vCARE
VIRTUAL COACHING ACTIVITIES
FOR REHABILITATION IN ELDERLY

30-08-22 **AI COMPONENTS IN VCARE**

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CONTEXT-AWARE RECOMMENDATION

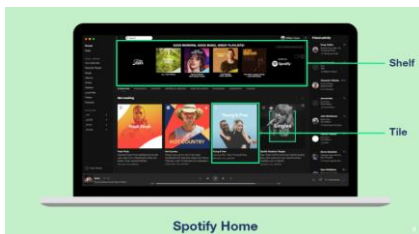Recommendation / Personalization in daily life:

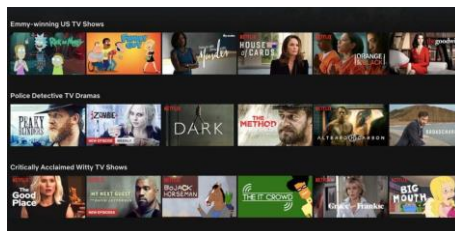Figure 1: Recommender system by Spotify [1]

Figure 2: Recommender system by Netflix [2]

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CONTEXT-AWARE PERSONALIZATION
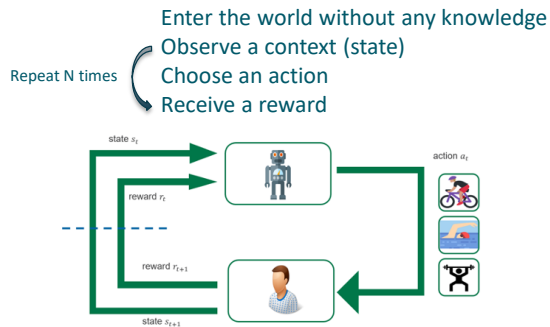
Contextual bandits concept [3][4]:

We have a smart agent…

Enter the world without any knowledge
Observe a context (state)
Repeat N times Choose an action
Receive a reward

state s_t

reward r_t

action a_t

reward r_{t+1}

state s_{t+1}

Figure 3: Smart agent reinforcement learning concept [5]

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STEPS RECOMMENDATION (CASE 1)

Core elements for recommendation
  Context: Patient daily state
    including: motor game scheduled, weekday, weather, steps yesterday, etc
  Actions: Increase the minimal value of steps by [0%, 10%, 20%, …, 100%]
    e.g. minimal value 3000, actions [3000, 3300, 3600, …, 6000]
  Reward: Derived from recommended steps and realized steps

Workflow:
1. Everyday at 8 am, we push a notification to the patient, telling him/her how many steps he/she needs to achieve
2. Patient updates the health related information on avatar, step goals and real-time steps shown on avatar

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EXAMPLES FOR STEPS RECOMMENDATION
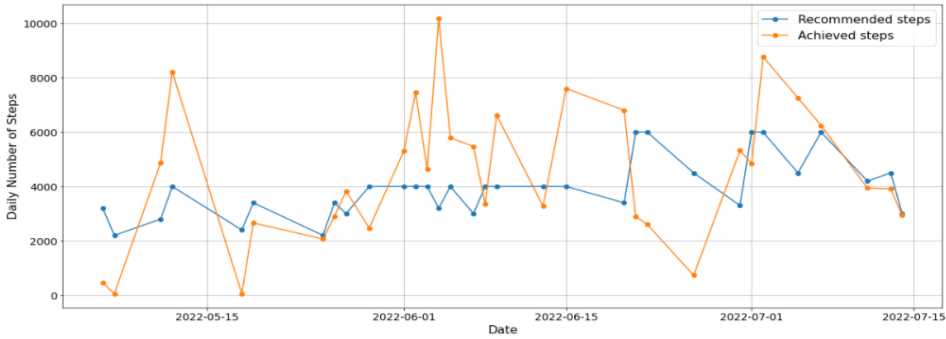
- **Recommended and real achieved steps**

Figure 4: Recommended and achieved steps for one patient with about 30 data points

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EXAMPLES FOR STEPS RECOMMENDATION
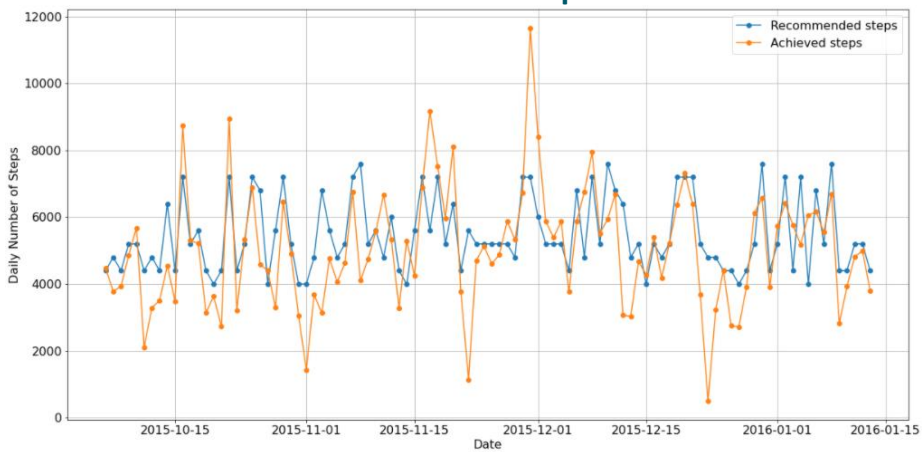
- **Recommended and real achieved steps**

Figure 5: Recommended and achieved steps with 365 simulated data points

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E-LEARNING RECOMMENDATION (CASE 2)

Core elements for recommendation

Context: Patient profile from professional portal

including: disease status, balance impairment, strength reduction, etc.

Actions: E-learning media groups

including: balance, dexterity, lower limbs, upper limbs, torso, risk factor

Reward: Patient liking assessment (0-10), extra bonus (5) for finishing watching

Workflow:

1. Patient clicks E-learning on Avatar or suggested by Avatar
2. A certain group from media groups is chosen. And a video in this group is shown to the patient
3. Patient watches video, gets feedback and liking assessment
4. Patient gives liking score for this recommendation

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E-LEARNING RECOMMENDATION EVALUATION

Statistics about E-learning Recommendation for Stroke patients

	Dexterity	Upper limbs	Balance	Torso	Lower limbs	Risk factor
Recommended	24	23	33	33	27	23
Reponses	18	12	15	19	15	10
Mean Reward	10.89	11.08	11.47	10.74	10.33	9.8

Problems: Agent recommended video randomly, hard to map the relationship between context information (patient profile) and video category

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POTENTIAL FOR AI COMPONENTS IN VCARE

- **Sensor & Telemonitoring App Data (Basic)**
  - Current amount of data are relative low, not widely utilized for Smart Agent
  - Prediction and outlier detection functions with telemonitoring data for supporting monitoring functions, especially for cardiological cases
  - More context information extracted in data from sensors installed at patient's home for activity recommendation

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POTENTIAL FOR AI COMPONENTS IN VCARE

- **BPMN & Goal-oriented Modelling (Advanced)**
  - Limited personalization possibilities due to deterministic pathway modelling with BPMN (Business Process Model and Notation)
  - Goal oriented modelling provides more flexibilities and possibilities [6]
  - Beginning with BPMN pathways for data collection about the patient's daily activity
  - Goal-oriented pathways could be implemented in the advanced stage

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CONCLUSIONS

- **Context-aware recommendation based on interactive learning**

- **Use case demo**

    - Daily Number of steps recommendation

    - E-learning recommendation

- **Goal oriented modelling provides further potential for personalization**

- **Factors for successful AI deployment**

    - Use case / Scenario

    - Legal and ethical issues

    - Proper amount of data for selected models

    - Iterative test, feedback and improvement

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REFERENCES

[1] Spotify Engineering: For Your Ears Only: Personalizing Spotify Home with Machine Learning, January 2020, https://engineering.atspotify.com

[2] Koldan, K., How Netflix Uses Contextually-Aware Algorithms To Personalize Movie Recommendations, June 2019, https://www.topbots.com

[3] McInerney, J., Contextual Bandits in Recommendation, August 2019, IVADO Recommender Systems Workshops

[4] Abe, N., Biermann, A., Long, P., Reinforcement Learning with Immediate Rewards and Linear Hypotheses, Algorithmica (2003) 37: 263-293, Springer New York

[5] Boecking, L., Philipp, P., Recommending safe actions by learning from sub-optimal demonstrations, HealthRecSys'20, September 2020

[6] Gißke, C., Liu, J., Gand, K., Applying Goal-Oriented Modelling for Machine Learning Based Rehabilitation Care. Stud Health Technol Inform, May 2022

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THANK YOU

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