Modeling Vocal Interaction for Text-Independent Participant Characterization in Multi-Party Conversation

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June 20, 2008

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- vocal activity patterns for all K participants, **seen together**
- talkspurt start/end times = text-independence
- at time t,
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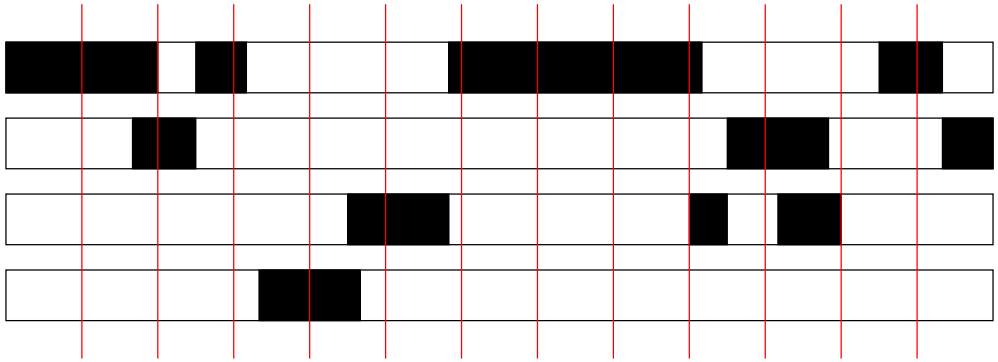

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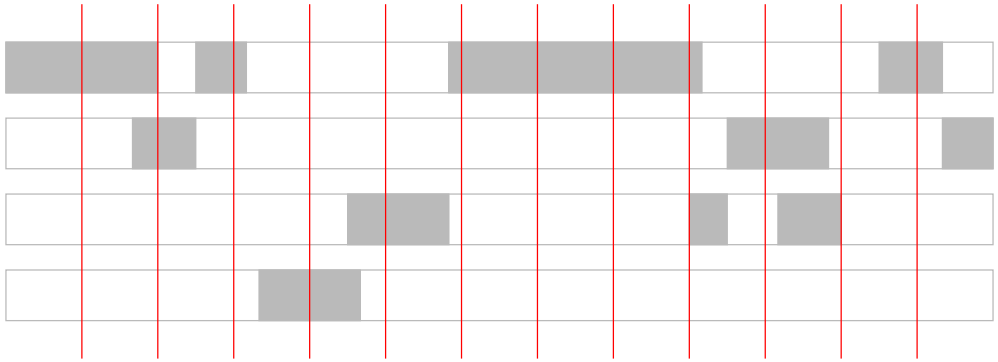

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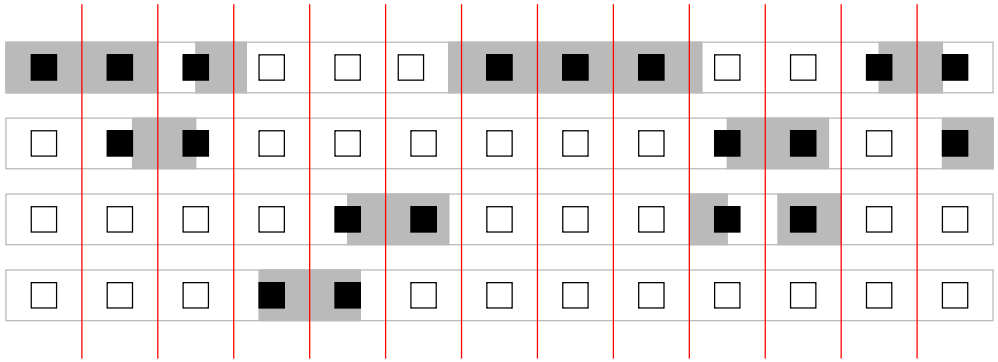

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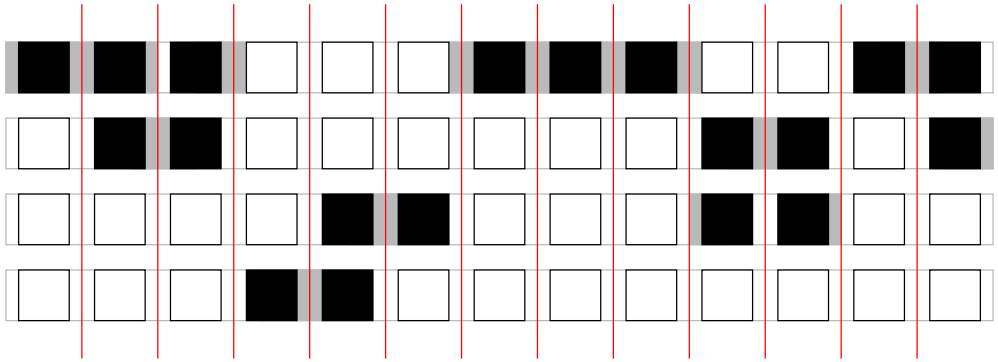

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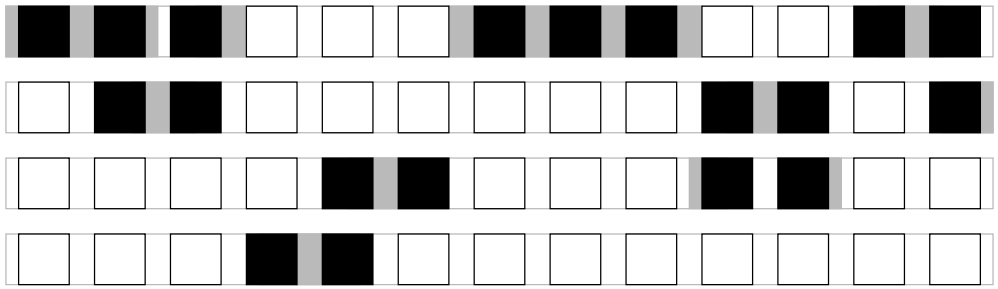

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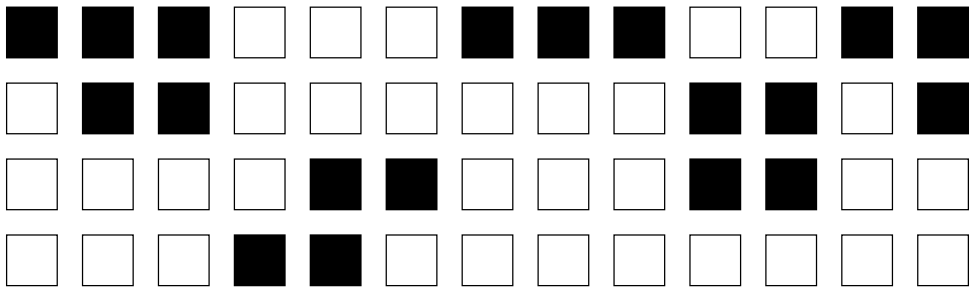

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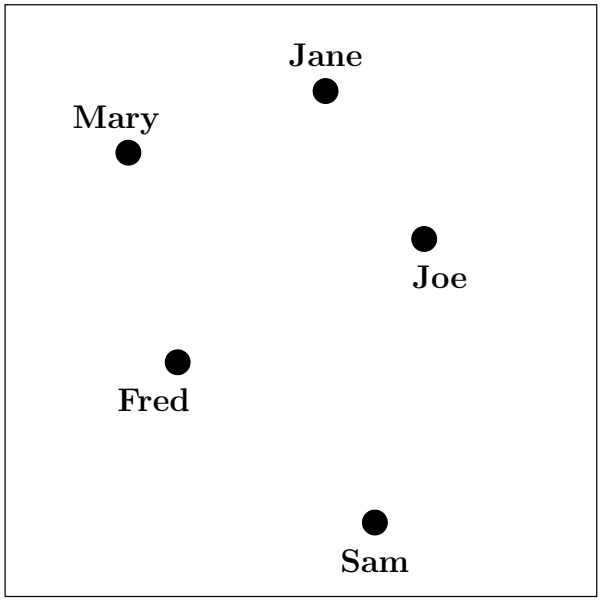

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  - role
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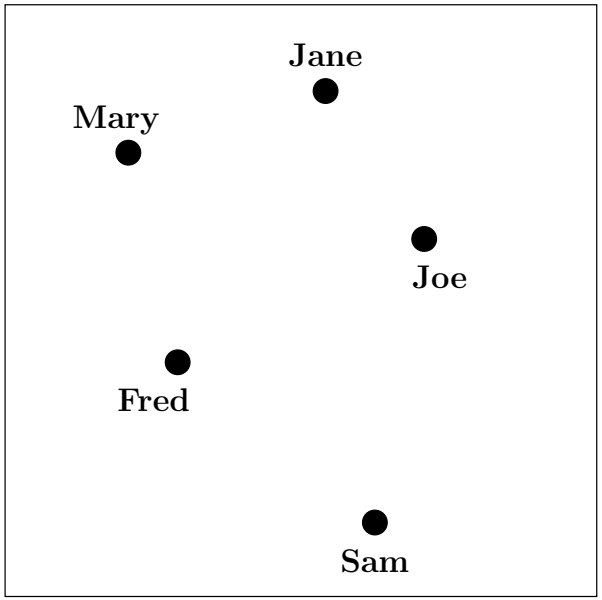

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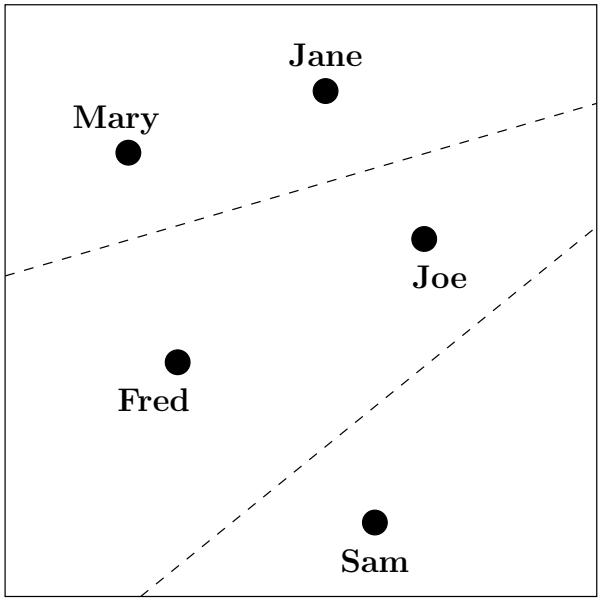

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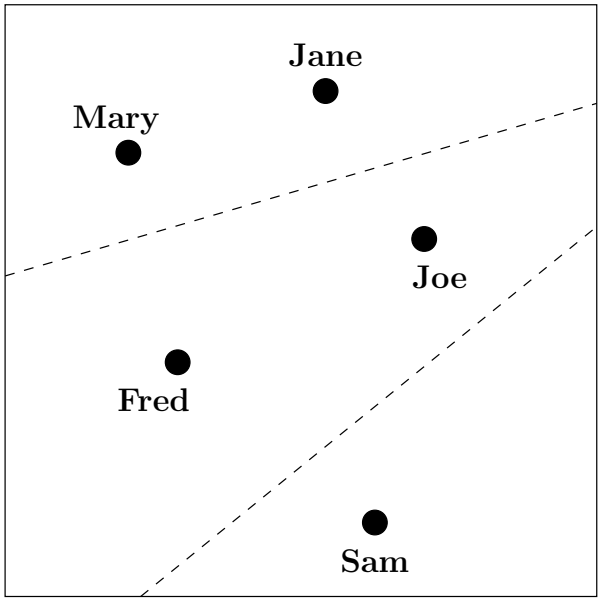

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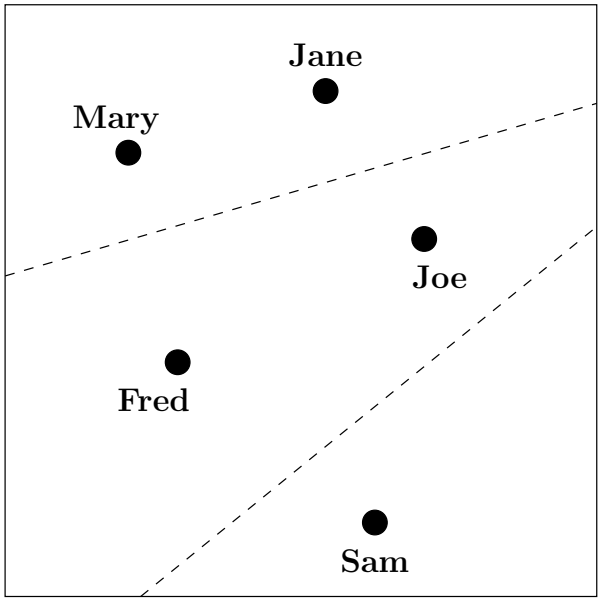

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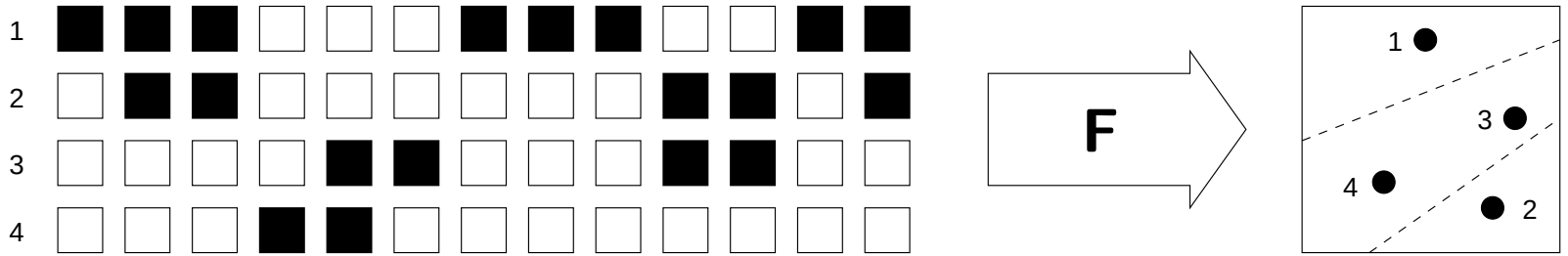

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$\mathbf{g} \in h(\mathcal{C})$

1. given a **sequence** of T K-participant states $\mathbf{q}_t$
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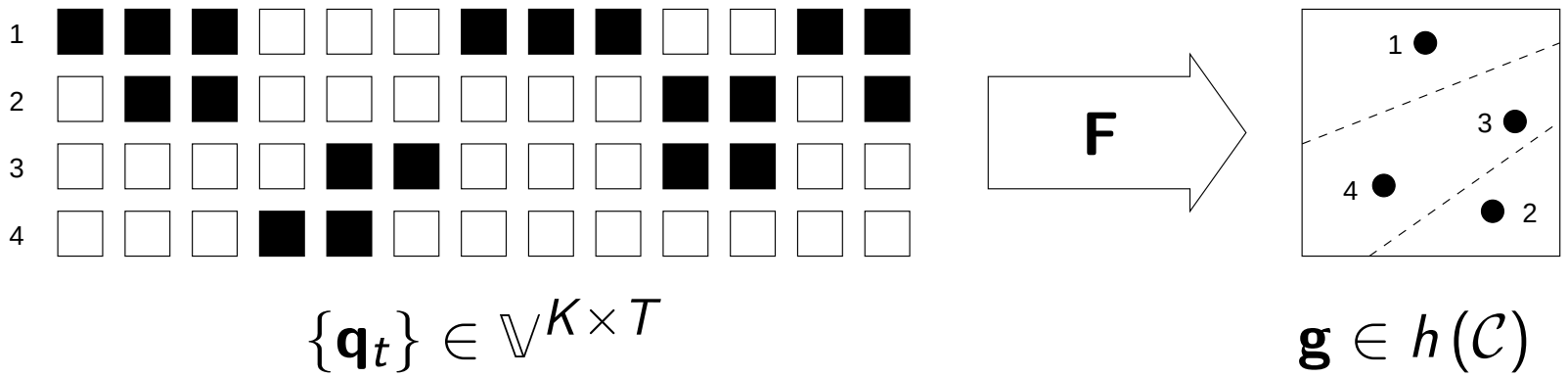

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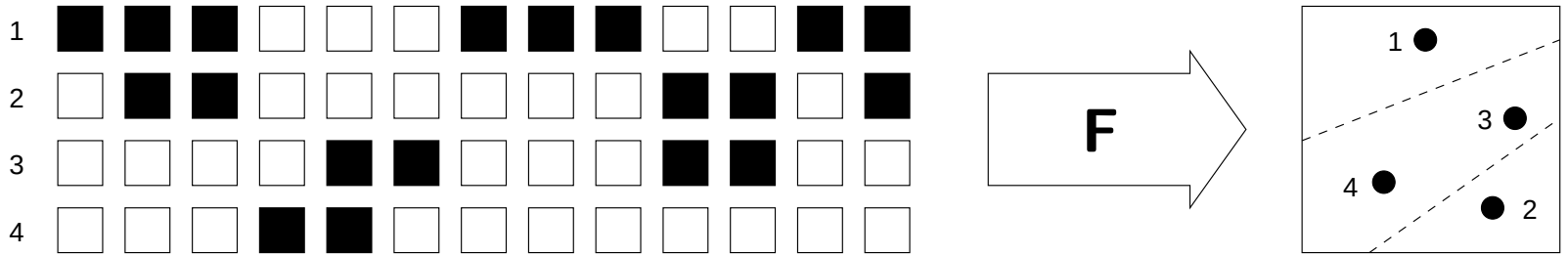

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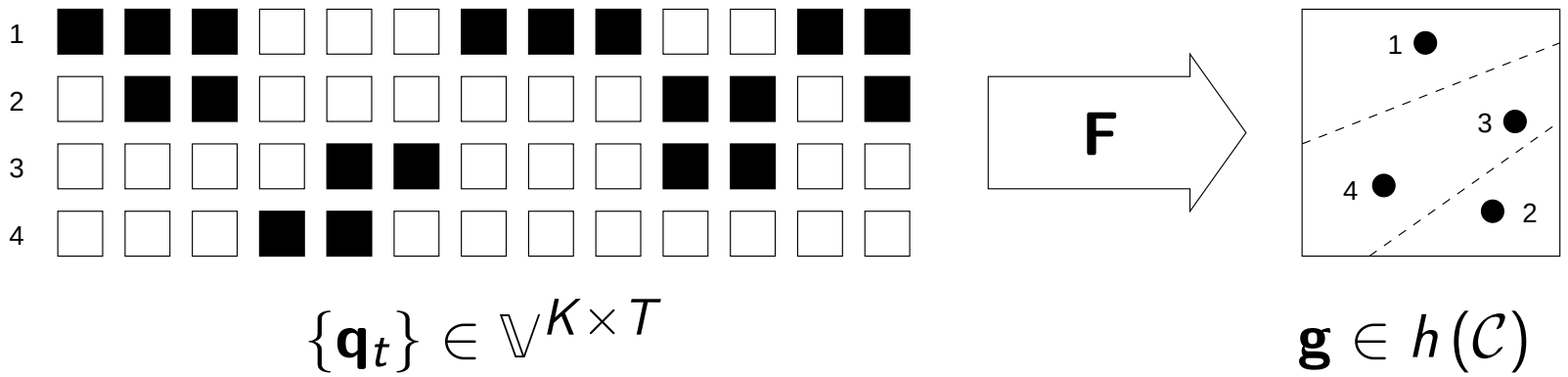

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Outline of Talk

0. ... Intro (Motivation & Related Work)
1. Computational Framework
2. Experiments
3. Conclusions

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- having observed a conversation/meeting, being able to say something about the participants is a **basic competence in conversation understanding**
- lots of research in psycho- and socio-linguistics, 1950-
  - conversation analysis
  - small group research
  - nonverbal interaction
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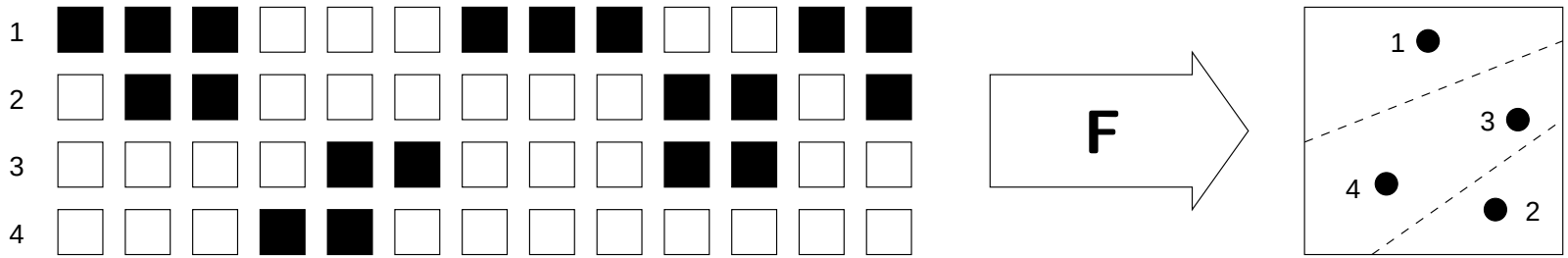

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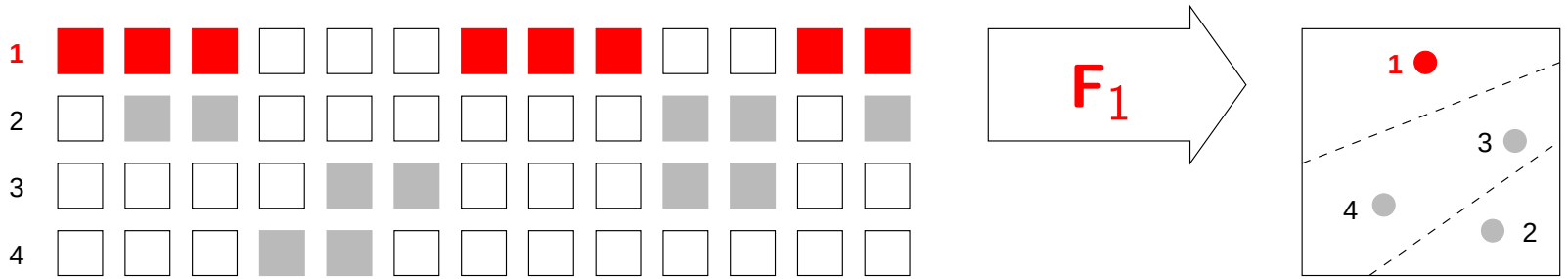

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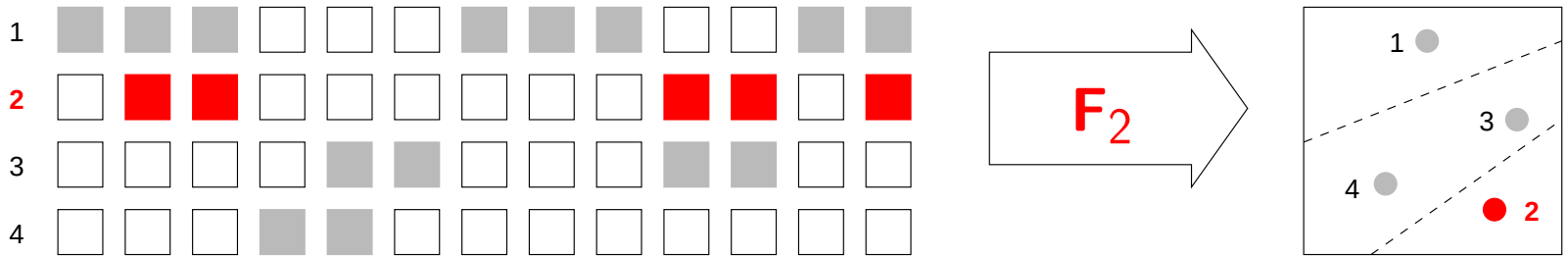

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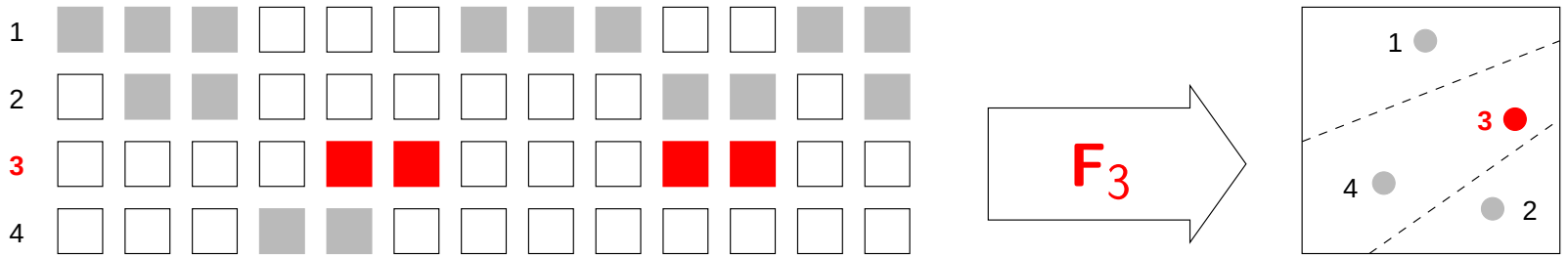

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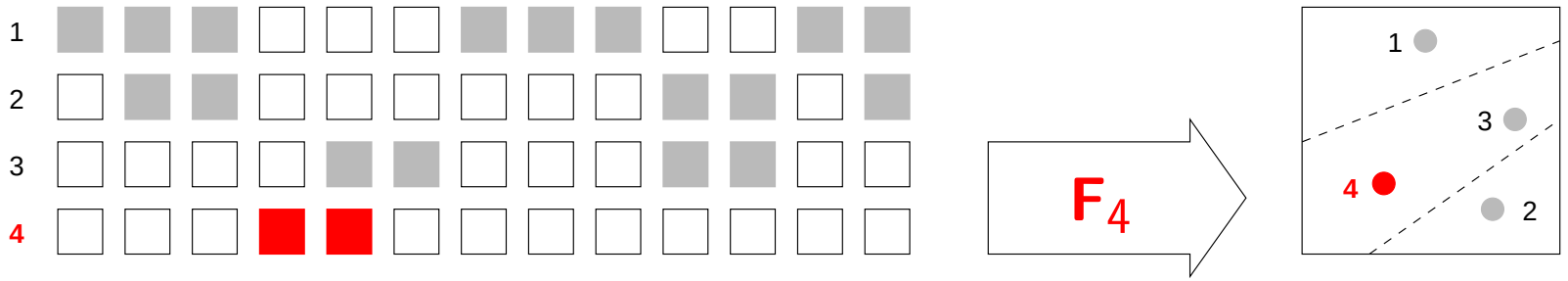

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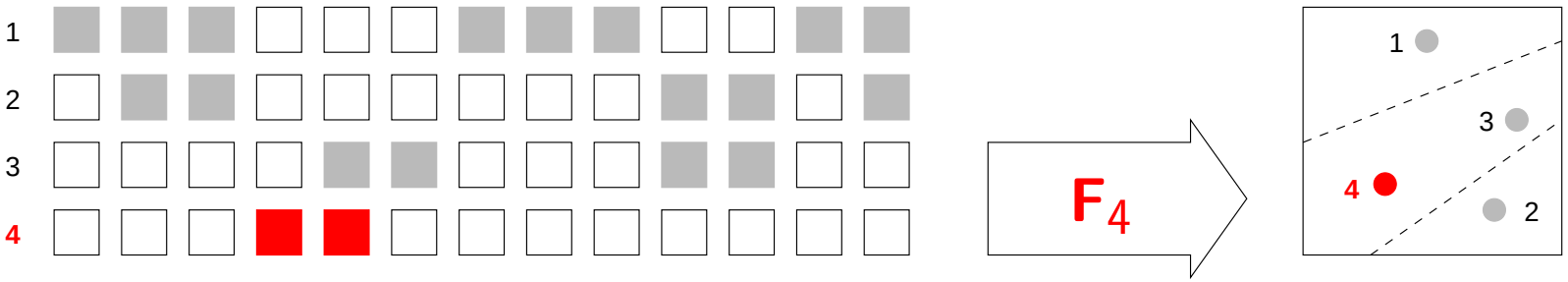

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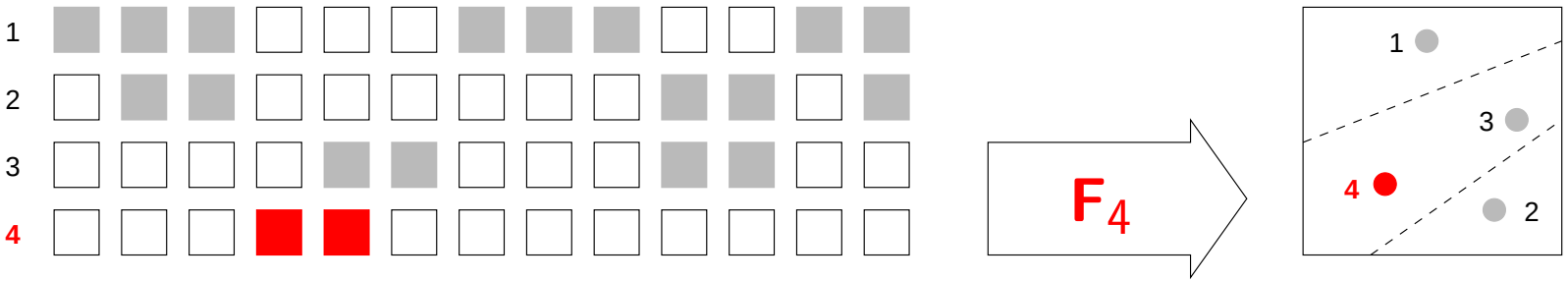

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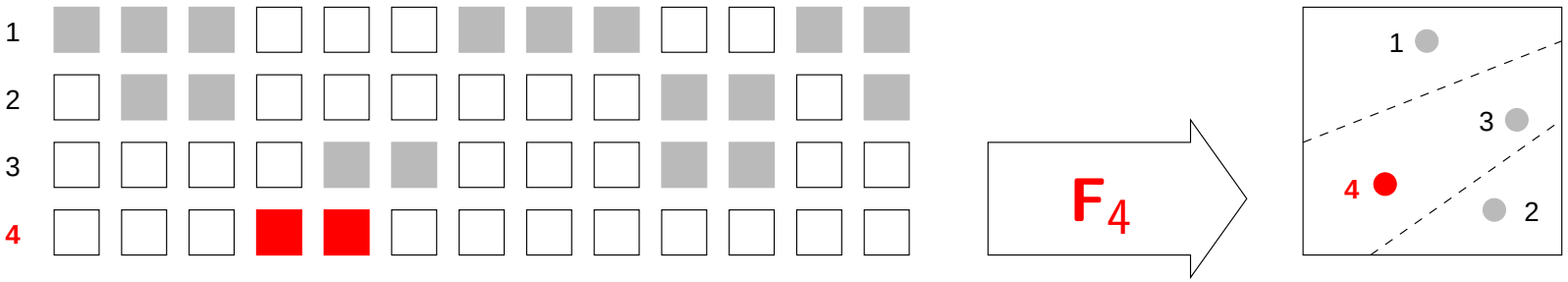

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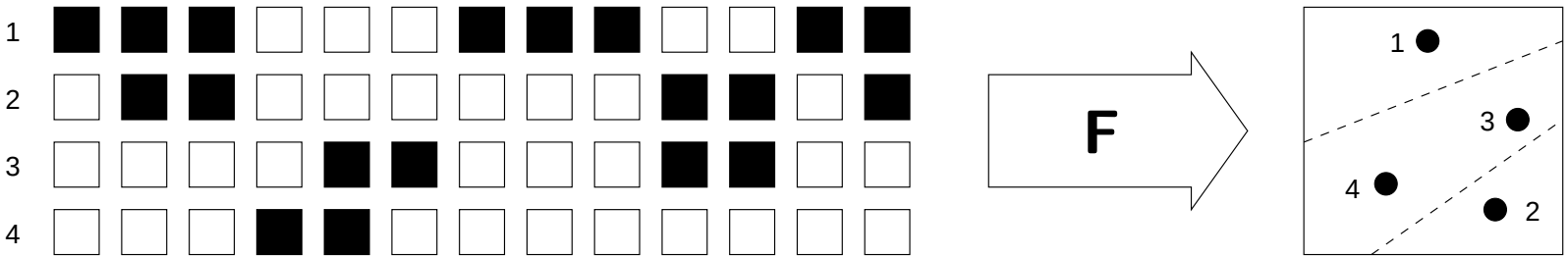

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Solution: model participants **jointly**

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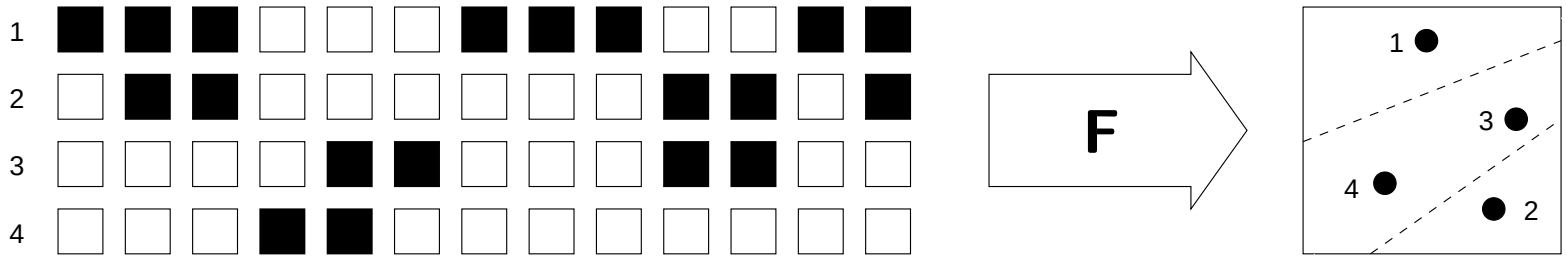

1. **F** describes interaction between **all** K participants
2. the most likely **group** assignment $\mathbf{g}^*$ is identified by enumerating over all possible group assignments $\mathbf{g} \in h(\mathcal{C})$

$$\begin{aligned} \mathbf{g}^* &= \arg\max_{\mathbf{g} \in h(\mathcal{C})} P(\mathbf{g} \mid \mathbf{F}) \\ &= \arg\max_{\mathbf{g} \in h(\mathcal{C})} \underbrace{P(\mathbf{g})}_{\text{MM}} \underbrace{P(\mathbf{F} \mid \mathbf{g})}_{\text{BM}} \end{aligned}$$

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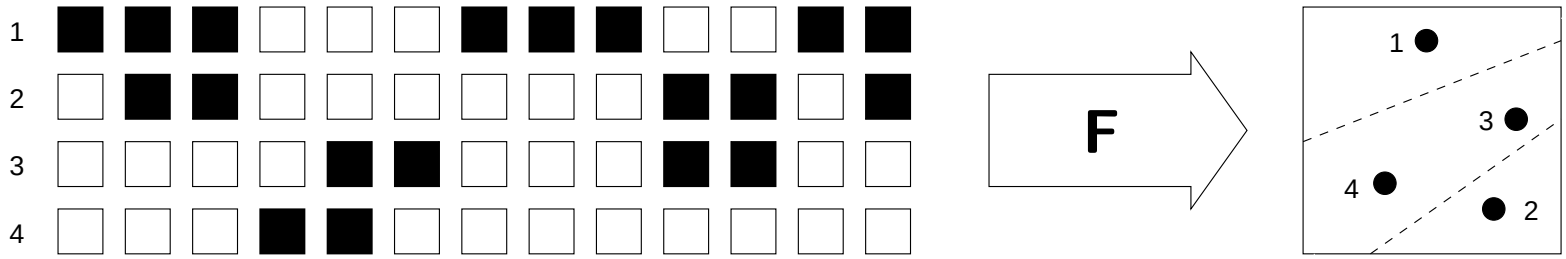

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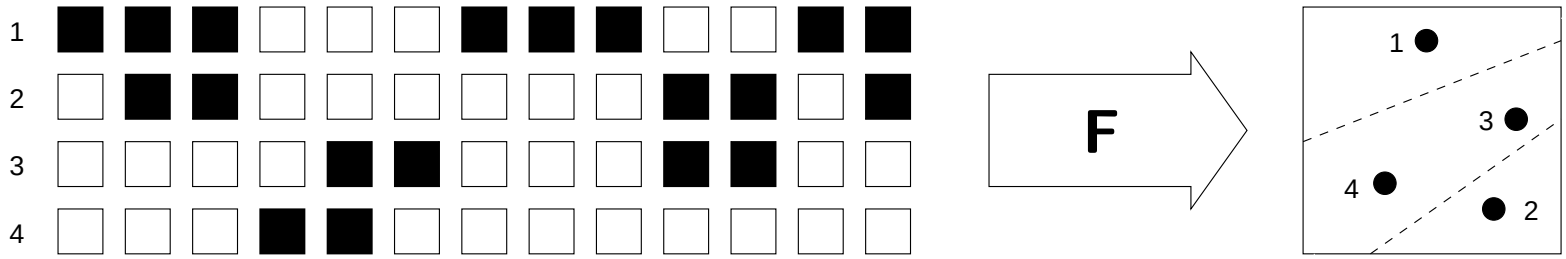

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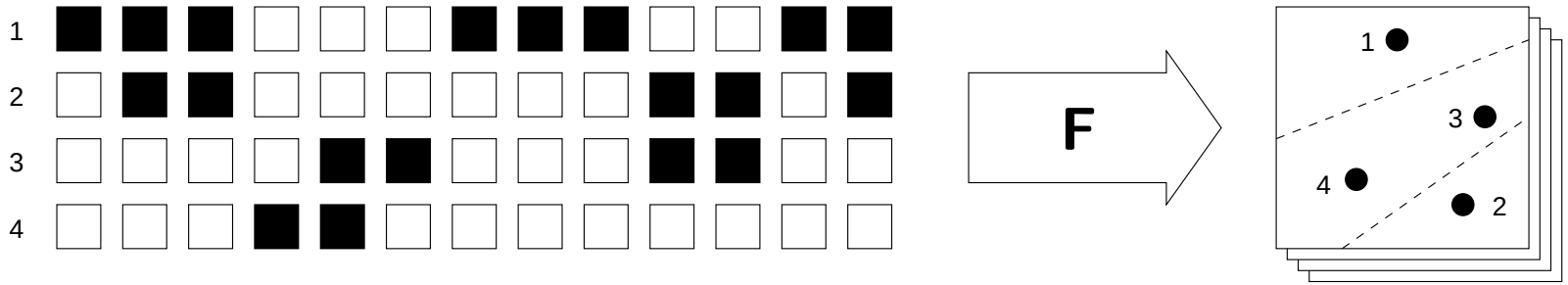

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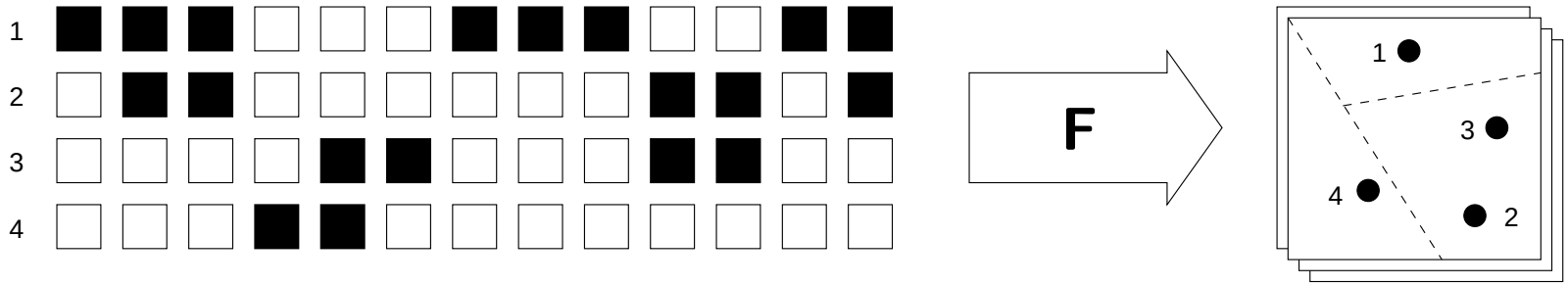

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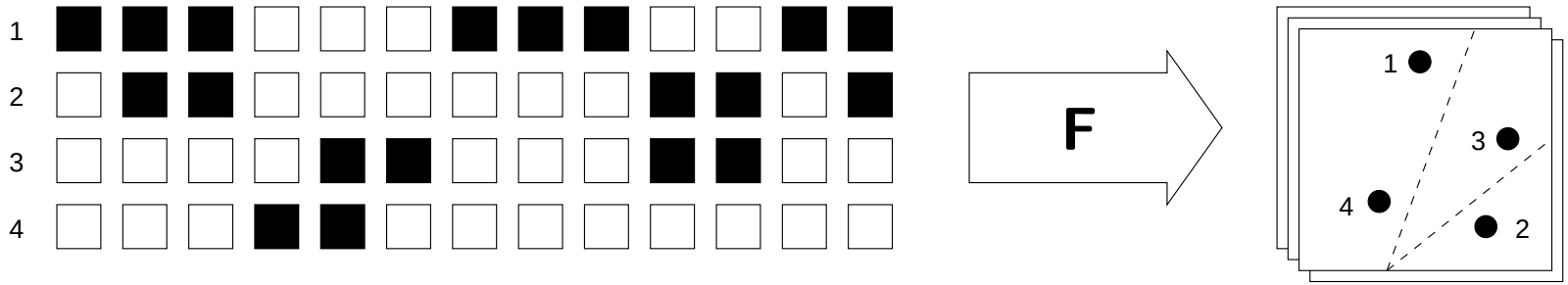

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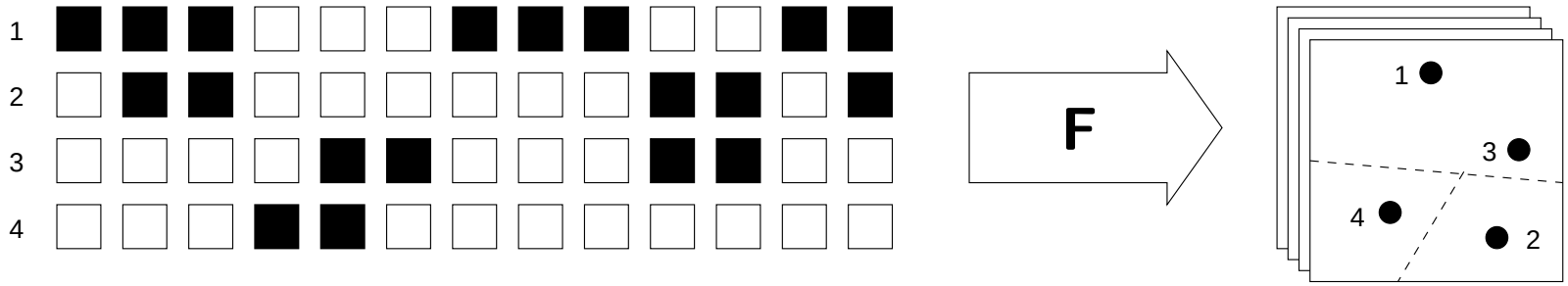

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What is $h(\mathcal{C})$?

That depends on what $\mathcal{C}$ is...

- each of K types assigned to exactly one participant
- $h(\mathcal{C})$ is a permutation space
- $|h(\mathcal{C})| = K!$

- each participant can be one of any N types
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- Unique Roles, $\mathcal{C} = \mathcal{R}$
- AMI Meeting Corpus
  - design scenario
  - train: 98 meetings
  - dev: 20 meetings
  - eval: 20 meetings
  - $K = 4$, always
- $\mathcal{R} = \{\mathrm{PM}, \mathrm{ME}, \mathrm{UI}, \mathrm{ID}\}$

- Seniority Levels, $\mathcal{C} = \mathcal{S}$
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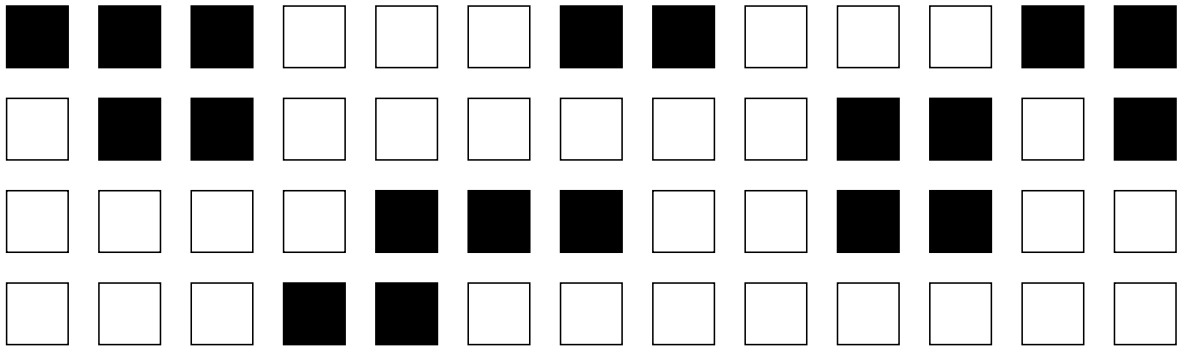

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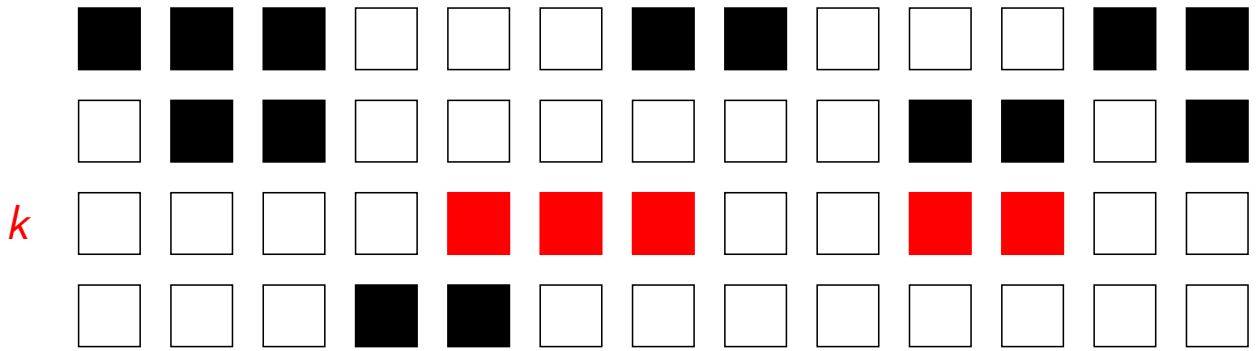

f_k^V

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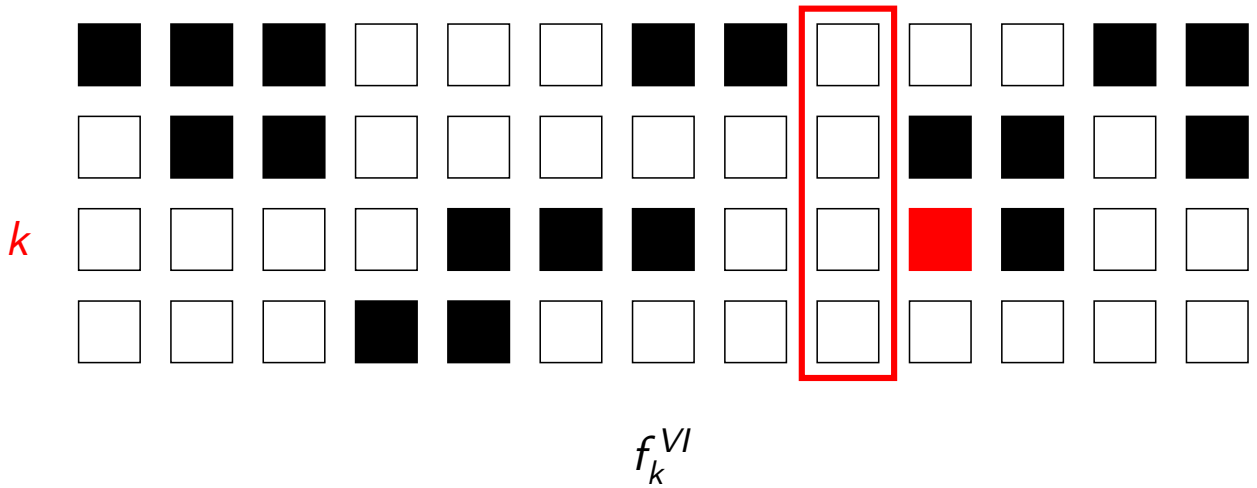

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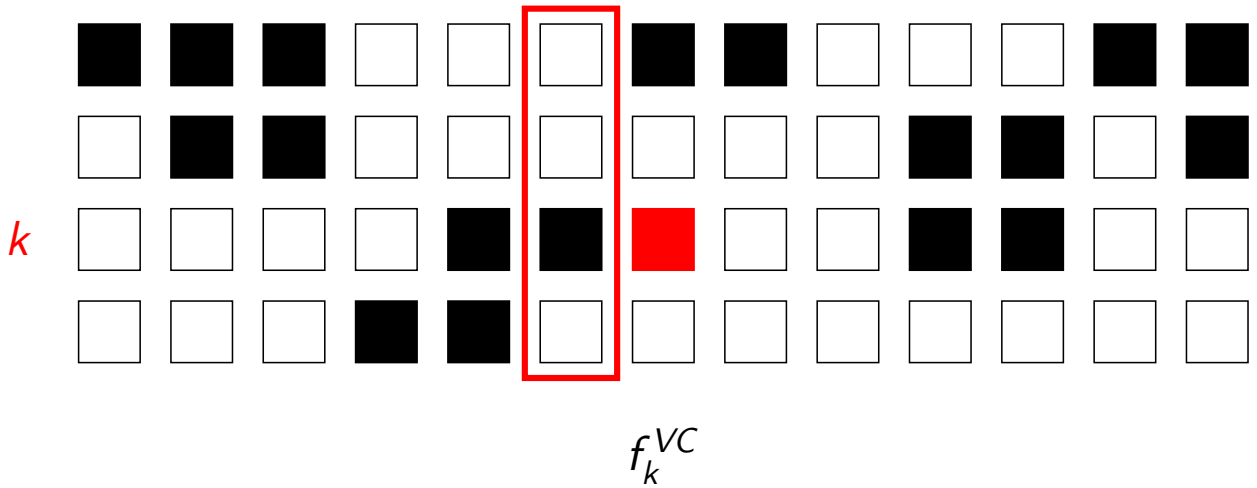

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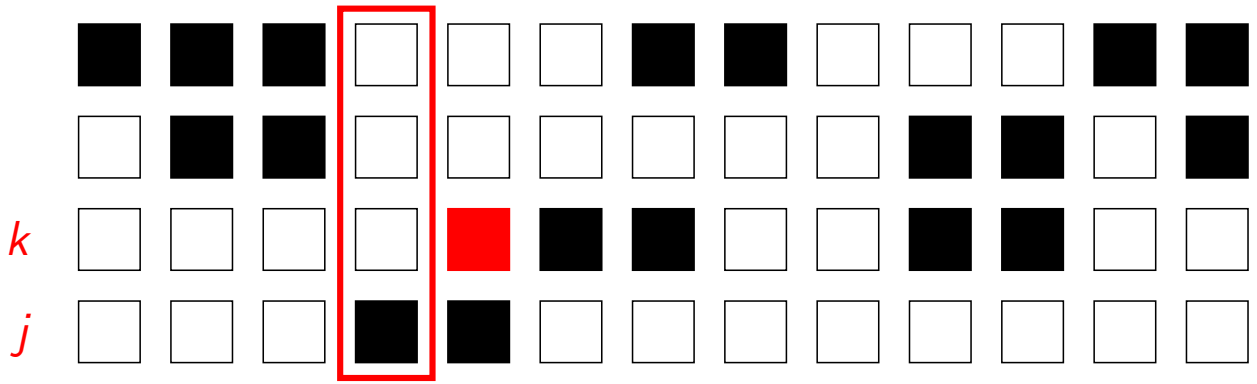

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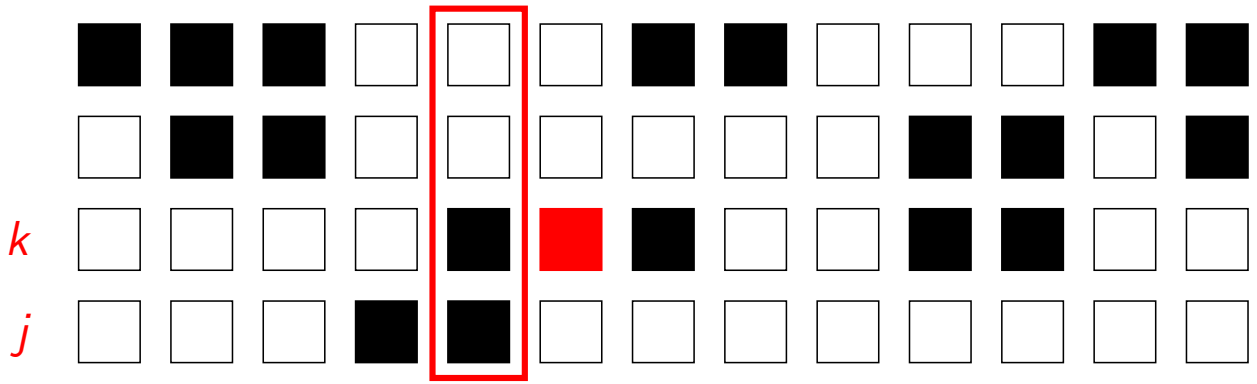

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Models

- behavior model (BM), where θ is a 1-dimensional Gaussian

$$P(\mathbf{F} \mid \mathbf{g}) = \prod_{k=1}^{K} P\left(f_k^V \mid \theta^V_{\mathbf{g}[k]}\right) P\left(f_k^{VI} \mid \theta^{VI}_{\mathbf{g}[k]}\right) P\left(f_k^{VC} \mid \theta^{VC}_{\mathbf{g}[k]}\right) \times \prod_{j \neq k}^{K} P\left(f_{k,j}^{OI} \mid \theta^{OI}_{\mathbf{g}[k],\mathbf{g}[j]}\right) P\left(f_{k,j}^{OC} \mid \theta^{OC}_{\mathbf{g}[k],\mathbf{g}[j]}\right)$$

- membership model (MM)

$$P(\mathbf{g}) = \frac{1}{Z_{\mathbf{g}}} \prod_{k=1}^{K} P(\mathbf{g}[k])$$

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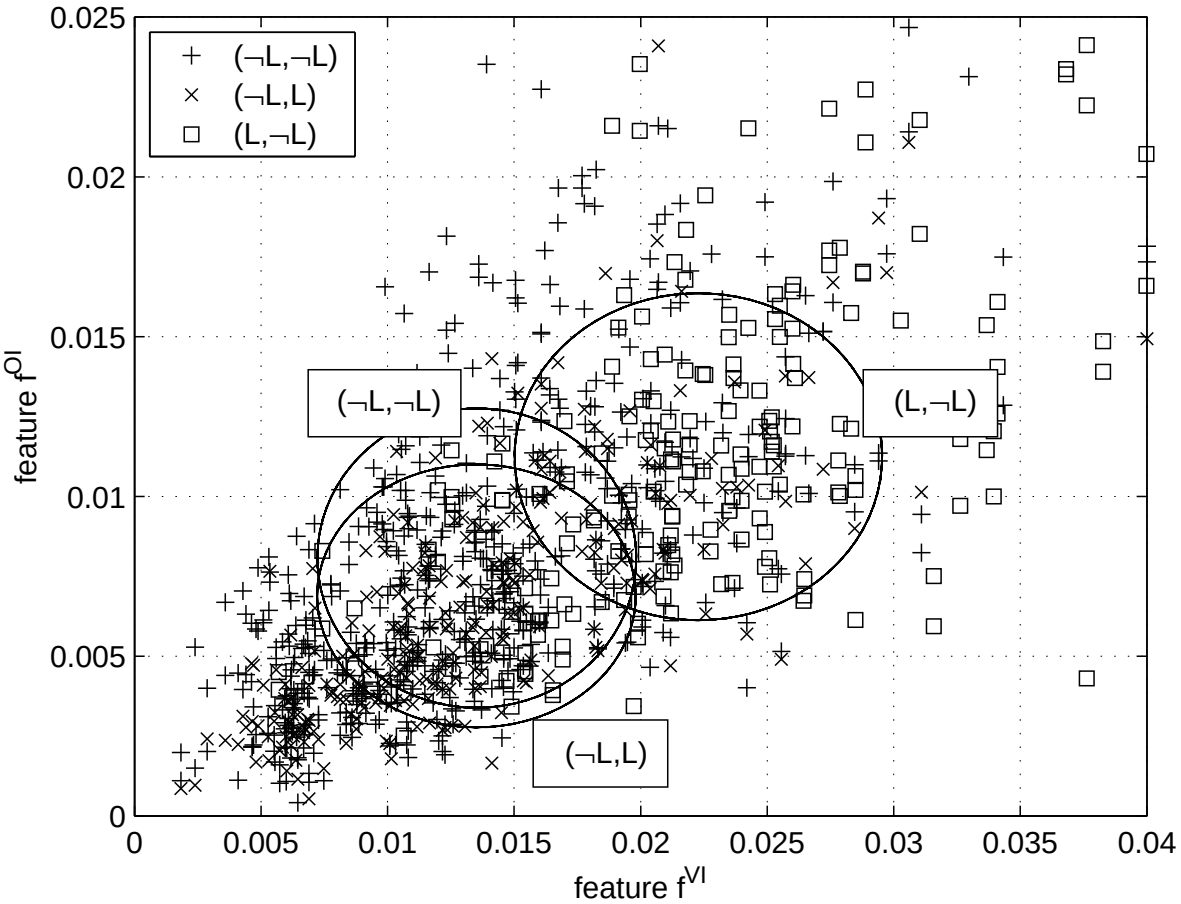
Unique Role $\mathcal{R}$ Classification

Feature Type	AMI $\mathcal{R}$
f_k^V	44
f_k^{VI}	*41
f_k^{VC}	34
$f_{k,j}^{OI}$	*53
$f_{k,j}^{OC}$	—
best*	53
all	46
priors	25

Aside: Looking for the Leader

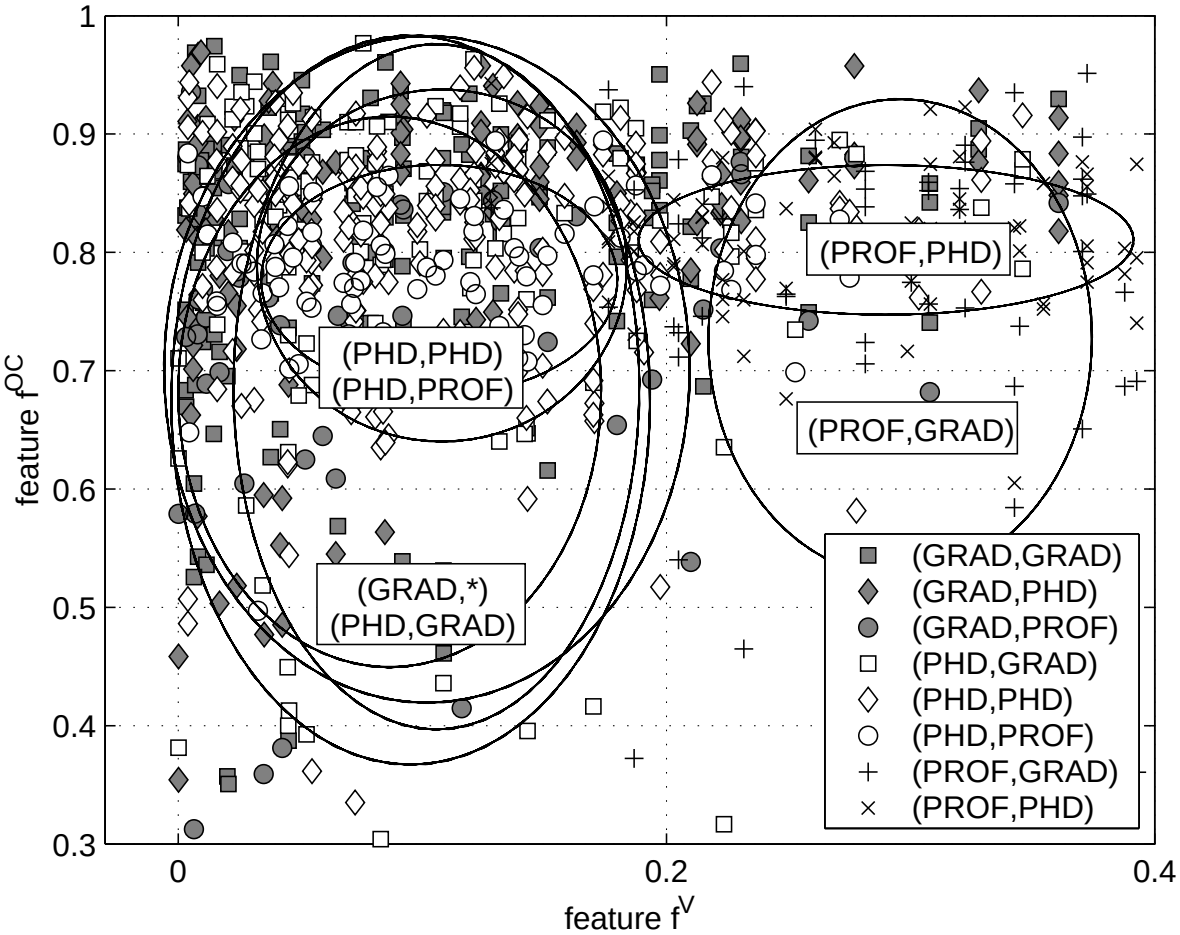
- find one unique role only, $\mathbf{g}[k] \in \mathcal{L} = \{L \equiv \text{PM}, \neg L\}$



Leader $\mathcal{L}$ Detection

Feature Type	AMI	
	$\mathcal{R}$	$\mathcal{L}$
f_k^V	44	—
f_k^{VI}	*41	*60
f_k^{VC}	34	—
$f_{k,j}^{OI}$	*53	*60
$f_{k,j}^{OC}$	—	—
best*	53	60
all	46	75
priors	25	25

Seniority Level Feature Distributions



Seniority Level $\mathcal{S}$ Classification

Feature Type	AMI		ICSI
	$\mathcal{R}$	$\mathcal{L}$	$\mathcal{S}$
f_k^V	44	—	*52
f_k^{VI}	*41	*60	52
f_k^{VC}	34	—	—
$f_{k,j}^{OI}$	*53	*60	*59
$f_{k,j}^{OC}$	—	—	*59
best*	53	60	61
all	46	75	58
priors	25	25	45

Conversation-Type-Dependent $\mathcal{S}$ Classification

- condition models on automatically inferred meeting type

Feature Type	AMI		ICSI	
	$\mathcal{R}$	$\mathcal{L}$	$\mathcal{S}$	$\mathcal{S}\|t^*$
f_k^V	44	—	*52	*57
f_k^{VI}	*41	*60	52	56
f_k^{VC}	34	—	—	62
$f_{k,j}^{OI}$	*53	*60	*59	*59
$f_{k,j}^{OC}$	—	—	*59	*63
best*	53	60	61	67
all	46	75	58	57
priors	25	25	45	45

Conclusions

- assigned unique roles $\mathcal{R}$ in the AMI corpus
  - 53% accuracy, 37% rel error reduction over baseline
  - improves to 75%, when only manager (PM) is sought
  - best features: initiation of talkspurts in silence and in overlap
- seniority level $\mathcal{S}$ in the ICSI corpus

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  - improves to 73%, with conditioning on true meeting type
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   - first baseline for several of the explored tasks
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Thank you for attending.

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