallub

Task List:

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Models to be worked on:

- CRC

Notes:

- Reorganized task list and scrumwise
- Studied GMM, HMM, and MFC
- Too much math
- Redistributed tasks and time
- Pain

1/30/24 - Fourth class meeting

Attendees: David Serfaty, Tahmina Tisha, Tabitha O'Malley, Milan Haruyama, Adam Gallub

Task List:

- SDD
- SRS
- CRC
- Class diagram

Models to be worked on:

- CRC
- Class diagram

Notes:

- Updated Requirements
- Researched GMM & HMM

2/1/24 - Fifth class meeting

Attendees: David Serfaty, Tahmina Tisha, Tabitha O'Malley, Milan Haruyama, Adam Gallub

Task List:

- Update class diagram

Models to be worked on:

- Class Diagram

Notes:

- Worked on class diagram

2/4/24 - Sixth out-of-class meeting

Attendees: David Serfaty, Tabitha O'Malley, Milan Haruyama

Task List:

- SRS 2.3, 3, 4, Appendix
- SDD 1.2.2, 2.1, 4.2
- Update Class Diagram

Models to be worked on:

- Class Diagram

Notes:

- Worked on class diagram
- Worked on SDD 2.1

2/5/24 - Seventh out-of-class meeting

Attendees: David Serfaty, Tahmina Tisha, Tabitha O'Malley, Milan Haruyama, Adam Gallub

Task List:

- Finish Demo

Models to be worked on:

- N/A

Notes:

- Worked on slides

2/6/24 - Sixth class meeting

Attendees: David Serfaty, Tahmina Tisha, Tabitha O'Malley, Milan Haruyama, Adam Gallub

Task List:

- Finish demo presentation
- Examine/update Test plan

Models to be worked on:

- N/A

Notes:

2/10/24 - Tenth out-of-class meeting

Attendees: David Serfaty, Tahmina Tisha, Tabitha O'Malley, Milan Haruyama, Adam Gallub

Task List:

- Test Plan
- Script from Liu
- Submit presentation

Models to be worked on:

- N/A

Notes:

- Test plan is cringe
- Jammin out
- Test Plan section 6 & 7
- Section 3.1

2/12/24 - Eleventh out-of-class meeting

Attendees: David Serfaty, Tabitha O'Malley, Milan Haruyama, Adam Gallub

Task List:

- Sorting out sprint 5
- Finalize sprint 4

Models to be worked on:

- N/A

Notes:

- Coming up with and finalizing goals of sprint 5
- Ending sprint 4
- Started sprint 5
- Working on test plan
- Reorganized files to set up sprint 5 folder
- Edited section 3.1 of test plan

2/13/24 - Seventh class meeting

Attendees: David Serfaty, Tabitha O'Malley, Milan Haruyama, Tahmina Tisha

Task List:

- Test plan

Models to be worked on:

- N/A

Notes:

- Worked on test plan/requirements

2/15/24 - Eighth class meeting

Attendees: David Serfaty, Tabitha O'Malley, Milan Haruyama, Tahmina Tisha, Adam Gallub

Task List:

- Test plan section 4.1

Models to be worked on:

- N/A

Notes:

- Worked on test plan 4.1
- Execution plan
- Updated requirements with formulas
- Tired