Hybrid Recommendation

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with slides of Danielle Lee

IS2480 Adaptive Information Systems

Three basic recommendation engines

- **Collaborative Filtering**: exploiting other likely-minded community data to derive recommendations
  - Effective, Novel and Serendipitous recommendations
  - Data Sparsity, cold-start problem and ad-hoc users
- **Content-based approach**: relying on product (information) features and textual descriptions
- **Knowledge-based approach** : reasoning on explicit knowledge models from the domain
  - Ability to generate recommendation with a small set of user preference and suggest reasonable recommendations
  - Easy to generate too obvious or boring recommendation and plasticity problems.
- Each engine also have variations
  - Content vs. metadata in CBF
  - Peers vs. friends in CF

Input Data Requirements of Recommendation Techniques

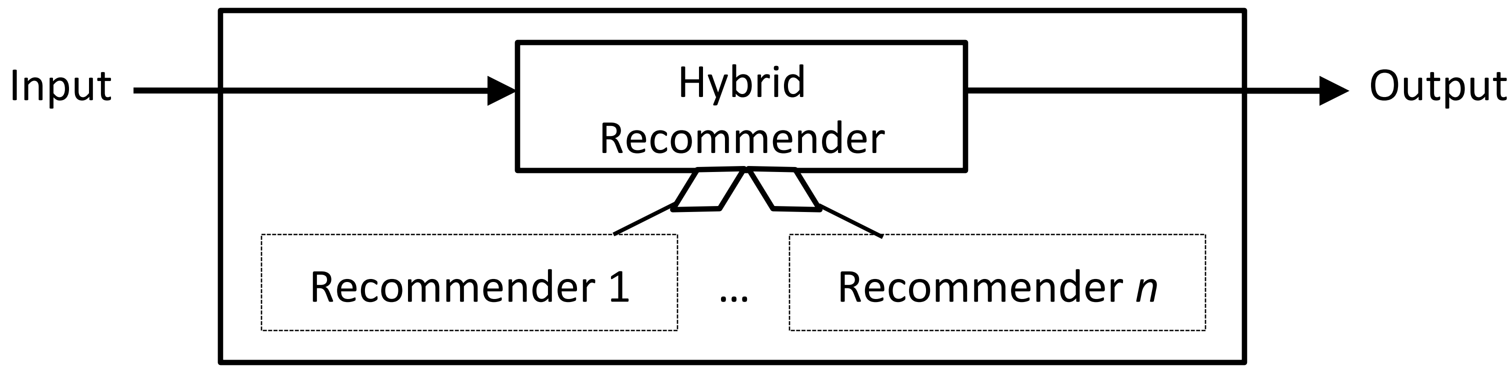
	User Profile & Contextual Parameters	Community Data	Product Features	Knowledge models
Collaborative Filtering	Yes	Yes	No	No
Content-based	Yes	No	Yes	No
Knowledge-based	Yes	No	Yes	Yes

Different engines and their variations typically use difference sources of data. It could be wise to combine the approaches to use more data

Hybridization Designs

- Monolithic Hybridization
  - Incorporating aspects of several recommendation strategies in one algorithm implementation
- Parallelized Hybridization
  - Operating independently of one another and produce separate recommendation lists. Then their output is combined into a final set of recommendations
- Pipelined Hybridization
  - Several recommender systems are joined together in a pipeline architecture. The output of one recommender becomes part of the input of the subsequent one.

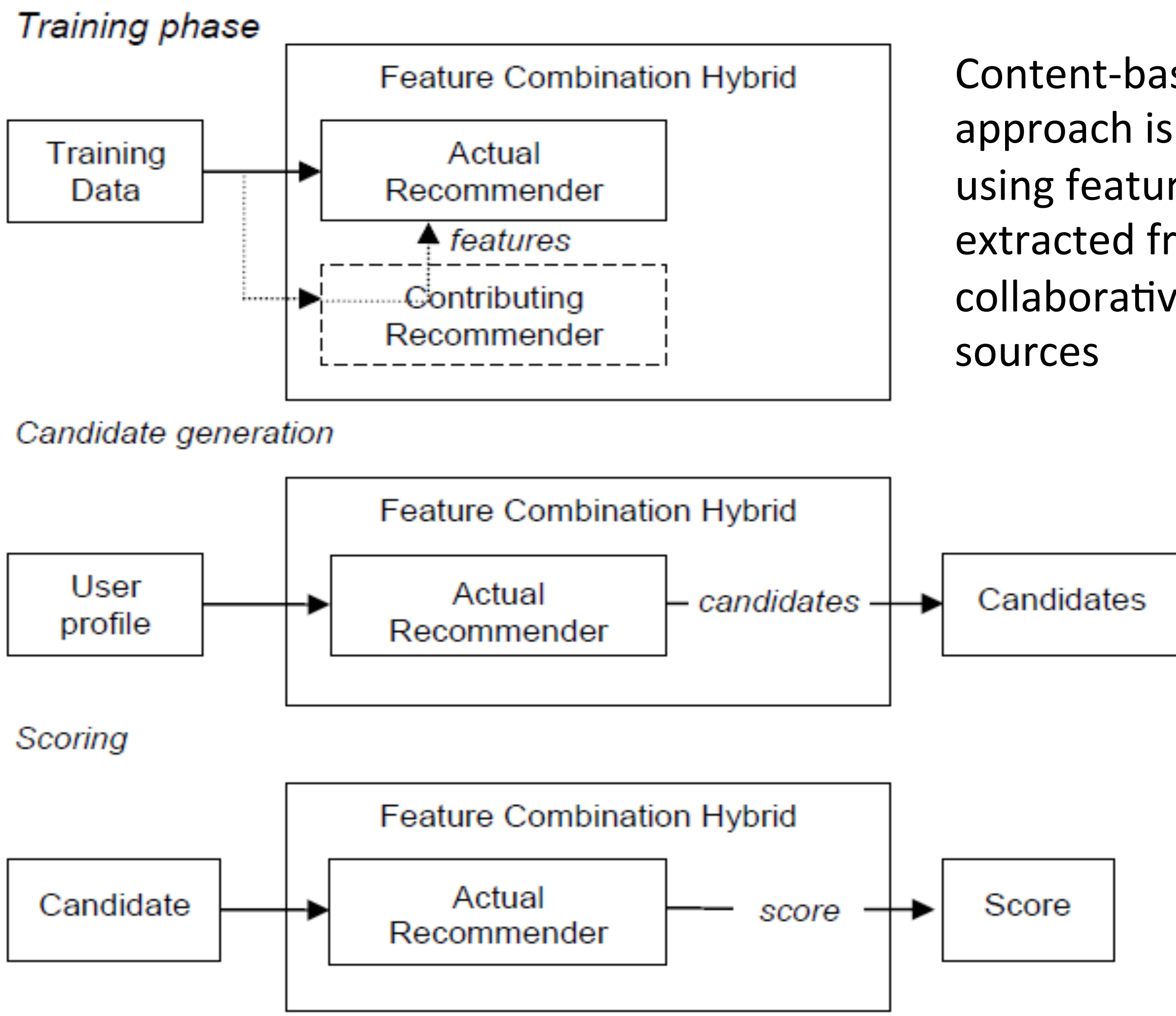
Monolithic Hybridization



- Built-in modification of recommendation algorithm to exploit different types of input data
- Apply one approach (i.e. CBF) but enhance with the knowledge sources that are typically used by other (CoF)
- Feature combination hybrids
  - Ex) Basu, et al. (1998), Zanker and Jessenitschnig (2009), Pazzani (1999)
- Feature augmentation hybrids
  - Melville, et al. (2002), Mooney and Roy (1999), and Torres et al. (2004)

Monolithic Hybridization

- Feature combination hybrids



Content-based approach is trained using features extracted from collaborative sources

Example (1)

User	Item1	Item2	Item3	Item4	Item5
Alice		1		1	
User1		1	1		1
User2	1	1			1
User3	1		1		
User4					1

Item	Genre
Item1	Romance
Item2	Mystery
Item3	Mystery
Item4	Mystery
Item5	Fiction

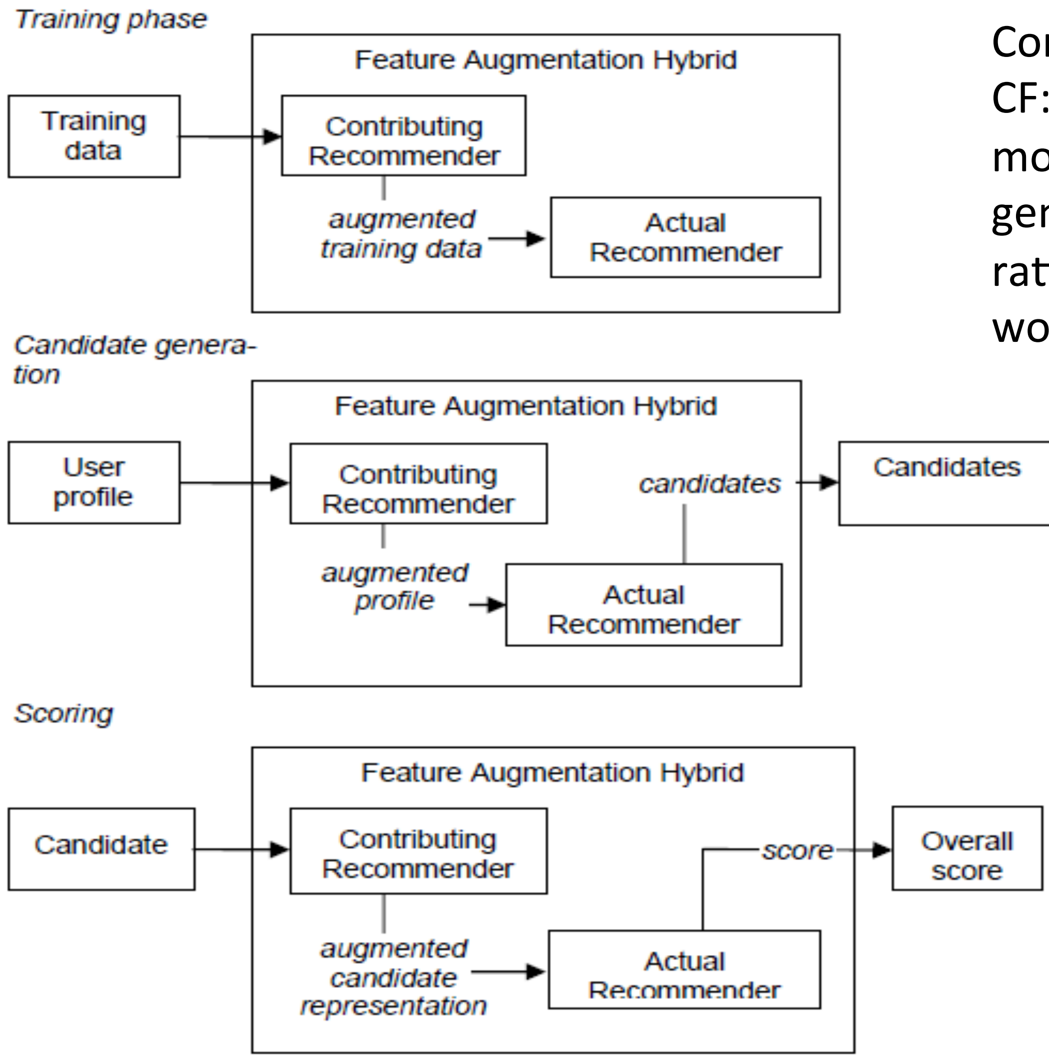
Example (1)

Feature	**Alice**	**User1**	**User2**	**User3**	**User4**
User likes many *mystery* books	true	true			
User likes some *mystery* books			true	true	
User likes many *romance* books					
User likes some *romance* books			true	true	
User likes many *fiction* books					
User likes some *fiction* books		true	true		true

Legend: If a user bought mainly books of genre *X* (two-thirds of the total purchases and at least two books), we say that 'Users likes many X books'

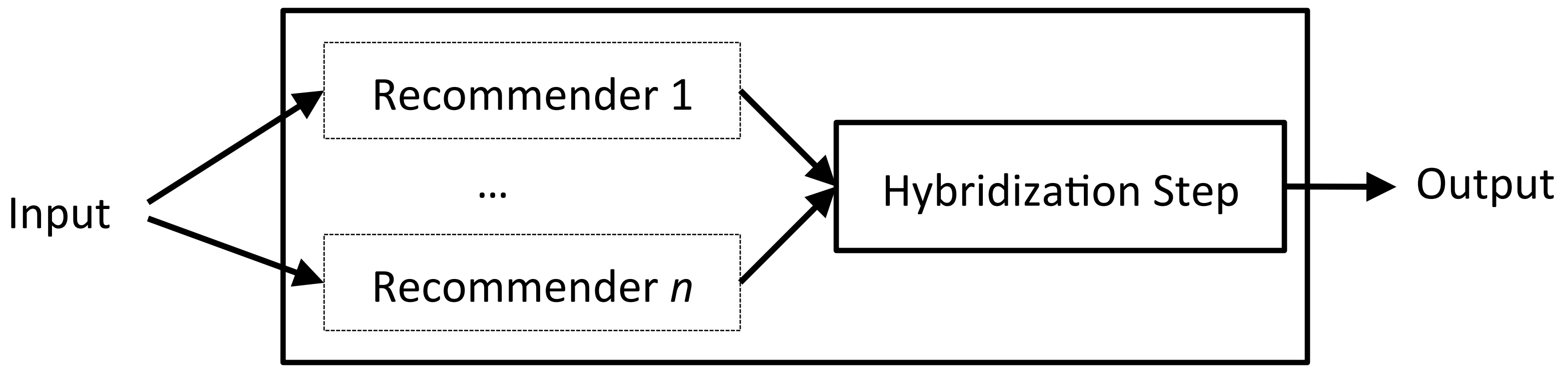
Monolithic Hybridization

- Feature augmentation hybrids



Content-boosted CF: content-based model used to generate missed ratings. Then CF works

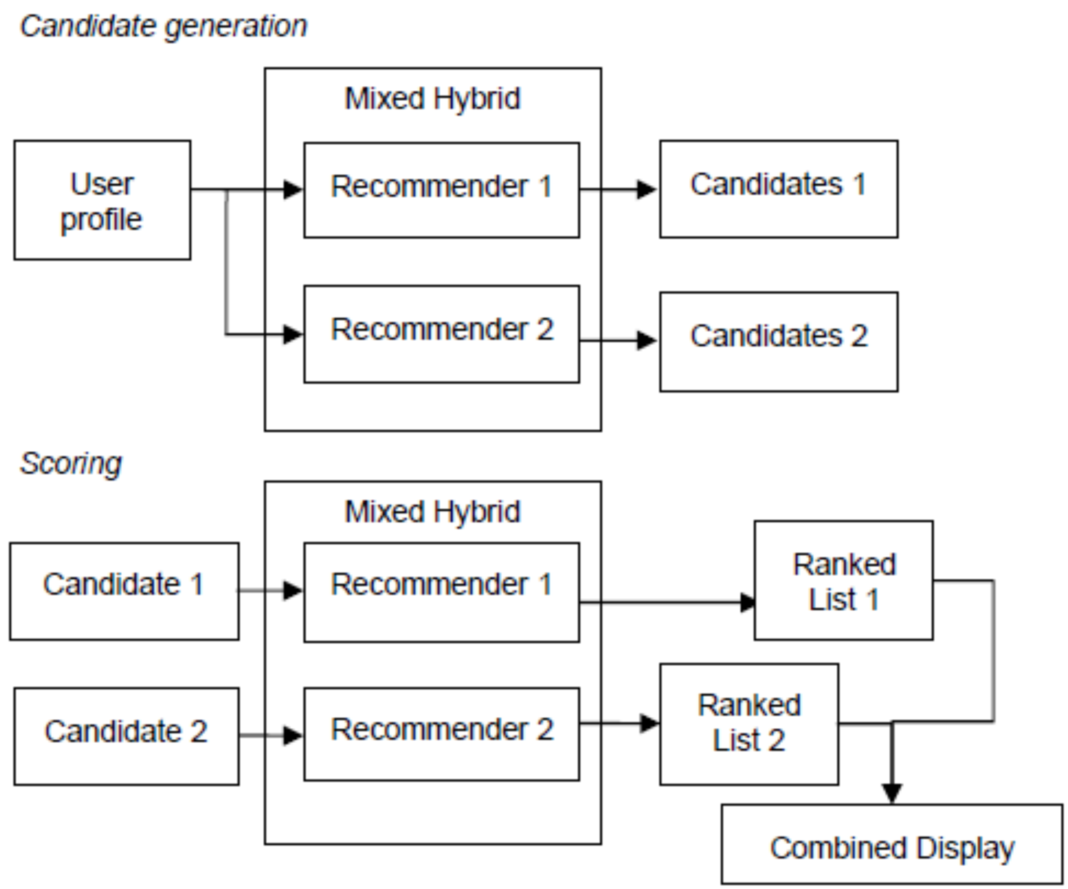
Parallelized Hybridization



- Employ several recommenders side by side and employ a specific hybridization technique to aggregate the outputs.
- Mixed Hybrids
  - Cotter & Smyth (2000), Zanker, et al. (2007)
- Weighted Hybrids
  - Zanker and Jessenitschnig (2009), Claypool, et al. (1999)
- Switching Hybrids
  - Zanker and Jessenitschnig (2009), van Setten (2005)

Parallelized Hybridization

- Mixed Hybrid: combines results of different recommenders at user interface level



Example of Combination

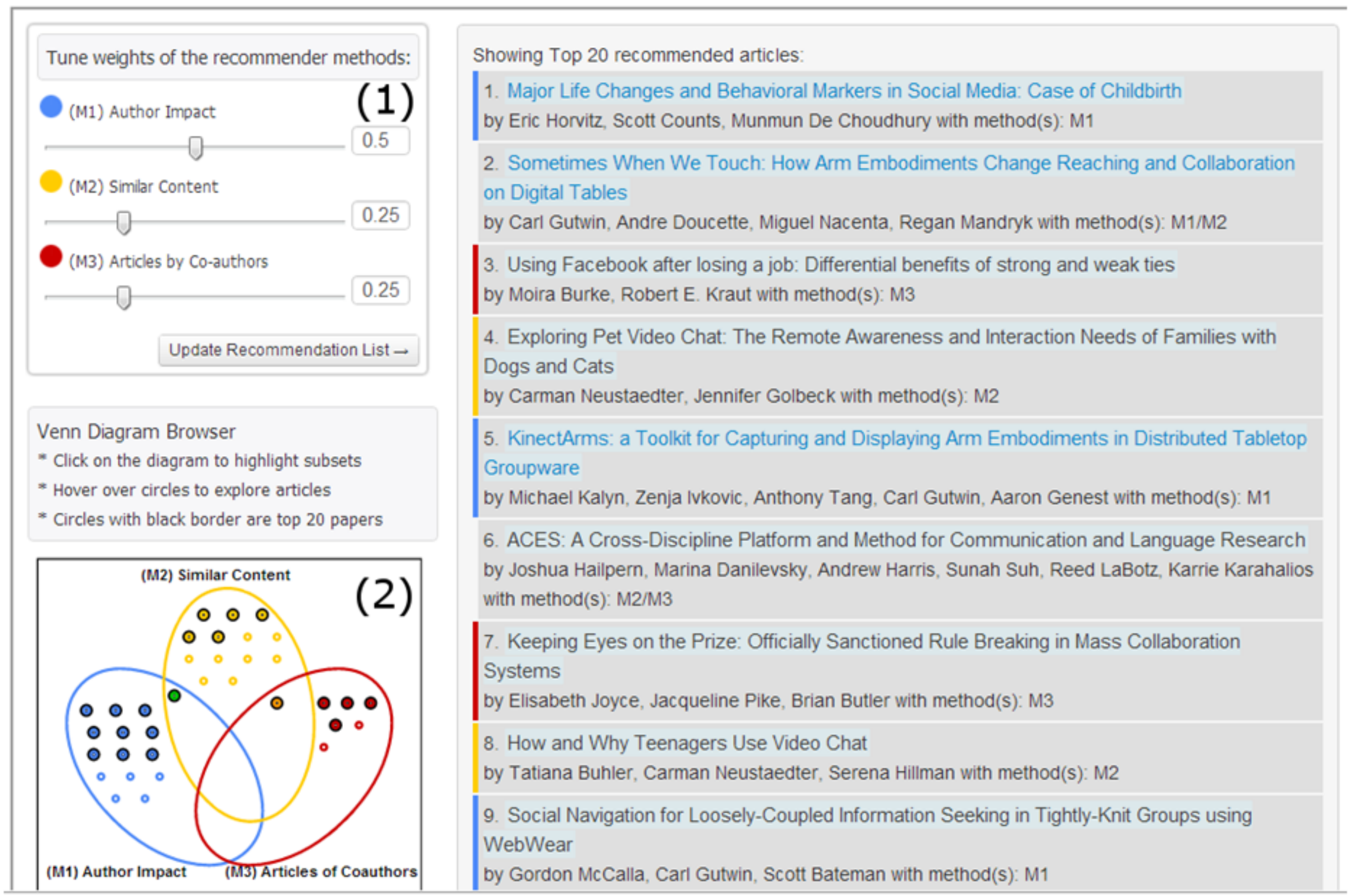
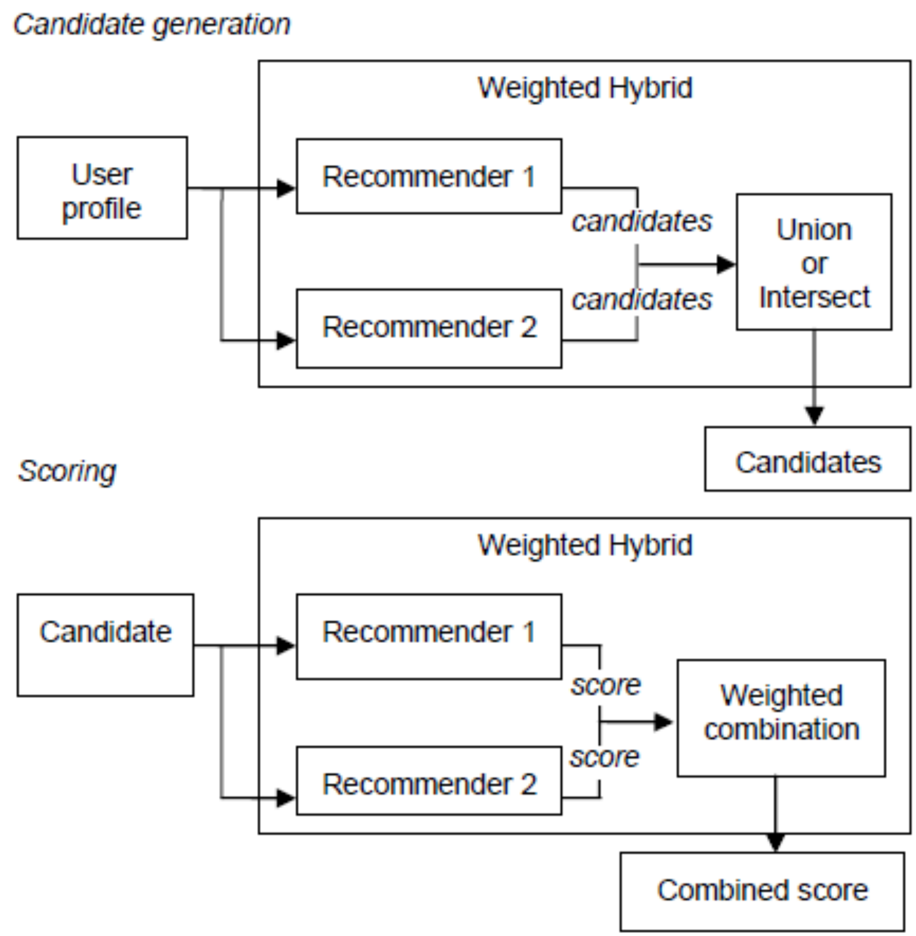


Image showing the condition of an interactive controllable interface. In addition to browsing a list the articles, the user can control (sliders at the top

Parallelized Hybridization

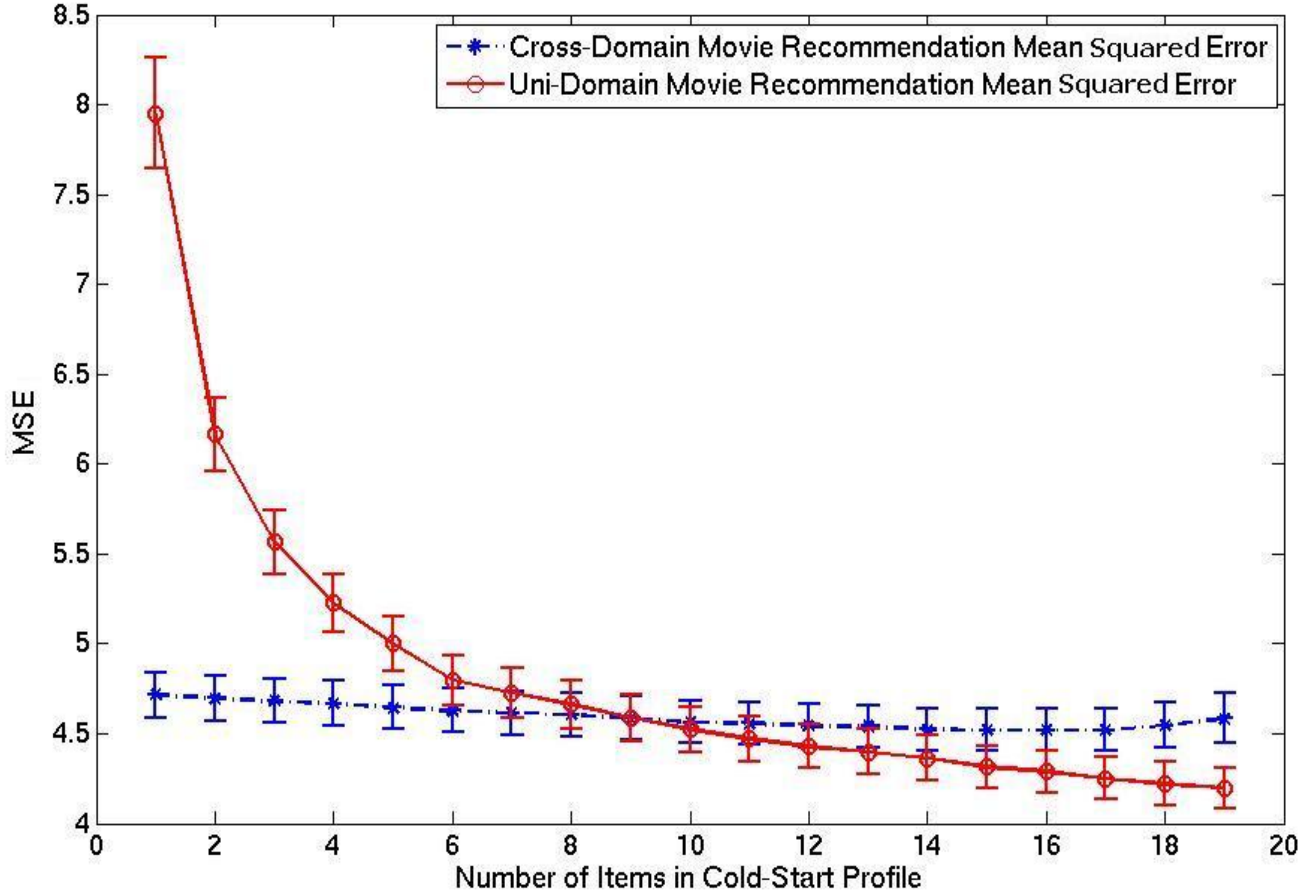
- Weighted Hybrids: Combines recommendations by computing weighted sums of their scores



Parallelized Hybridization

	rec1 score	rec1 rank	rec2 score	rec2 rank	recw score	recw rank
Item1	0.5	1	0.8	2	0.65	1
Item2	0		0.9	1	0.45	2
Item3	0.3	2	0.4	3	0.35	3
Item4	0.1	3	0		0.05	
Item5			0		0	

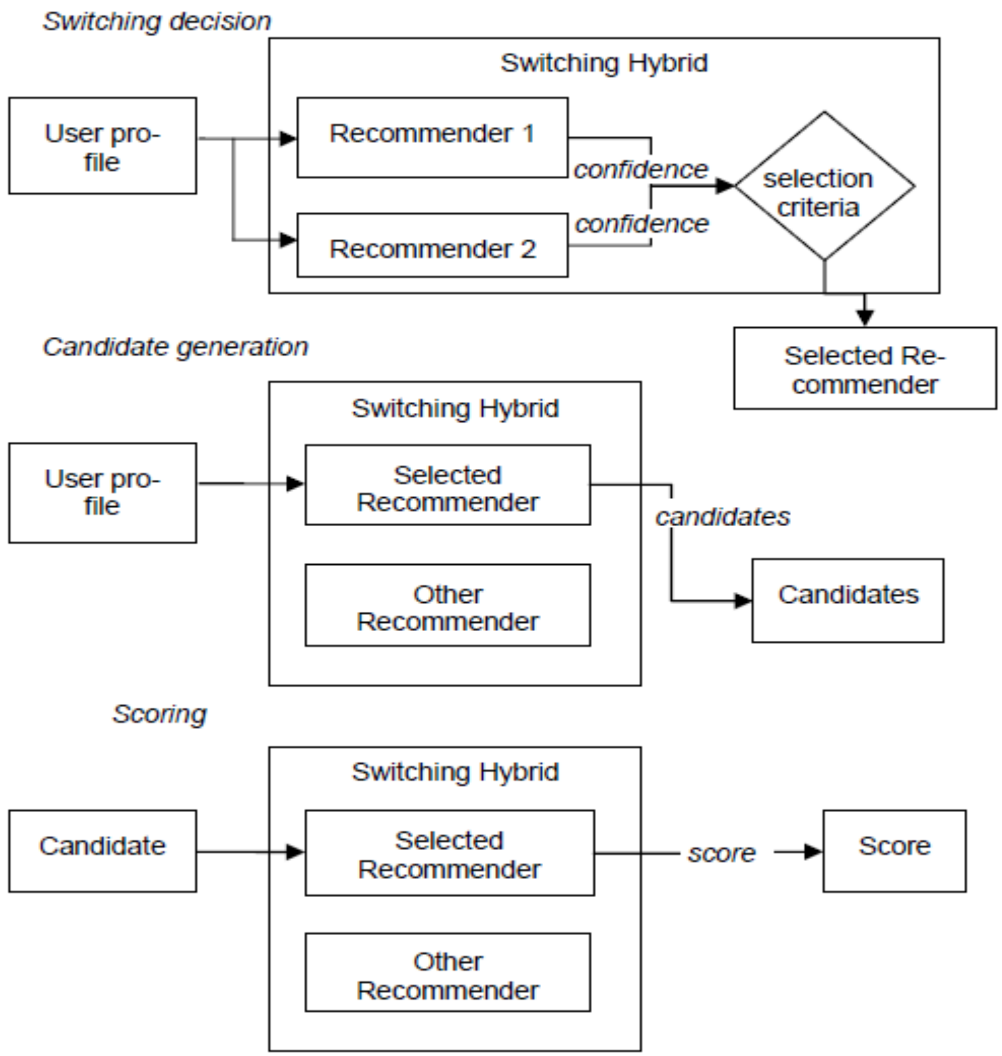
Parallelized Hybridization



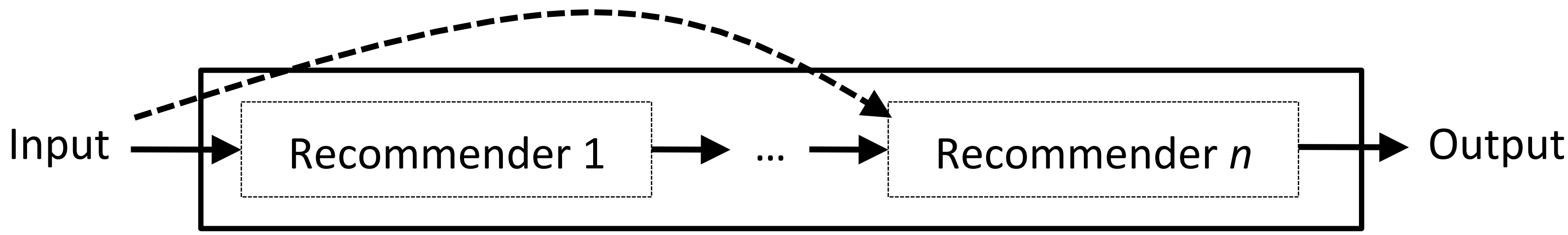
Why switching might be better than weighting?

Parallelized Hybridization

- Switching hybrids



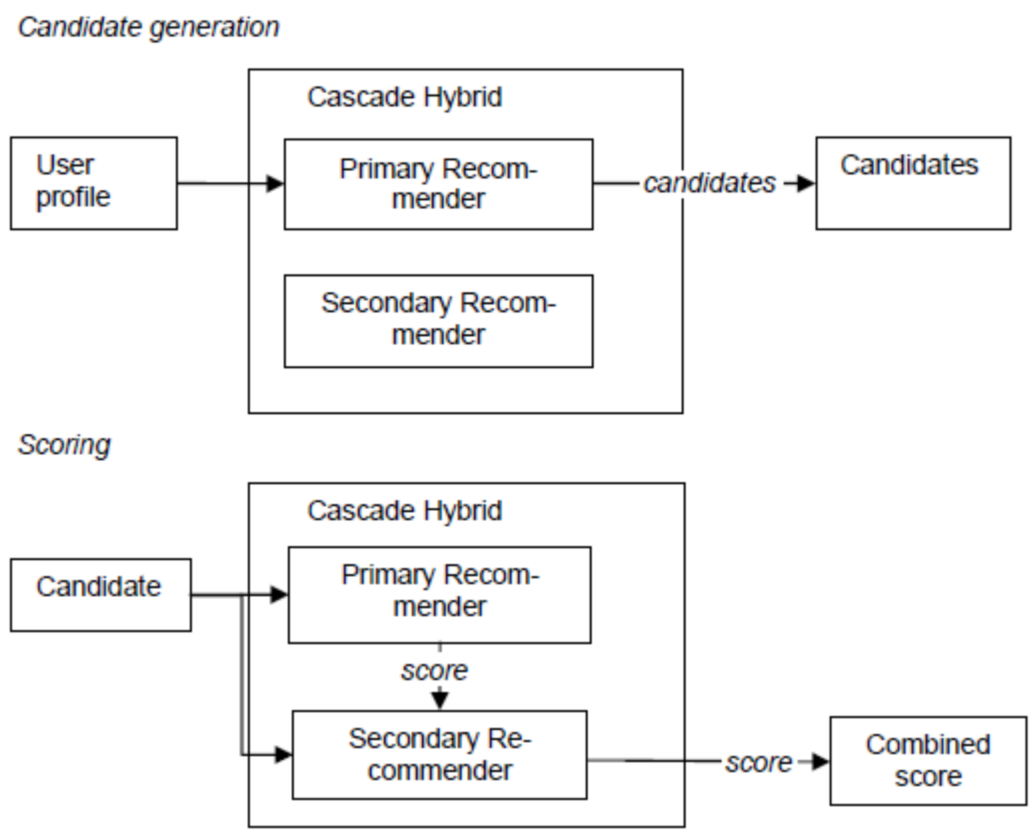
Pipelined Hybridization



- A staged process in which several techniques sequentially build on each other before the final one produces recommendations
- Cascade Hybrids
  - Zanker and Jessenitschnig (2009)
- Meta-level Hybrids
  - Zanker (2008), Pazzani (1999)

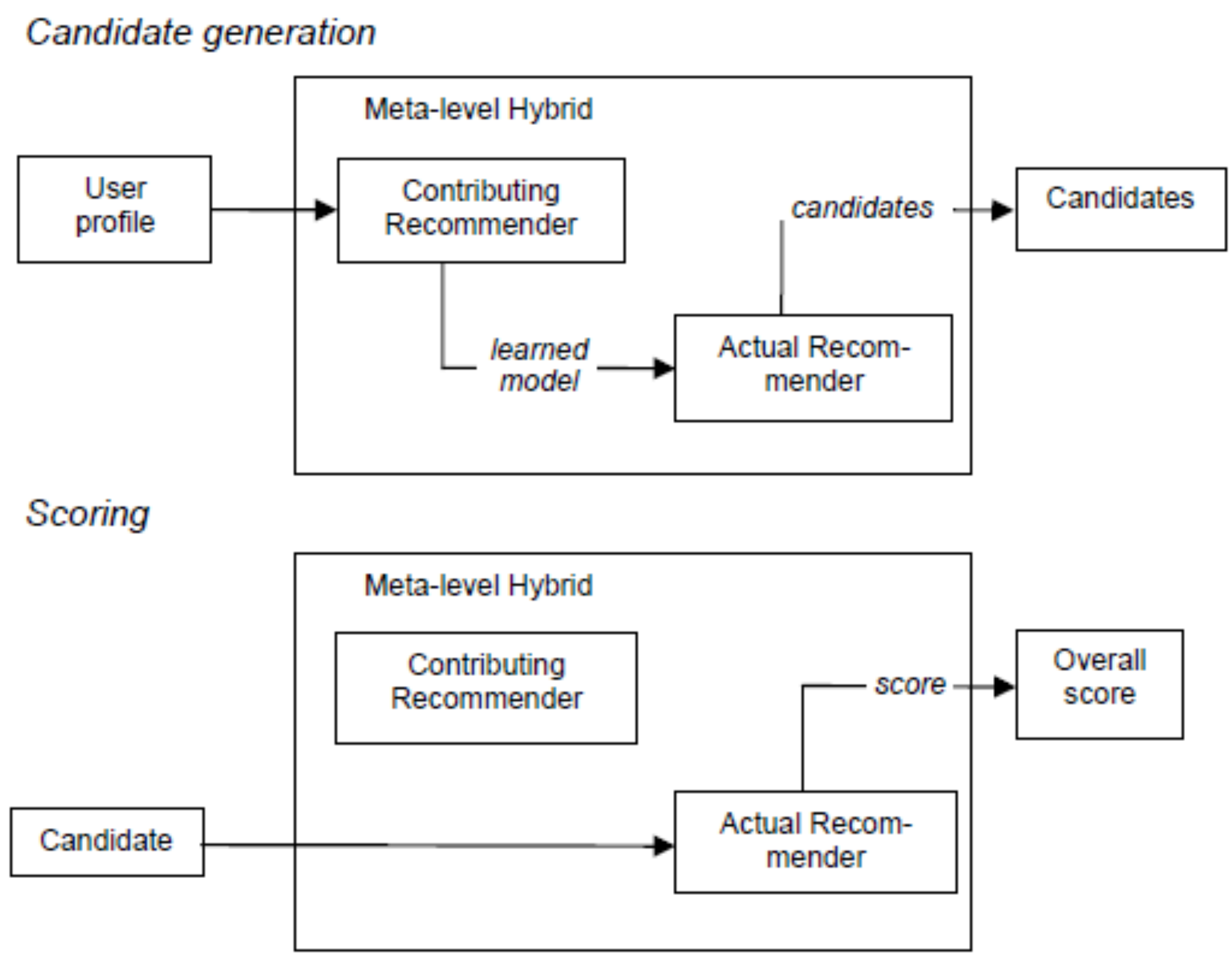
Pipelined Hybridization

- Cascade hybrids: based on a sequenced order of techniques.

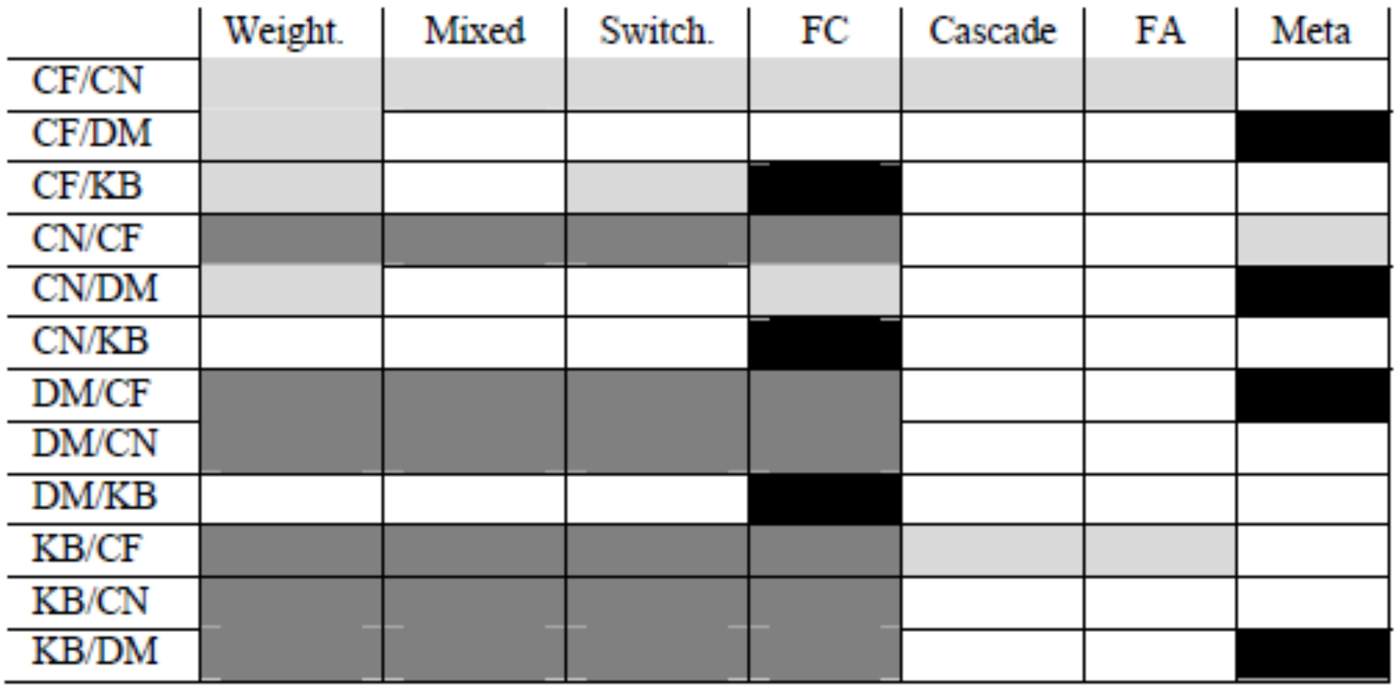


Pipelined Hybridization

- Meta-Level Hybrids: one recommender builds a model that is exploited by the principal recommender



Hybridization Summary



FC = Feature Combination, FA = Feature Augmentation
CF = collaborative, CN = content-based, DM = demographic, KB = knowledge-based