Information Fusion (IFU), Summer Semester 2023

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Supplement: Dempster's Rule of Combination

This supplement is a small compilation of example exercises of Dempster's Rule of Combination. It is intended to help you practice and is therefore not scheduled to be discussed in one of our Exercises. But, if you want to discuss results or have questions, we will set an online meeting.

Dempster's Rule of Combination:

$$
m_{12}(A) = \begin{cases} \dfrac{1}{1 - k_{\mathrm{c}}} \displaystyle\sum_{B \cap C = A} m_1(B) \cdot m_2(C) & \text{if } A \neq \varnothing, \\ 0 & \text{if } A = \varnothing, \end{cases}
$$

in which $B \in \mathcal{P}(\Omega)$, $C \in \mathcal{P}(\Omega)$, and

$$
k_{\mathrm{c}} = \sum_{B \cap C = \varnothing} m_1(B) \cdot m_2(C).
$$

1 Traffic Lights

An autonomous vehicle approaches a traffic light which can either be green (G), yellow (Y), or red (R)[1]. The vehicle drives in the US, so no combination of lights are possible $(\Omega = \{\varnothing, G, Y, R\})$. The traffic light is observed by optical sensors whose signals are fed into an image processing algorithm. The algorithm outputs evidences about the state of the traffic light in an array as follows: $\mathbf{m} = \{\varnothing, G, Y, R, \{G, Y\}, \{G, R\}, \{Y, R\}, \{\Omega\}\}$. To increase the safety of the vehicle multiple sensors are used. Combine the evidential masses of the sensors for the following cases.

1.

	$\varnothing$	G	Y	R	$\{G, Y\}$	$\{G, R\}$	$\{Y, R\}$	Ω
s_1	0	0	0	0	0	0	0.8	0.2
s_2	0	0	0	0.3	0.7	0	0	0

Does the result surprise you?

2.

	$\varnothing$	G	Y	R	$\{G, Y\}$	$\{G, R\}$	$\{Y, R\}$	Ω
s_1	0	0.6	0	0	0.3	0	0	0.1
s_2	0	0	0.3	0	0.2	0	0	0.5
s_2	0	0	0.7	0	0.2	0	0	0.1

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[1]This example is inspired by this code golf competition posted on StackExchange.

2 Zadeh's Example

Two doctors (d_1 and d_2) examine a patient. They agree that the patient either suffers from meningitis (M), concussion (C), or a brain tumour (B):

	$\varnothing$	M	C	B	$\{M,C\}$	$\{M,B\}$	$\{C,B\}$	Ω
d_1	0	0.99	0	0.01	0	0	0	0
d_2	0	0	0.99	0.01	0	0	0	0

Fuse the doctors' opinions. Is the result intuitive?

3 Speeding Motorist

Did the motorcyclist exceed the speed limit?