



Advanced Topics in Information Theory

Lecture Notes

Stefan M. Moser

© Copyright Stefan M. Moser

Signal and Information Processing Lab
ETH Zurich
Zurich, Switzerland

Institute of Communications Engineering
National Yang Ming Chiao Tung University (NYCU)
Hsinchu, Taiwan

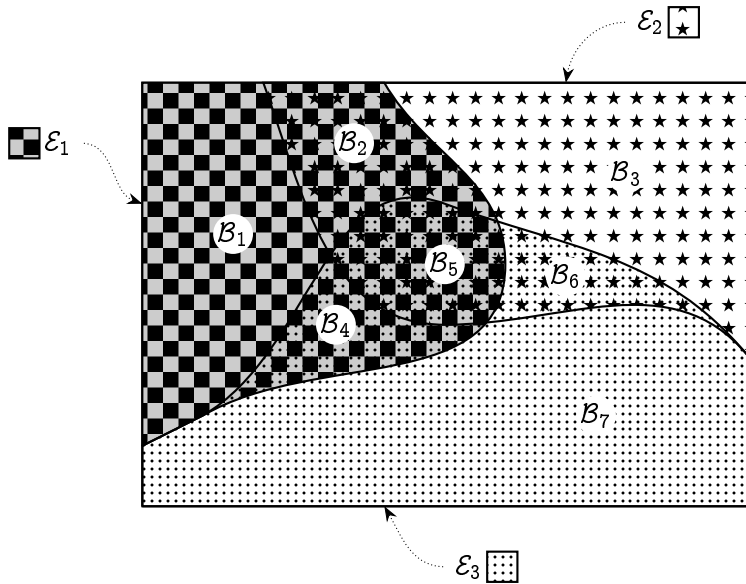
You are welcome to use these lecture notes for yourself, for teaching, or for any other noncommercial purpose. If you use extracts from these lecture notes, please make sure to show their origin. The author assumes no liability or responsibility for any errors or omissions.

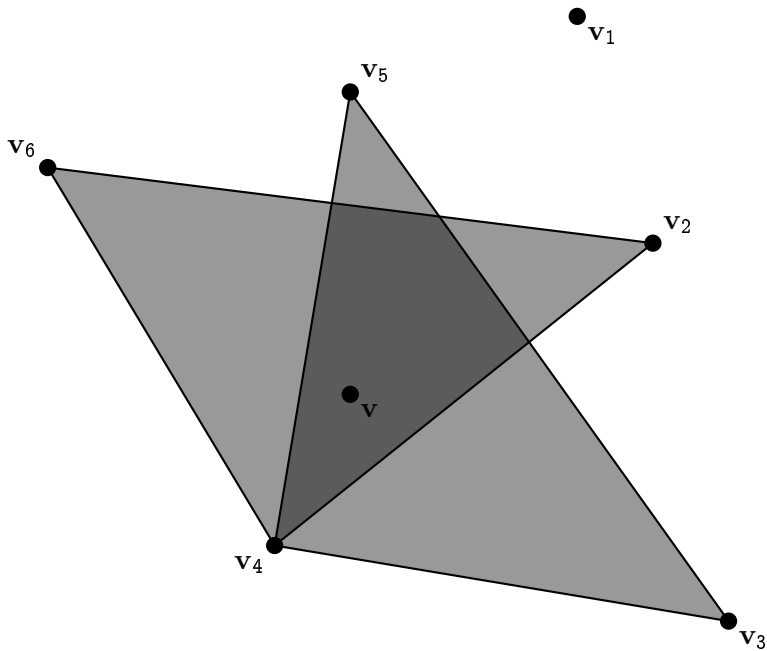
6th Edition — 2025.

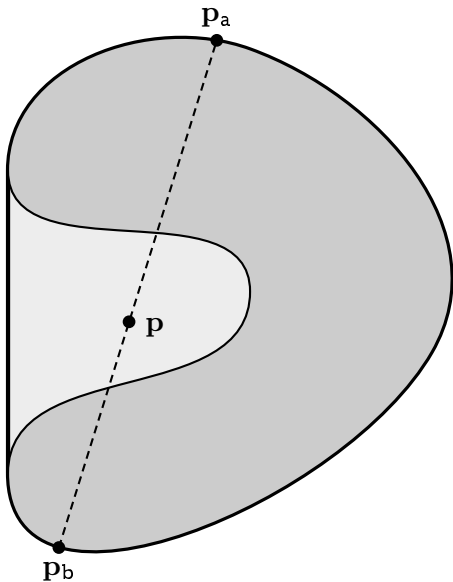
Version 6.5.

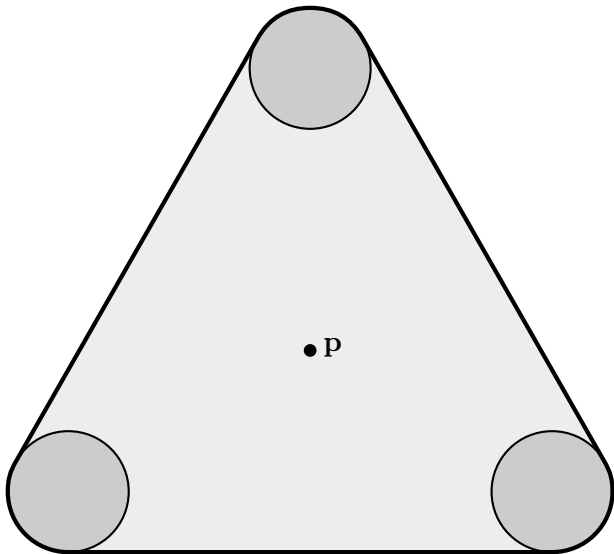
Compiled on 18 December 2025.

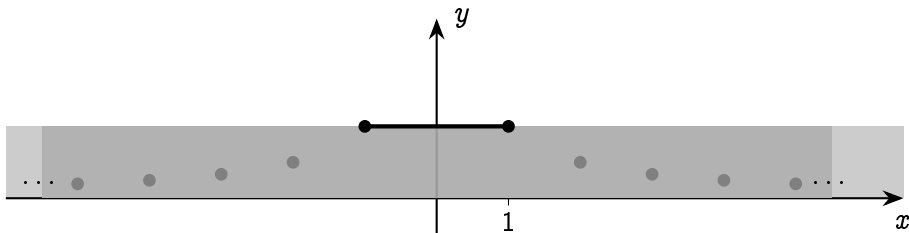
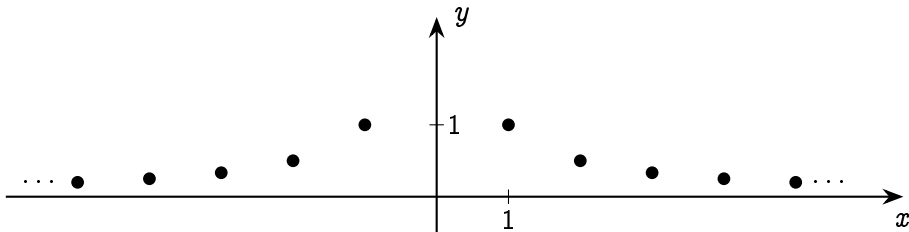
For the latest version see <https://moser-isi.ethz.ch/scripts.html>

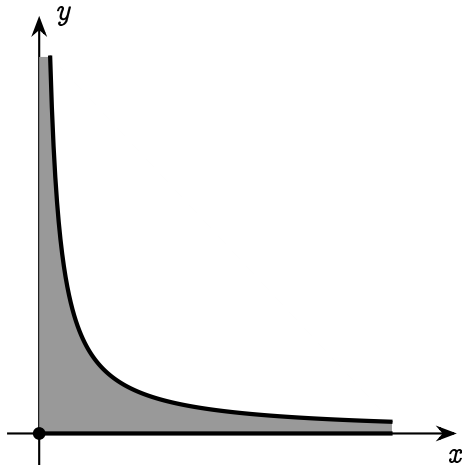
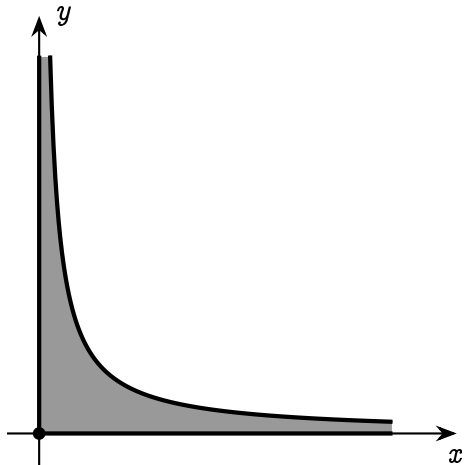


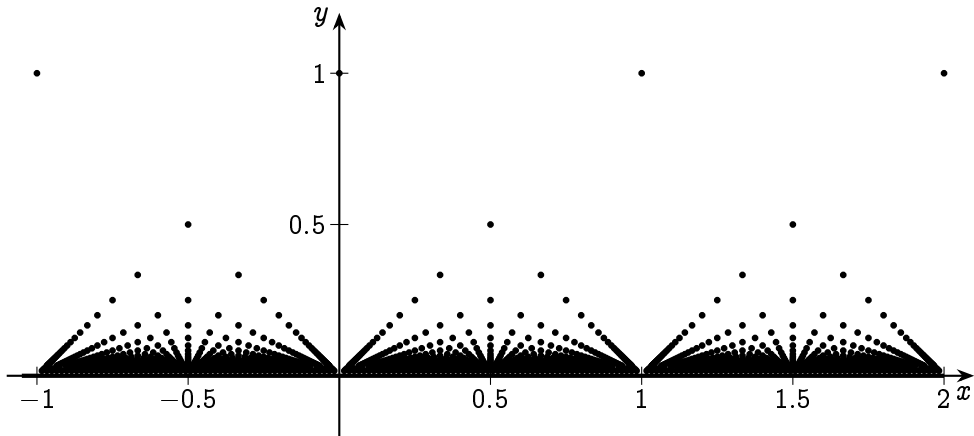


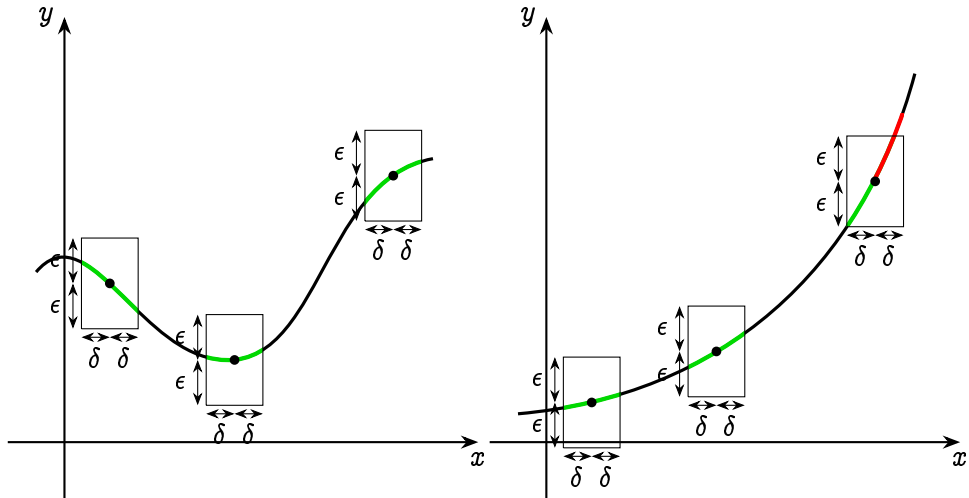


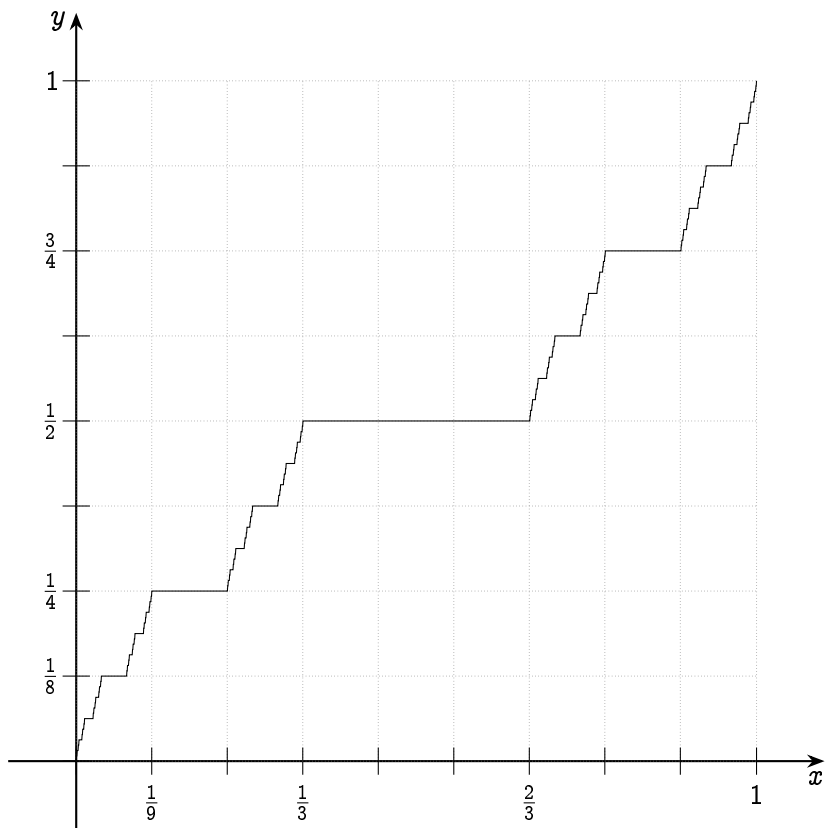


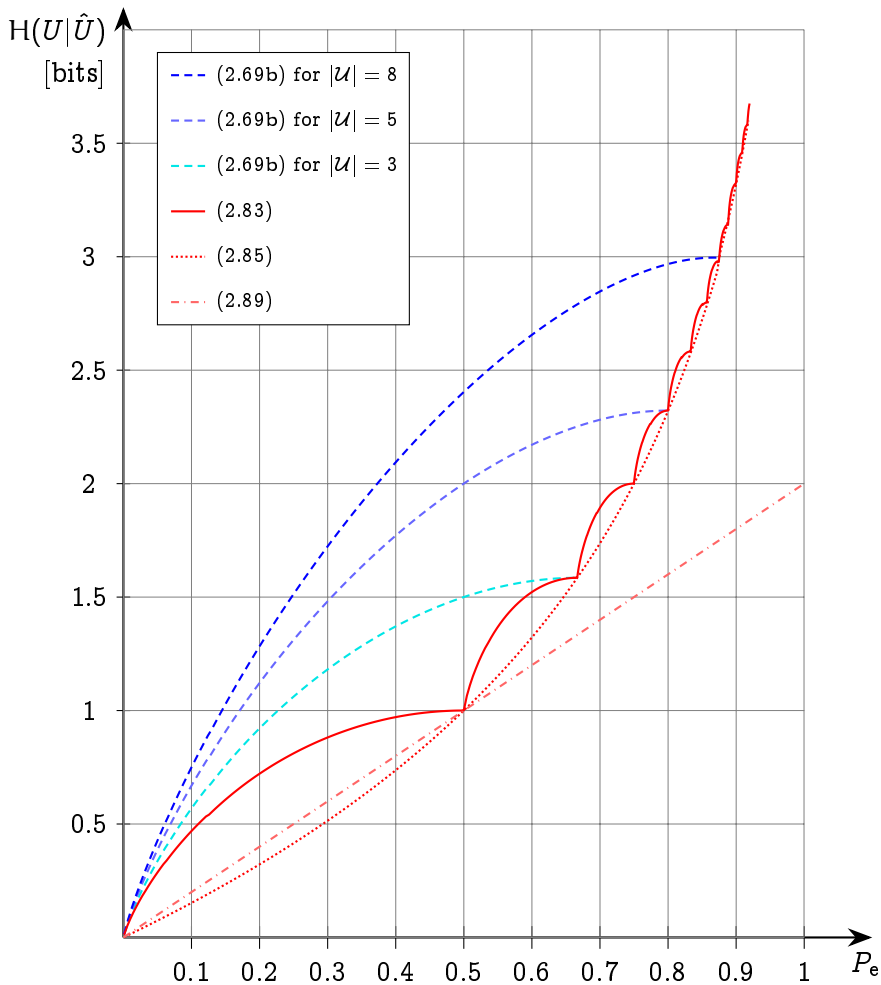


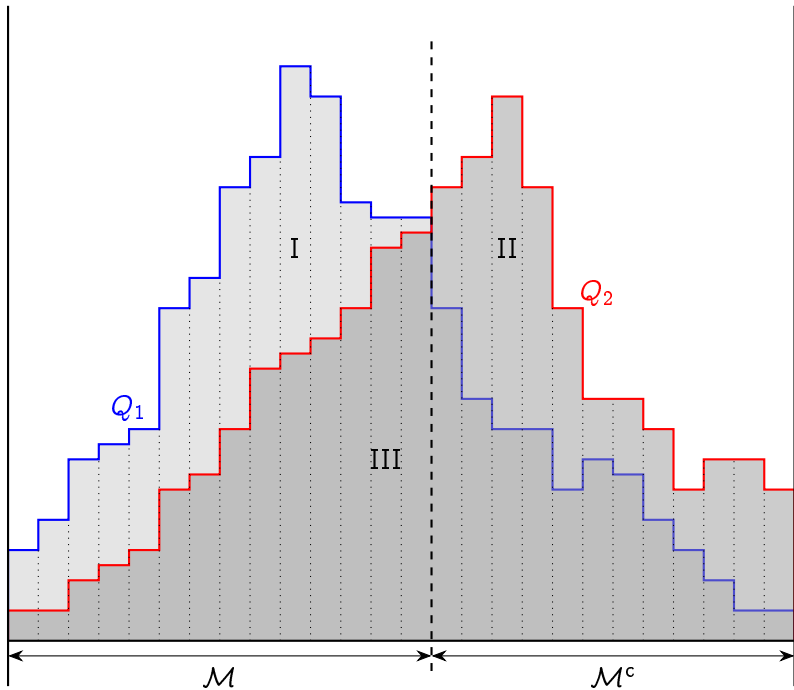


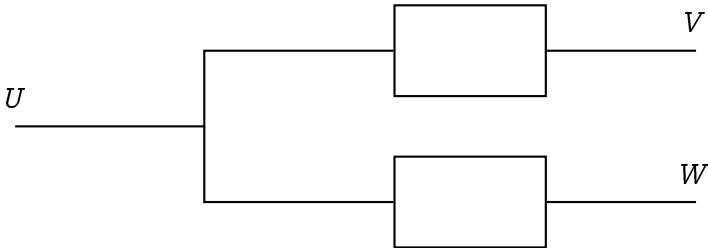


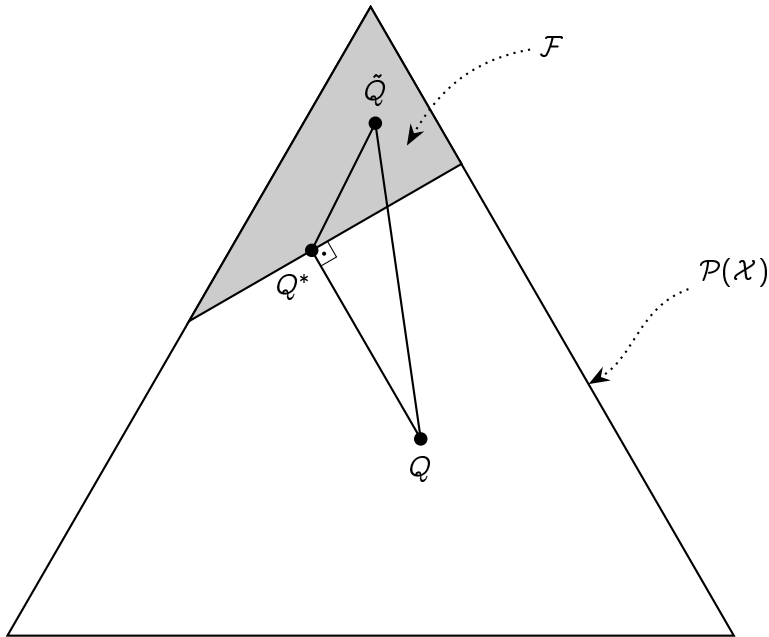


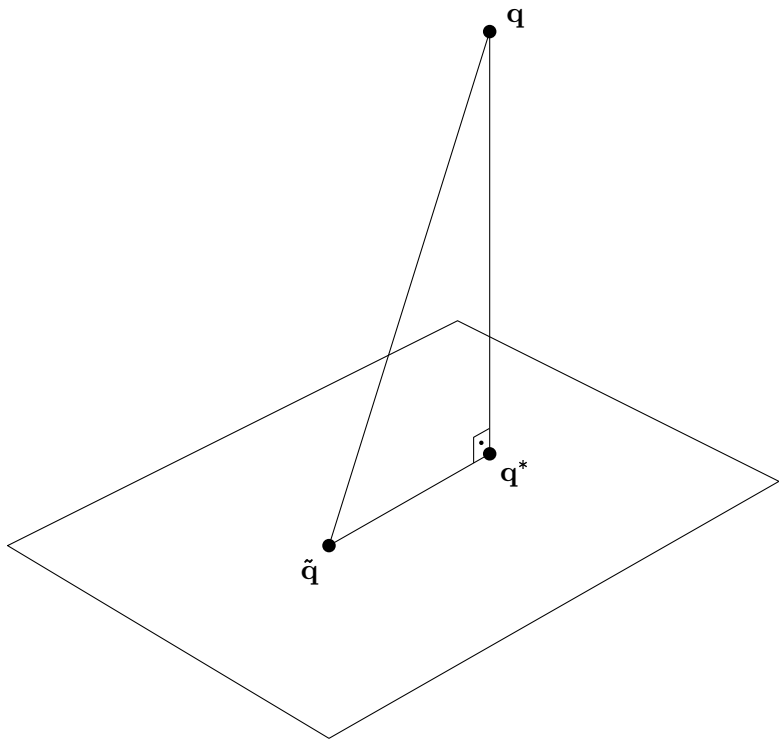


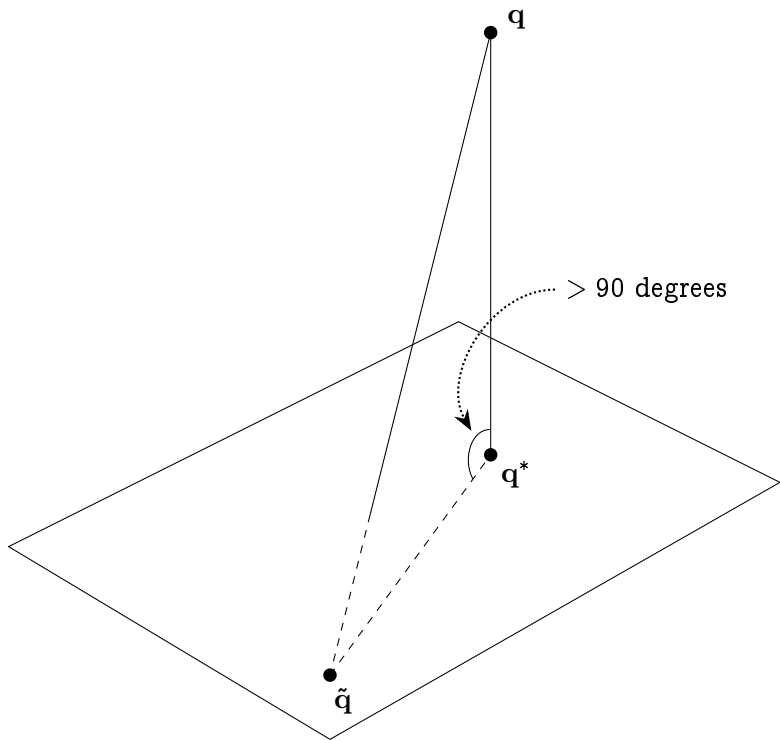


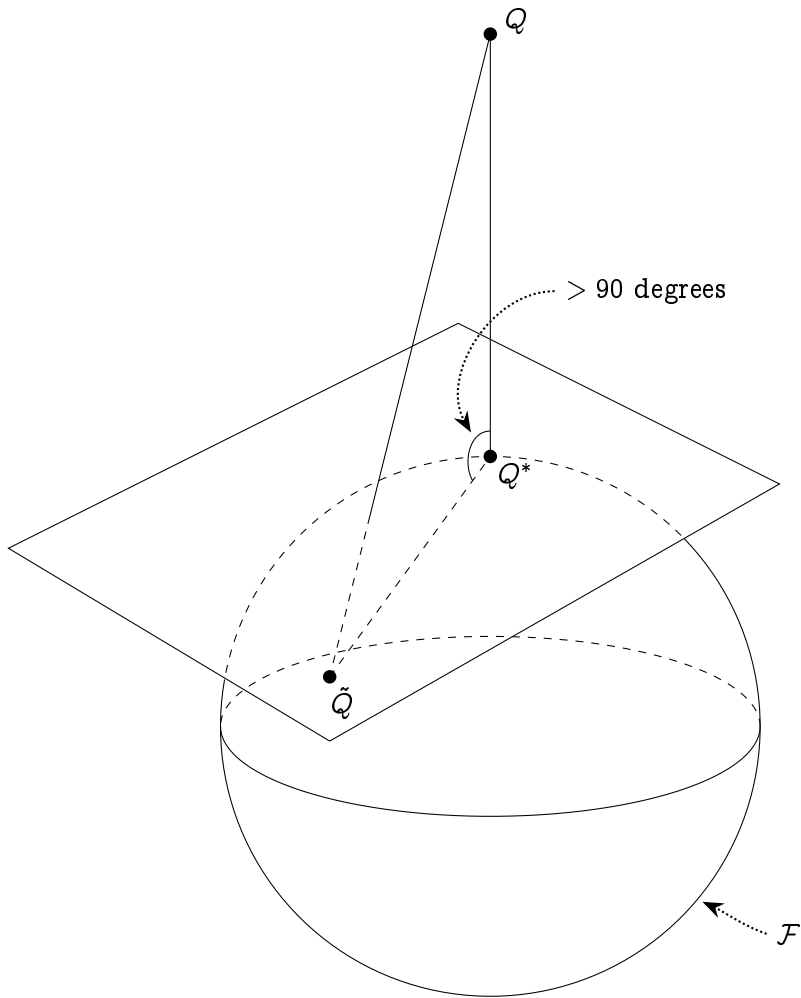


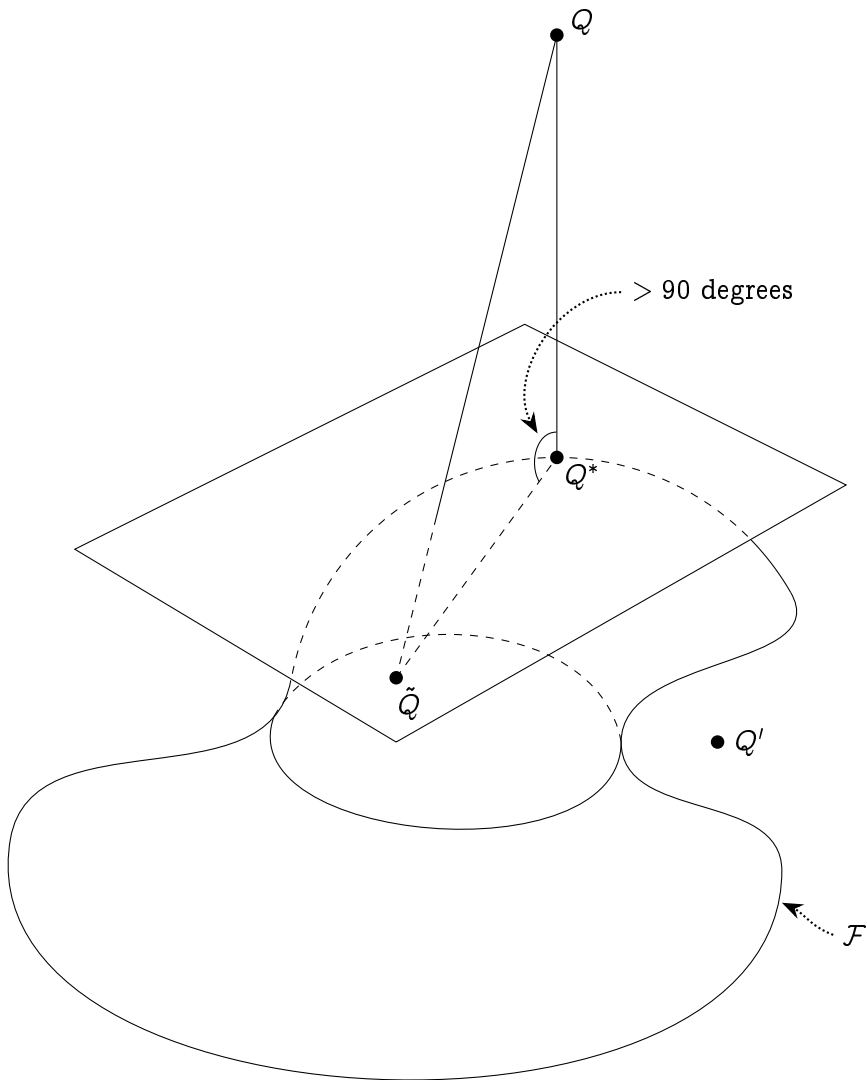


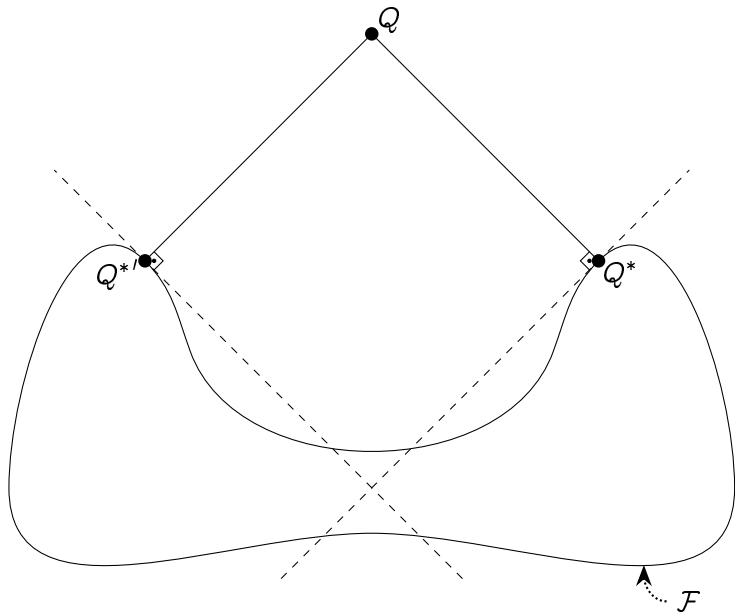


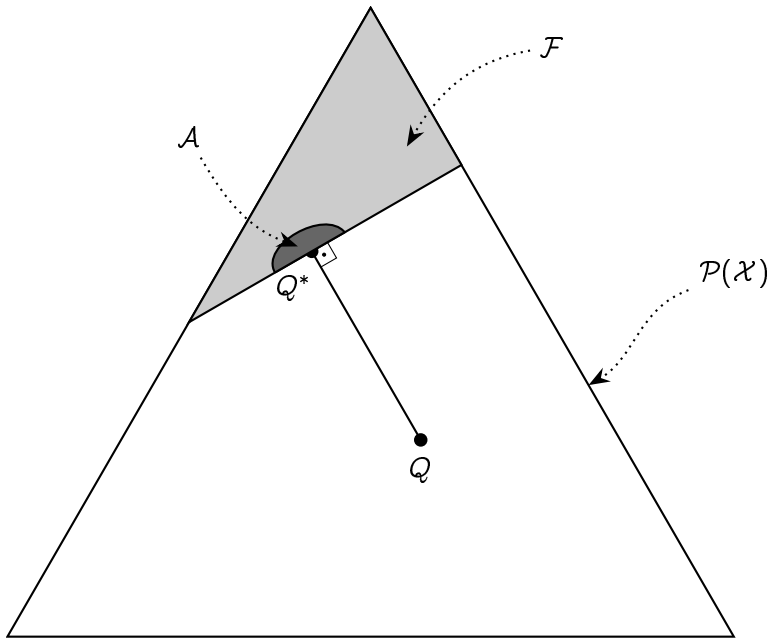


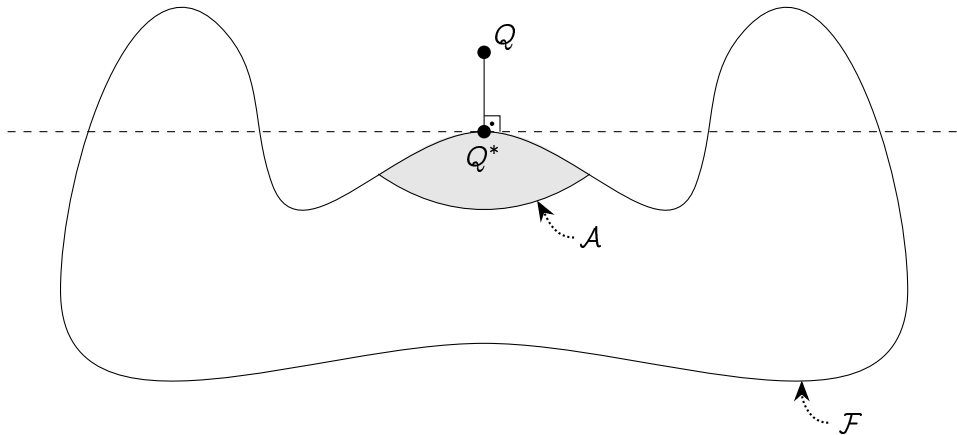


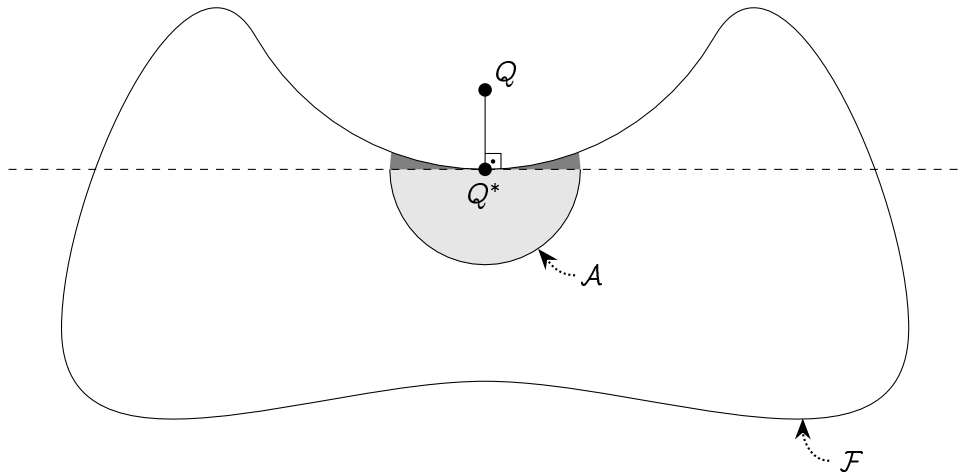


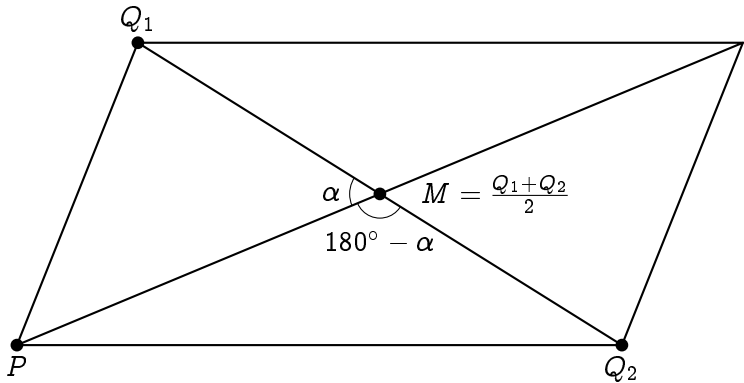


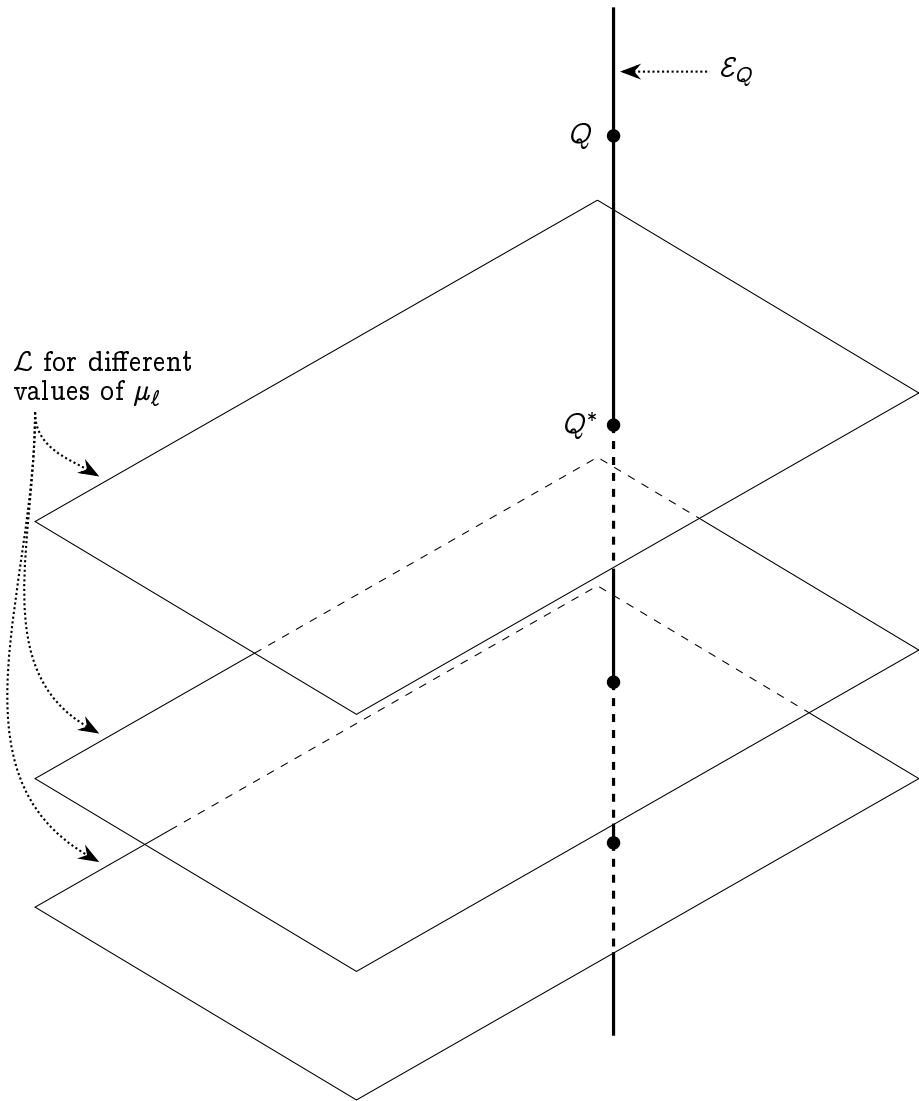


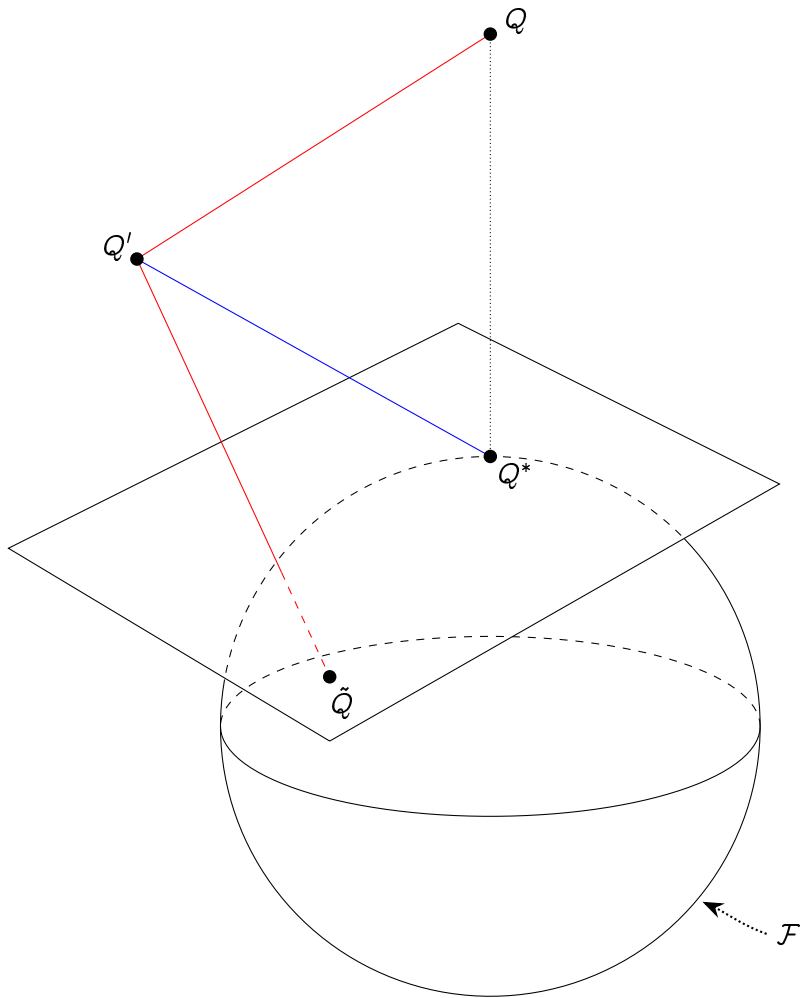


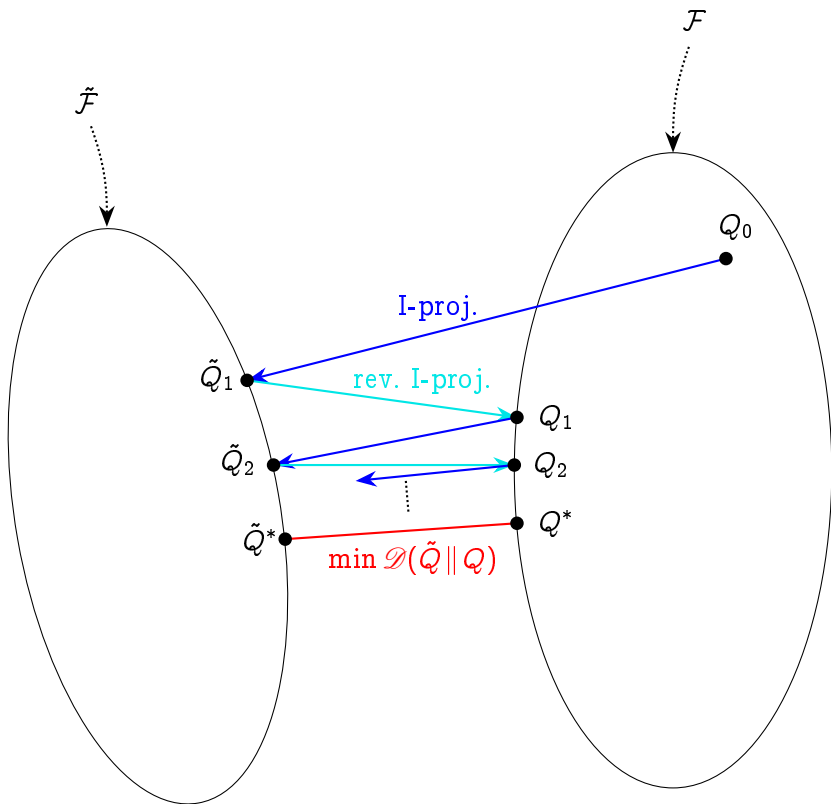


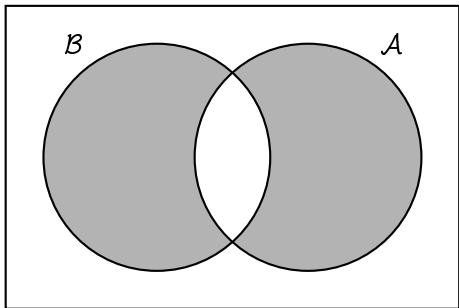


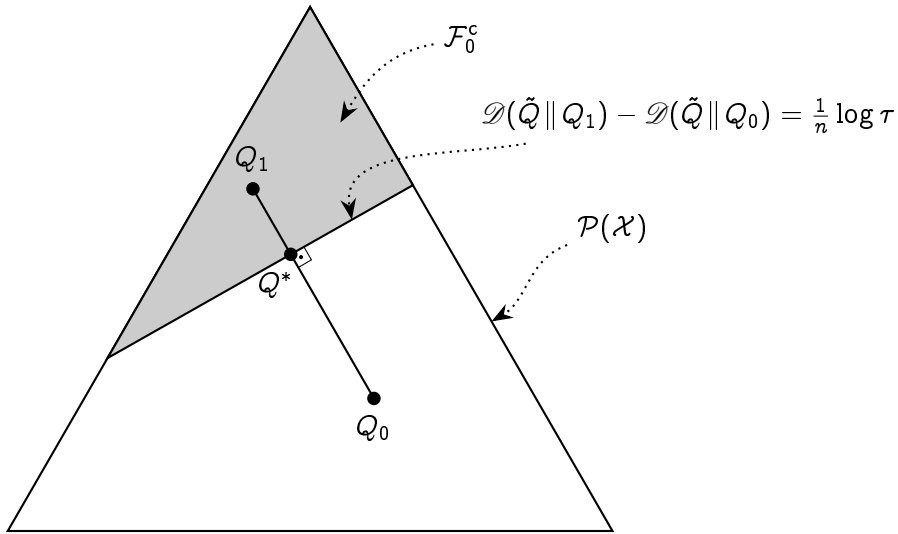


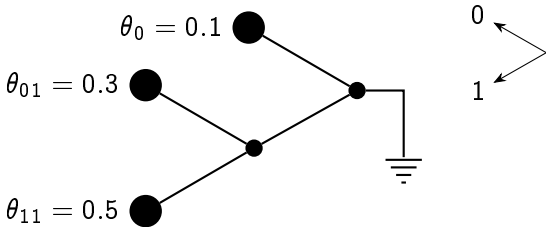


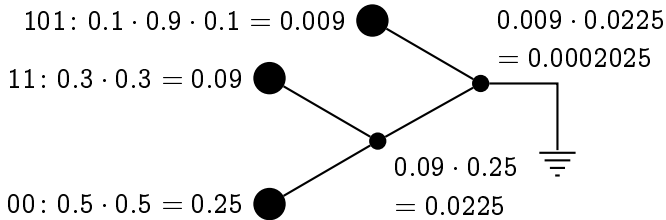


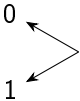


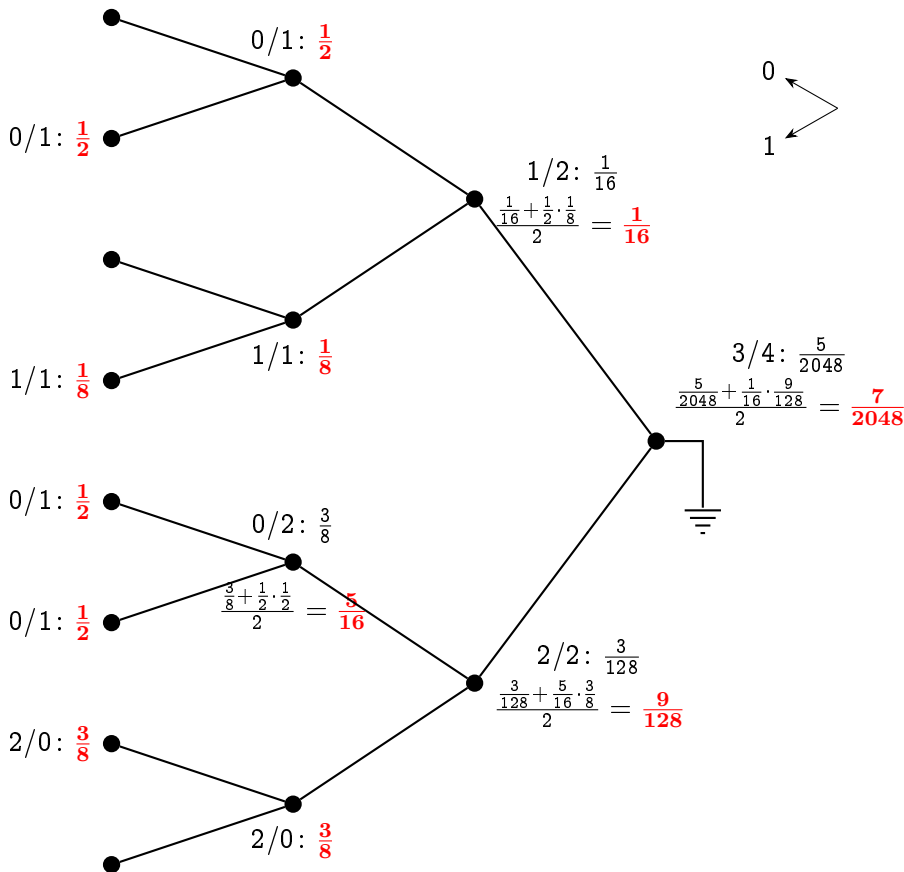


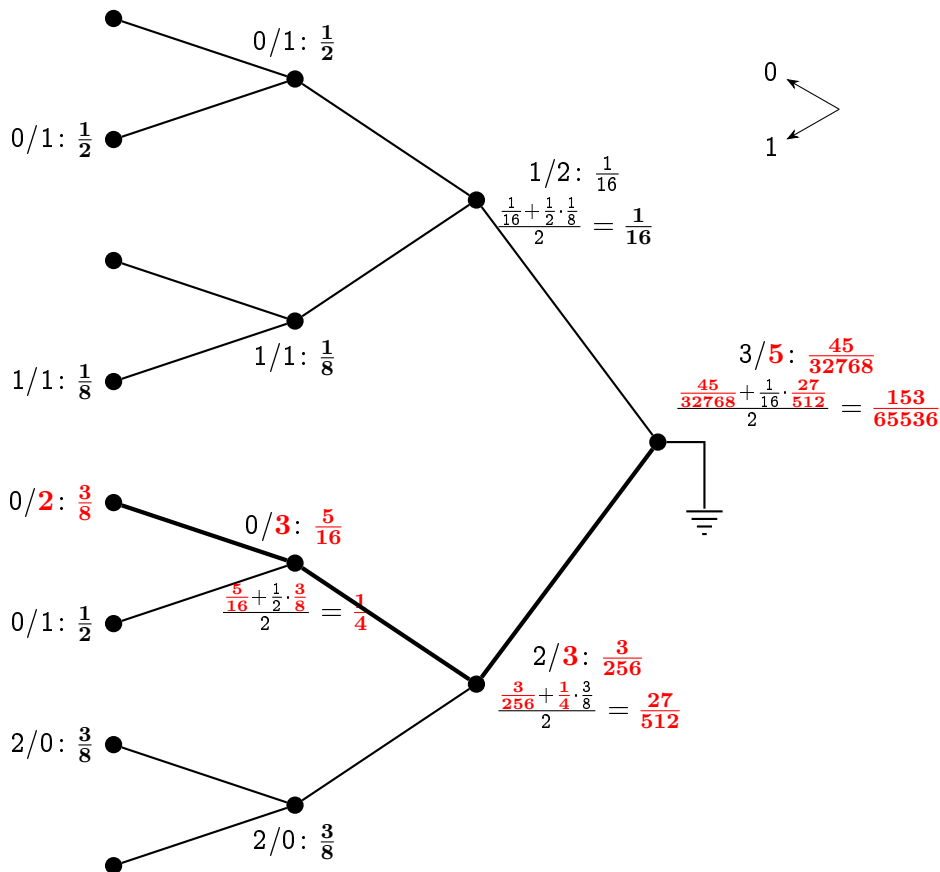


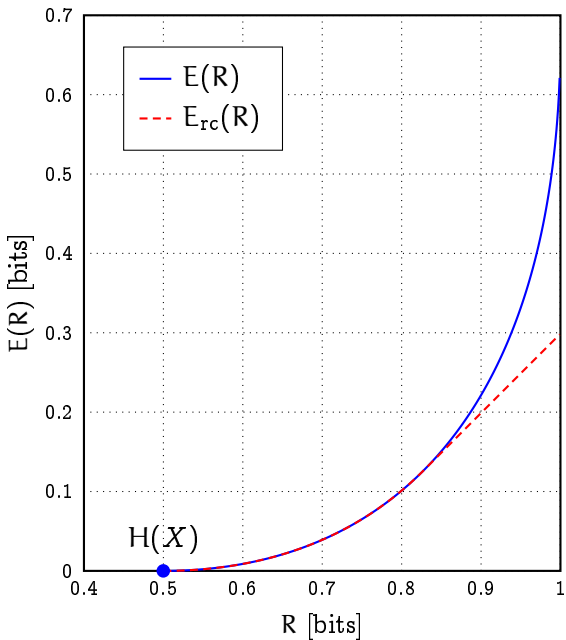


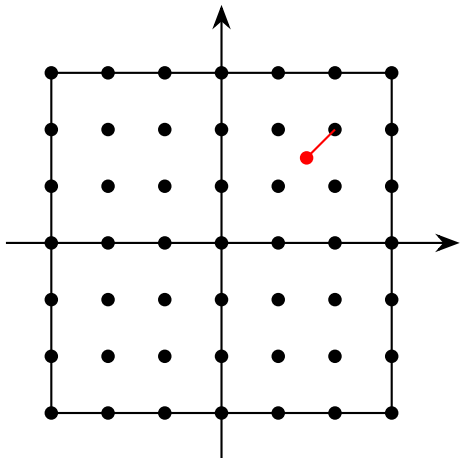




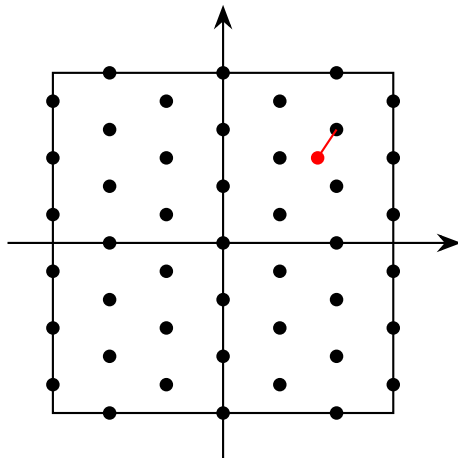




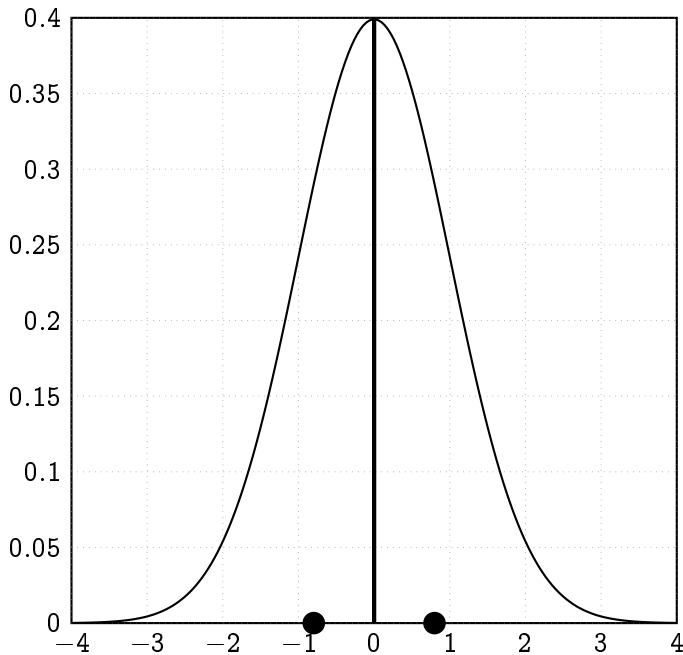




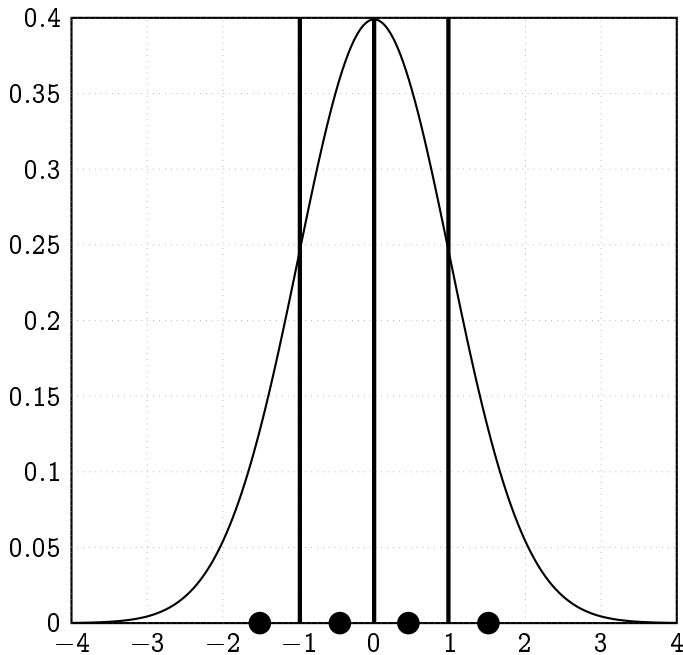
independent description
49 points

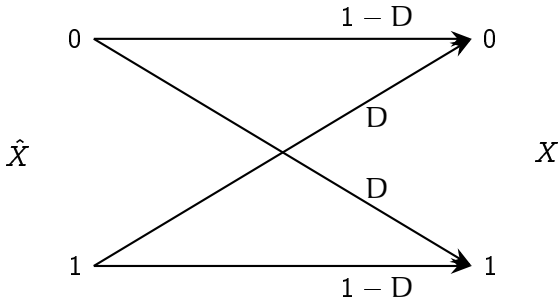


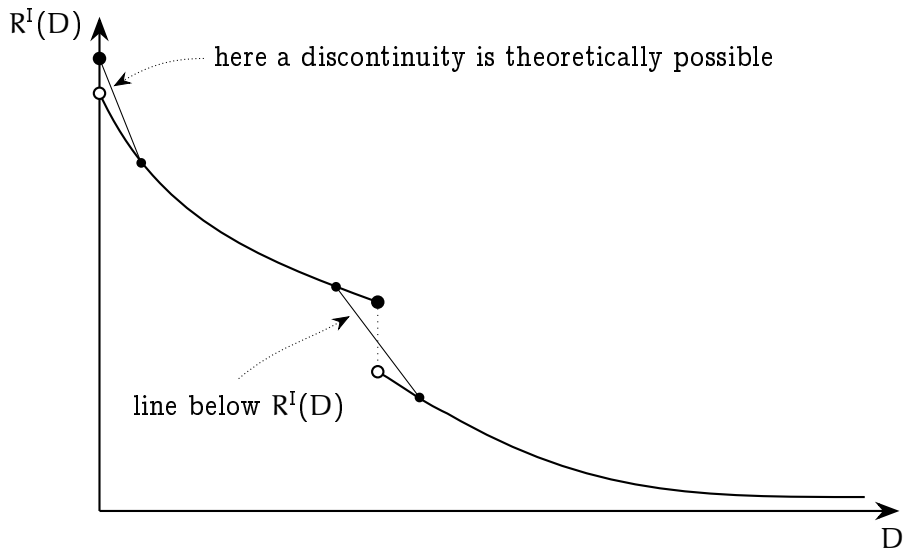
dependent description
45 points

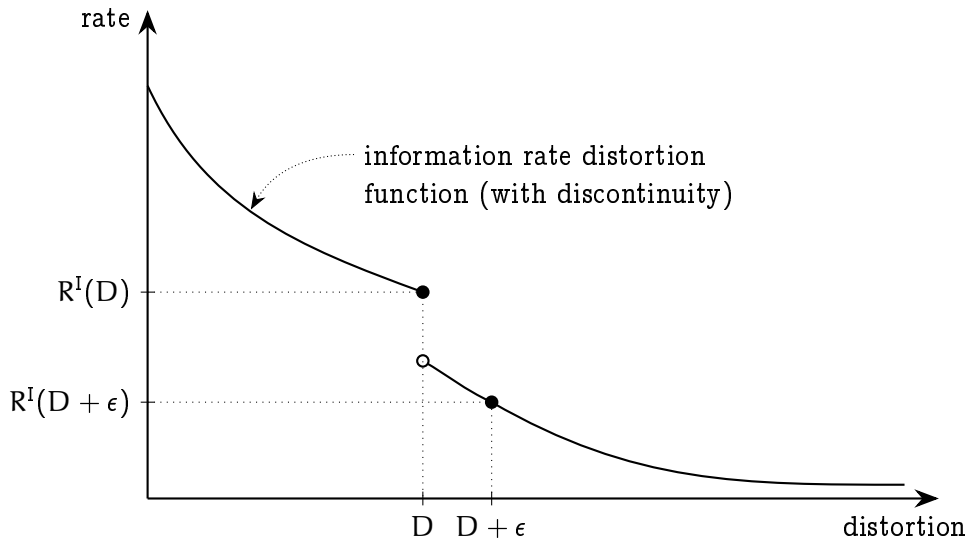


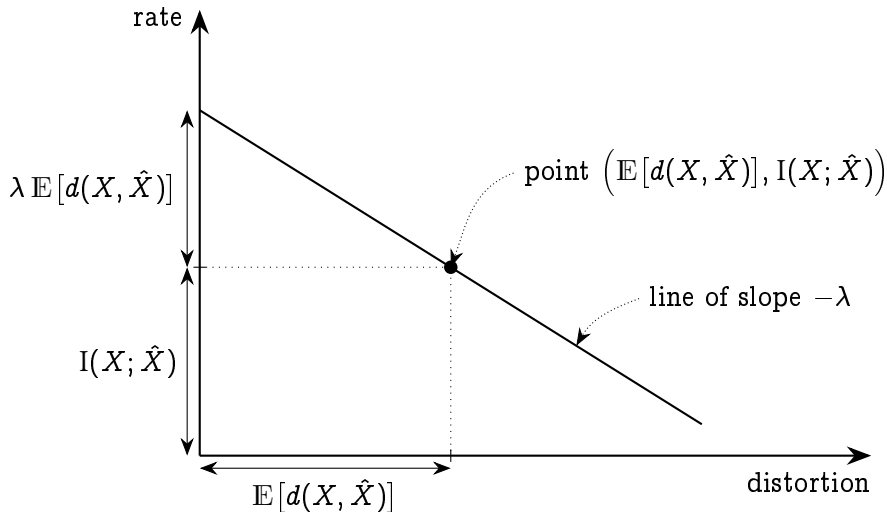
$\hat{x}_1$	$\hat{x}_2$	θ
0.5	1	0.75
0.3578	1.3288	0.8433
0.3973	1.4011	0.8992
0.4202	1.4450	0.9326
0.4336	1.4714	0.9525
0.4414	1.4872	0.9643
0.4461	1.4966	0.9714
0.4488	1.5022	0.9755
$\vdots$		
0.4528	1.5104	0.9816

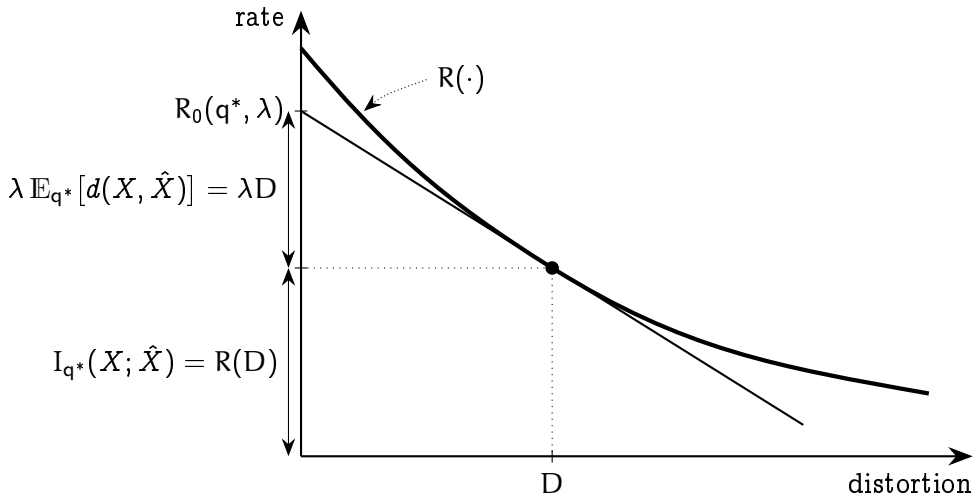


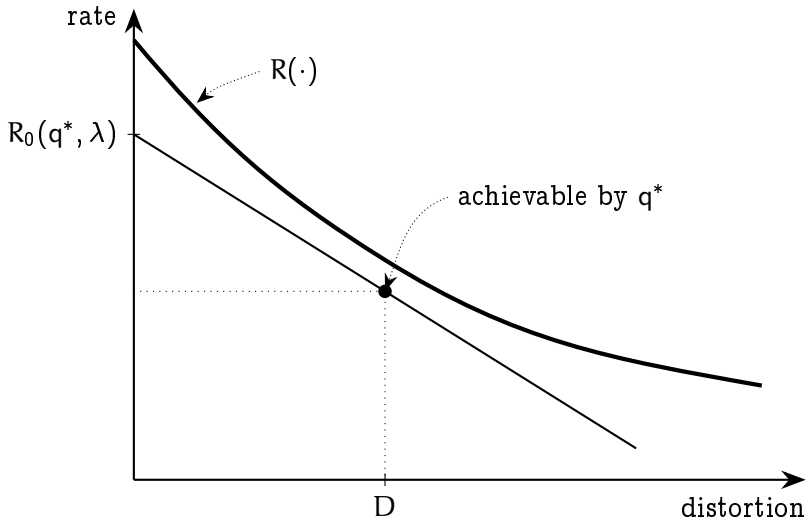


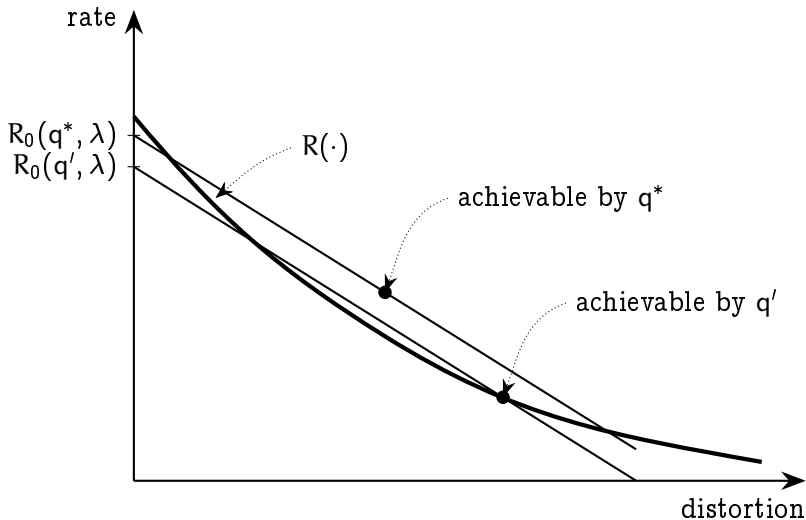


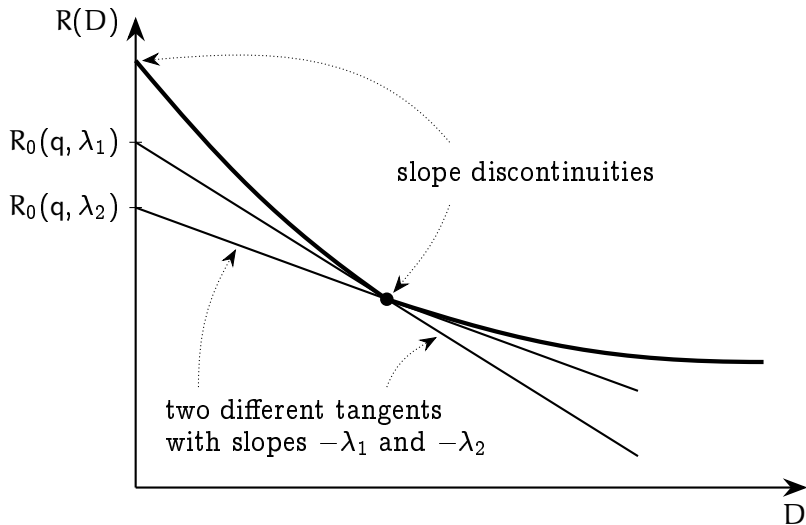


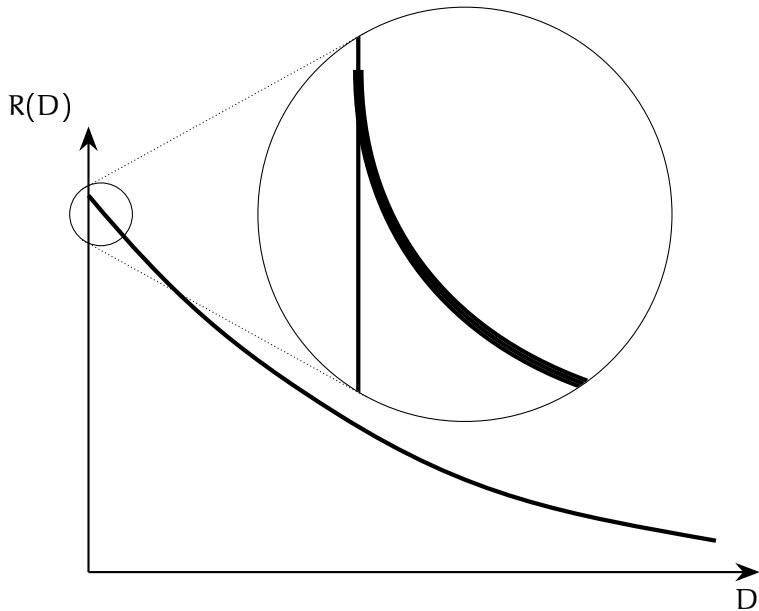




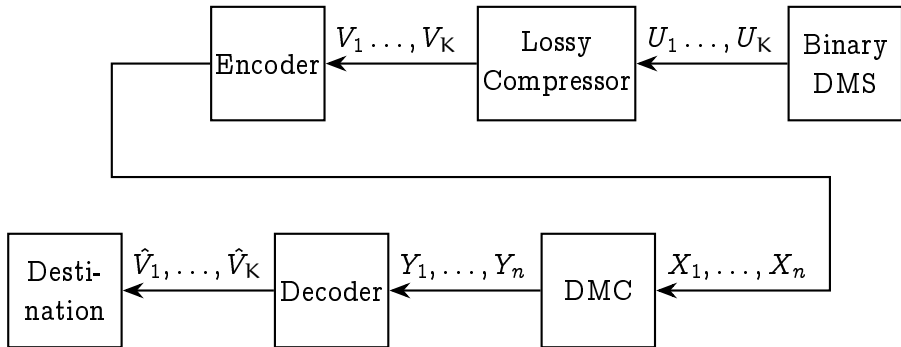


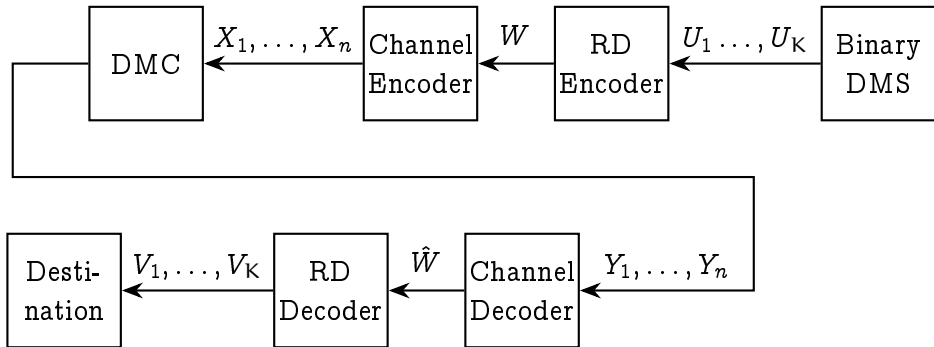


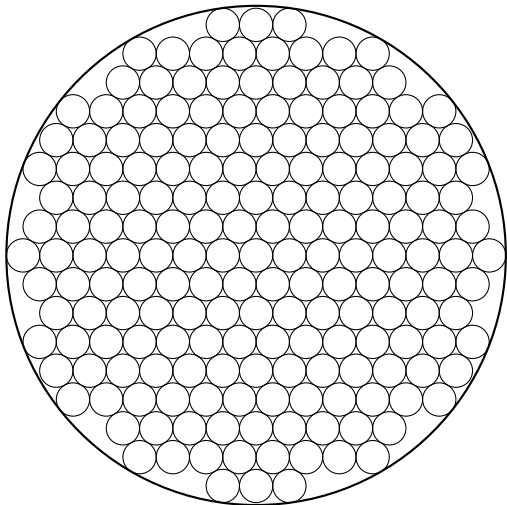


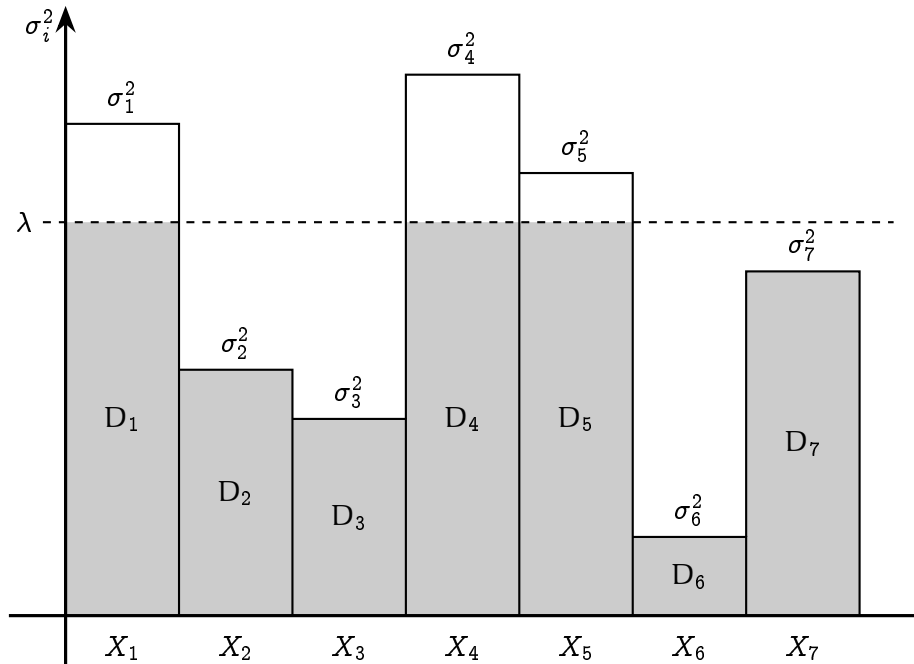


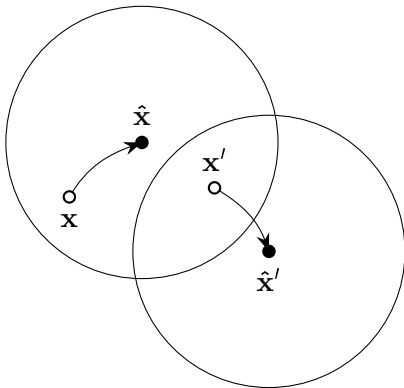






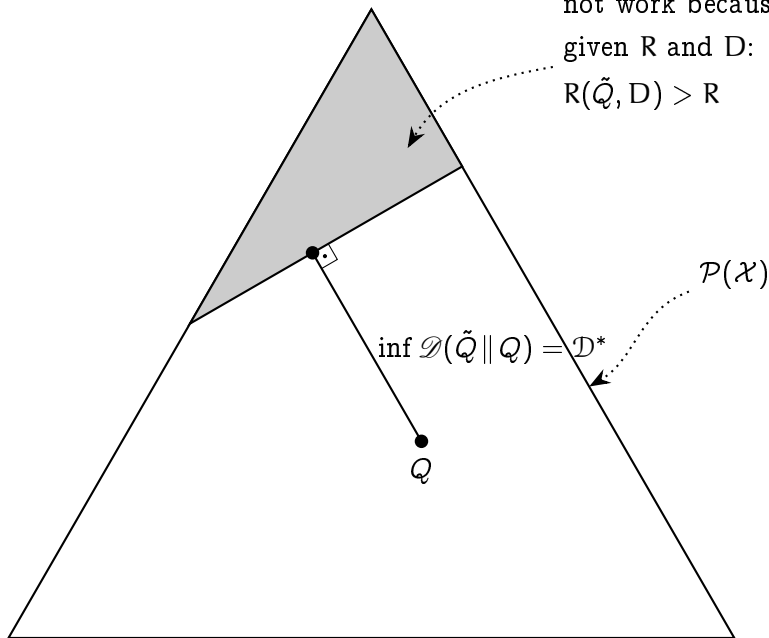


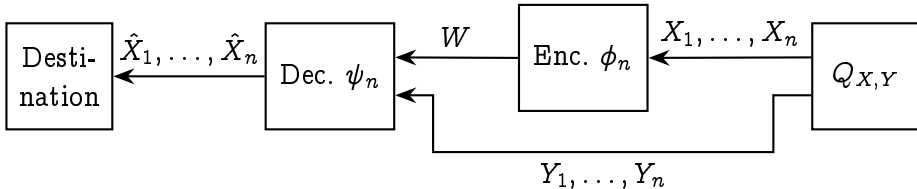


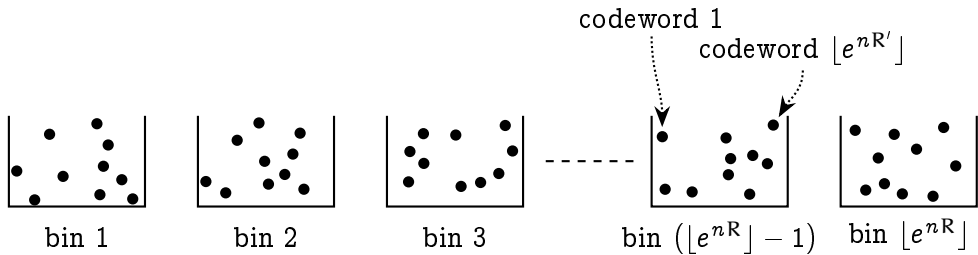


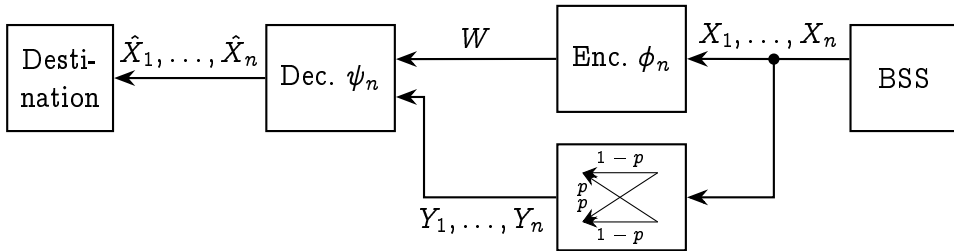
the sources $\tilde{Q}$ that do
not work because for the
given R and D :

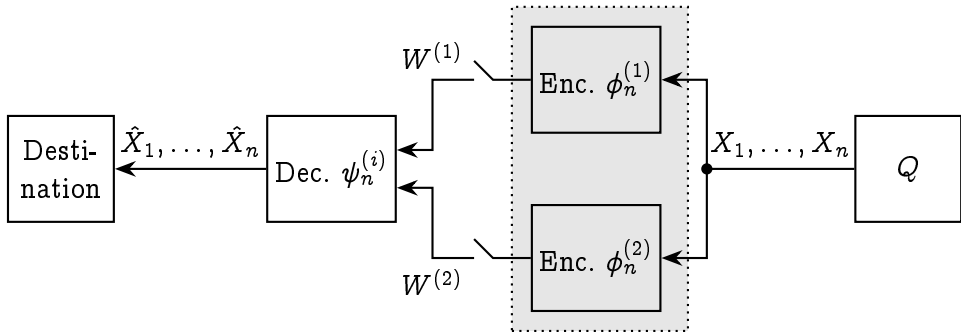
$$R(\tilde{Q}, D) > R$$





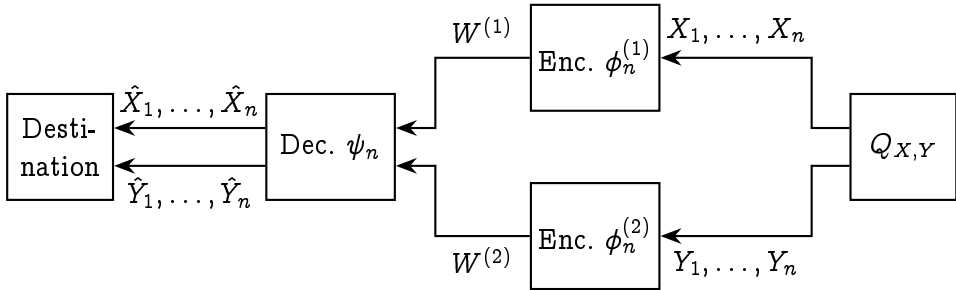


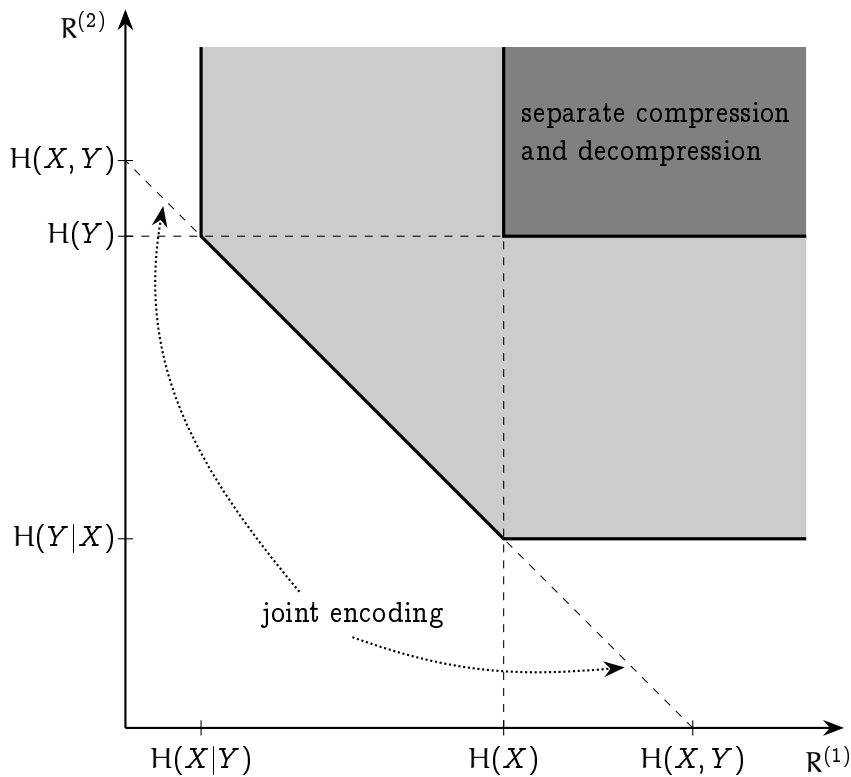




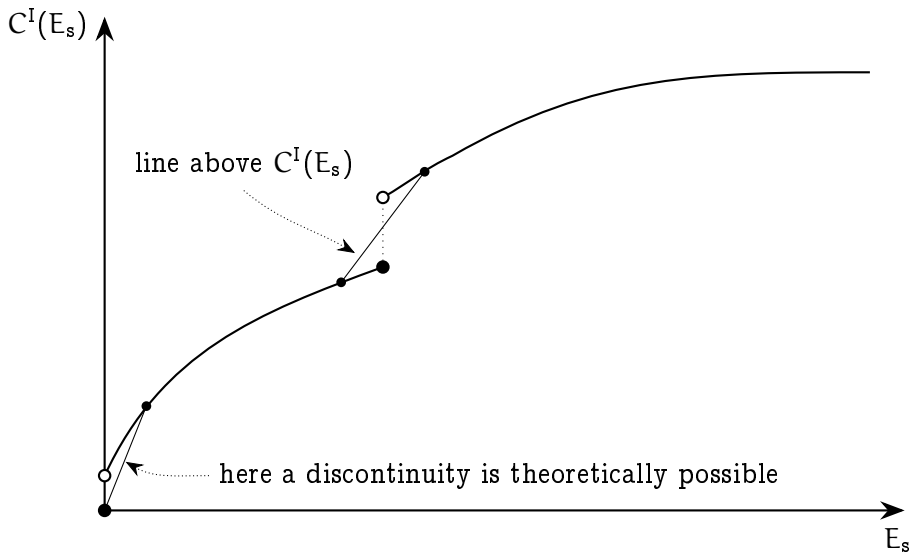
$Q_{\hat{X}^{(1)}, \hat{X}^{(2)} X}(\cdot, \cdot 0)$	$\hat{X}^{(2)} = 0$	$\hat{X}^{(2)} = 1$	$Q_{\hat{X}^{(1)} X}(\cdot 0)$
$\hat{X}^{(1)} = 0$	$3 - 2\sqrt{2}$	$\sqrt{2} - 1$	$2 - \sqrt{2}$
$\hat{X}^{(1)} = 1$	$\sqrt{2} - 1$	0	$\sqrt{2} - 1$
$Q_{\hat{X}^{(2)} X}(\cdot 0)$	$2 - \sqrt{2}$	$\sqrt{2} - 1$	
$Q_{\hat{X}^{(1)}, \hat{X}^{(2)} X}(\cdot, \cdot 1)$	$\hat{X}^{(2)} = 0$	$\hat{X}^{(2)} = 1$	$Q_{\hat{X}^{(1)} X}(\cdot 1)$
$\hat{X}^{(1)} = 0$	0	0	0
$\hat{X}^{(1)} = 1$	0	1	1
$Q_{\hat{X}^{(2)} X}(\cdot 1)$	0	1	

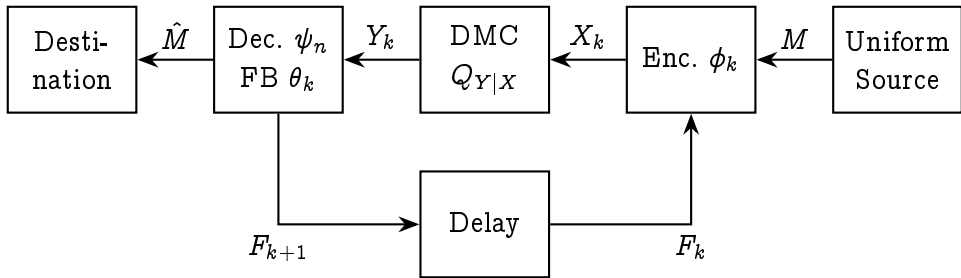
$Q_{\hat{X}^{(1)}, \hat{X}^{(2)}}(\cdot, \cdot)$	$\hat{X}^{(2)} = 0$	$\hat{X}^{(2)} = 1$	$Q_{\hat{X}^{(1)}}(\cdot)$
$\hat{X}^{(1)} = 0$	$\frac{3}{2} - \sqrt{2}$	$\frac{\sqrt{2}}{2} - \frac{1}{2}$	$1 - \frac{\sqrt{2}}{2}$
$\hat{X}^{(1)} = 1$	$\frac{\sqrt{2}}{2} - \frac{1}{2}$	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$
$Q_{\hat{X}^{(2)}}(\cdot)$	$1 - \frac{\sqrt{2}}{2}$	$\frac{\sqrt{2}}{2}$	

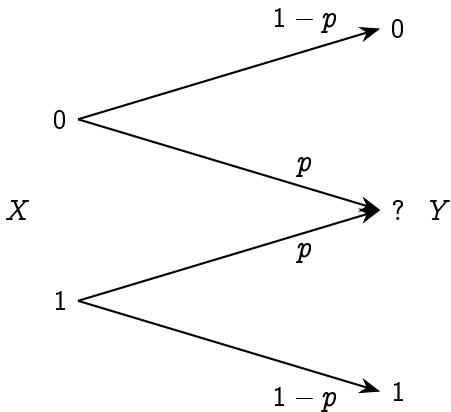


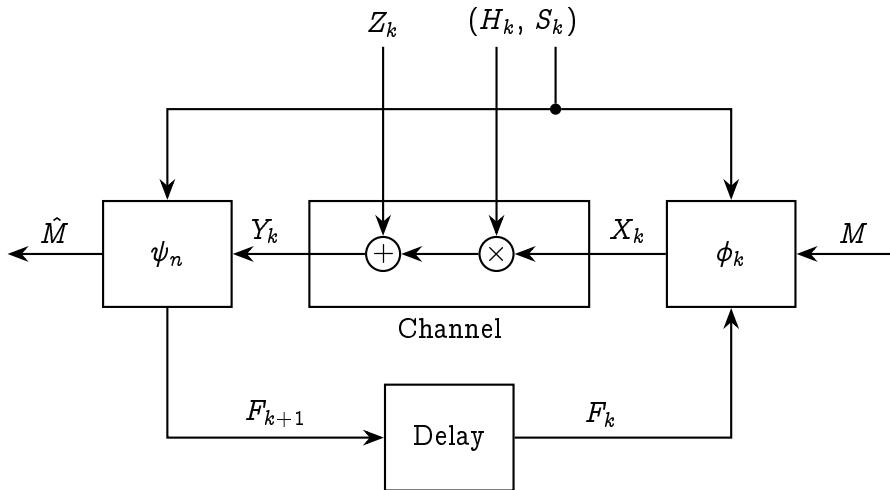


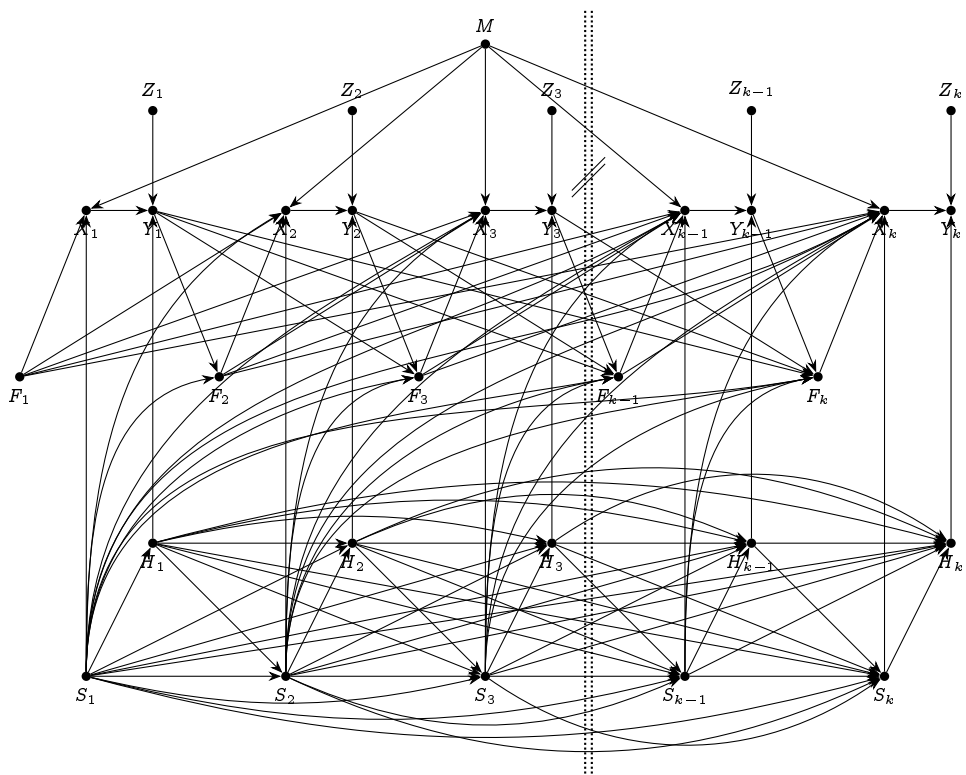
$Q_{X,Y}(\cdot, \cdot)$		Taichung Y		
		rain	sun	Hsinchu total
Hsinchu X	rain	0.445	0.055	0.5
	sun	0.055	0.445	0.5
Taichung total		0.5	0.5	

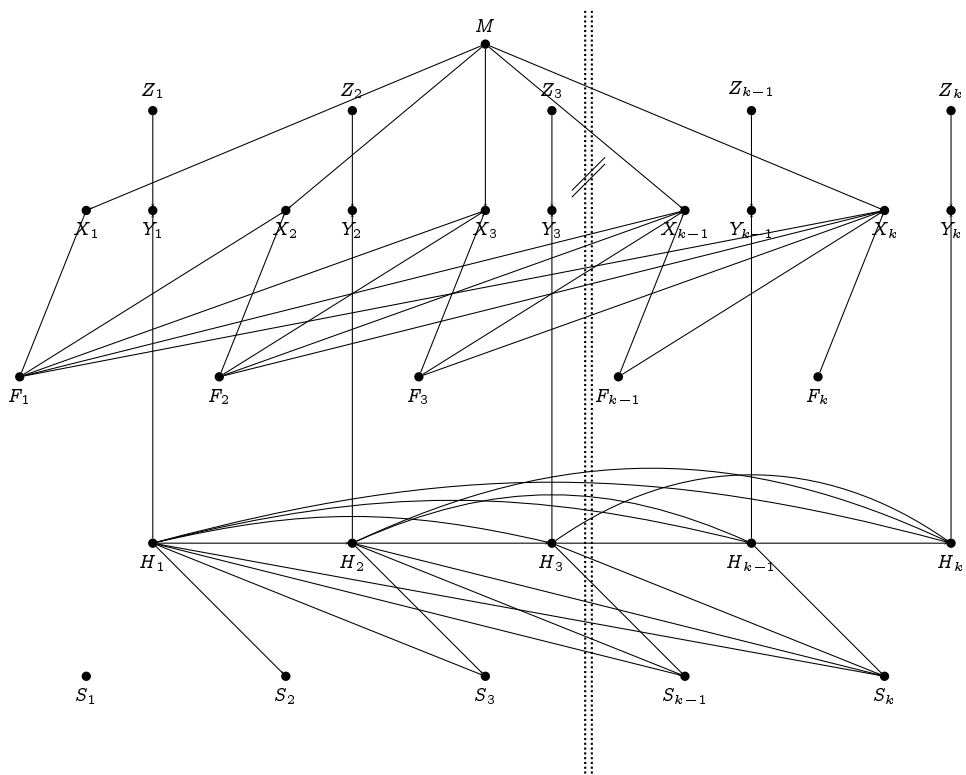


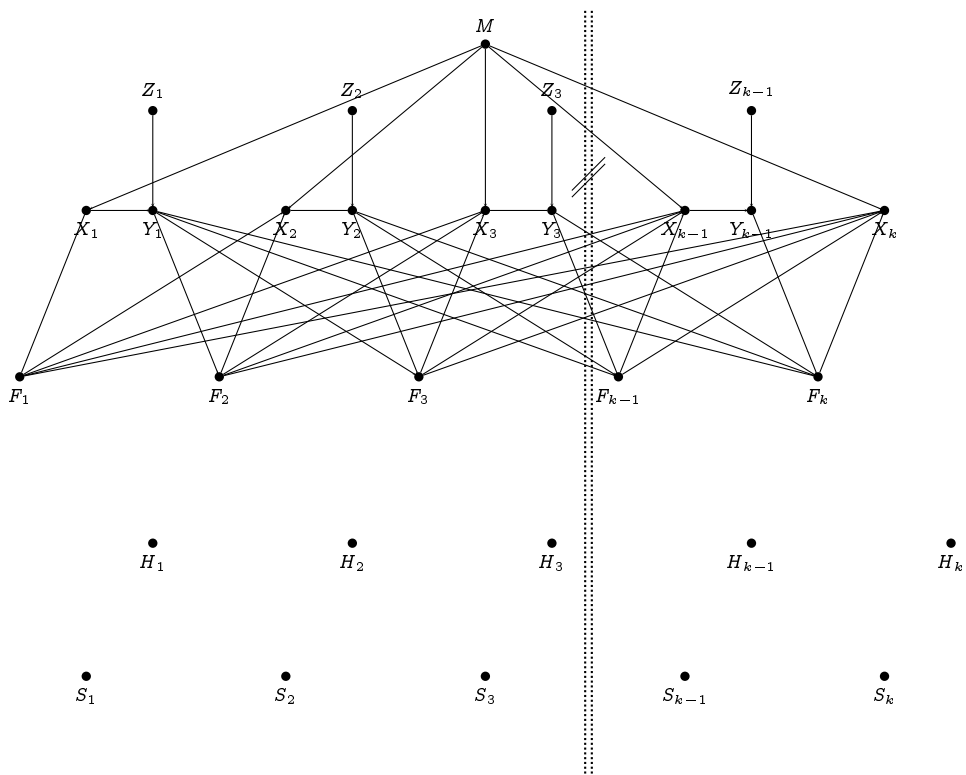


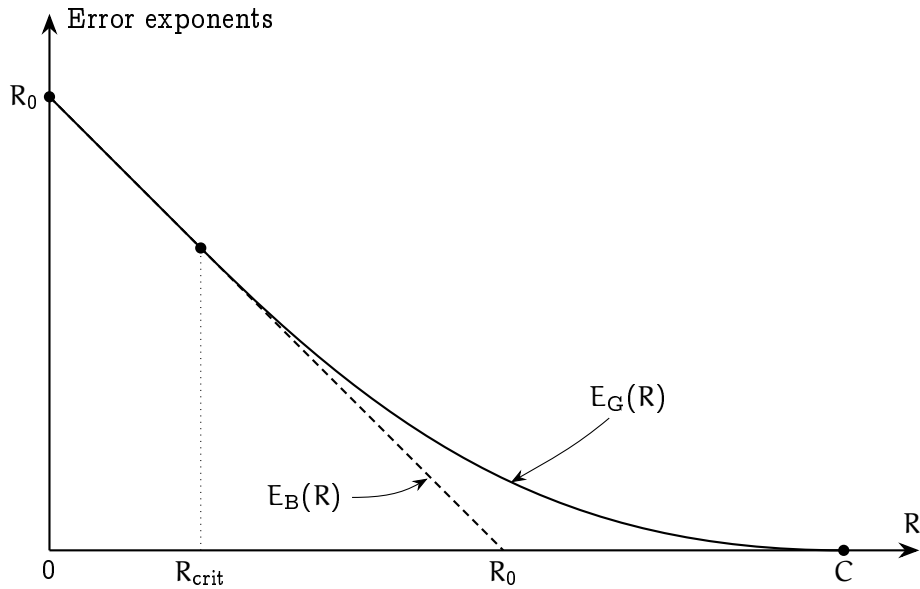


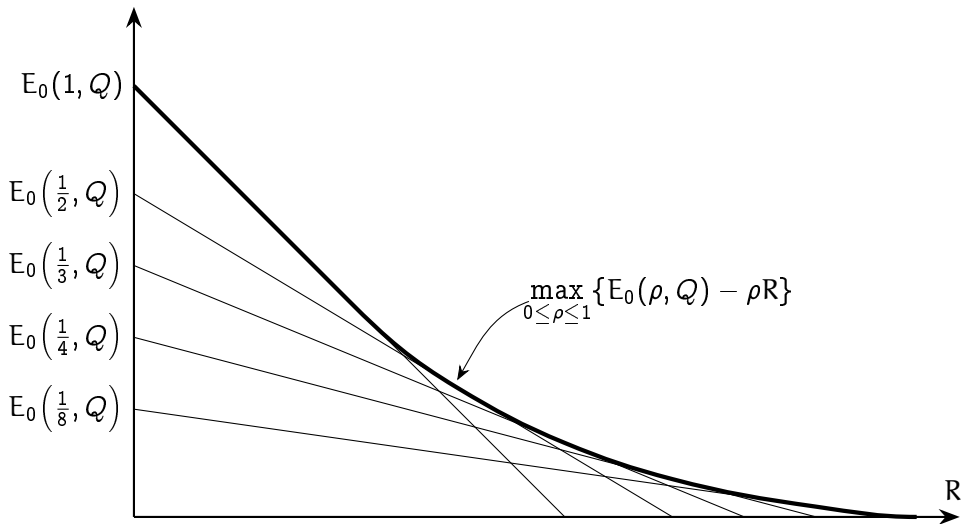


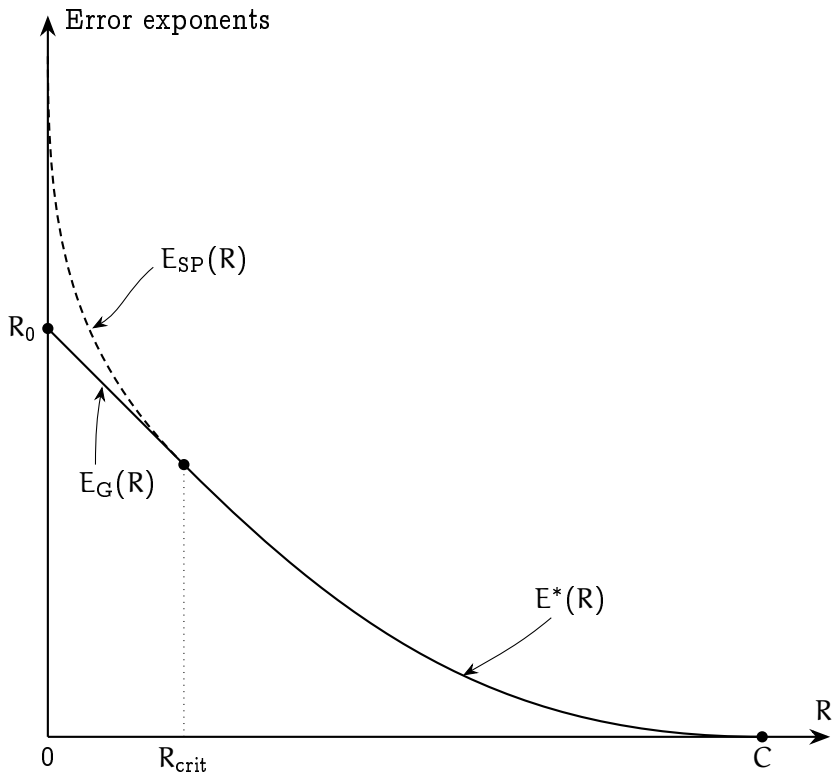


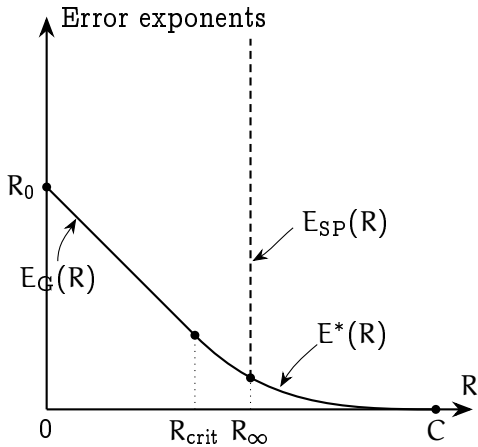
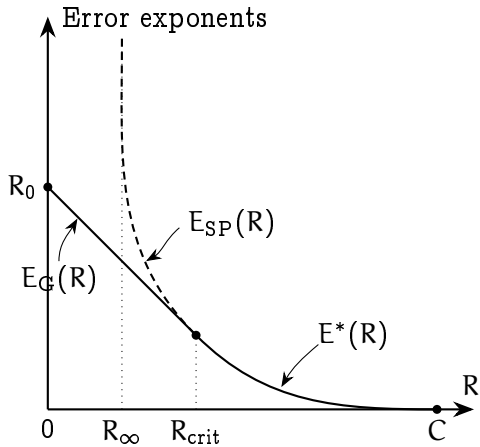


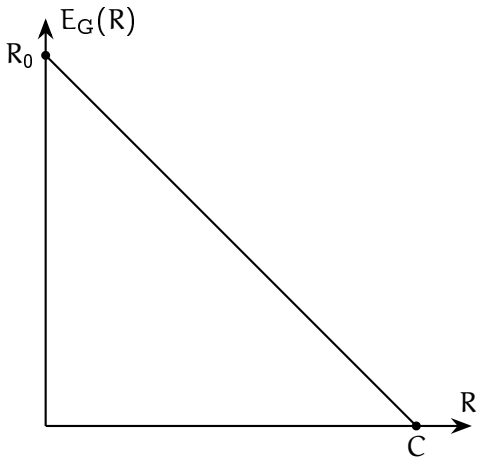
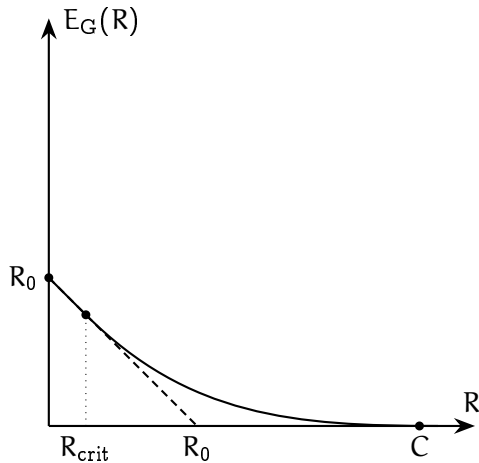


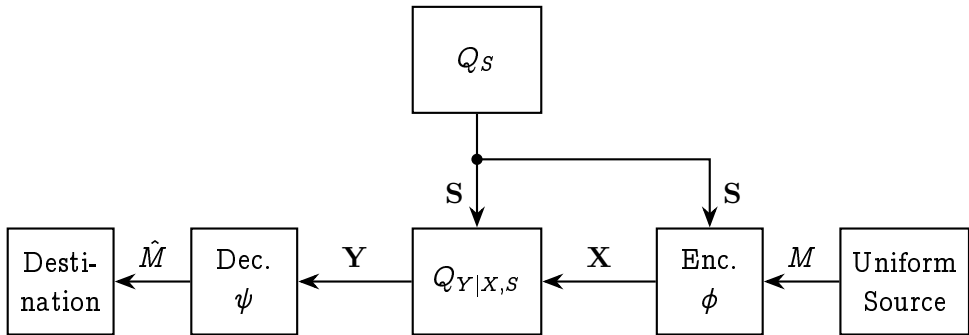


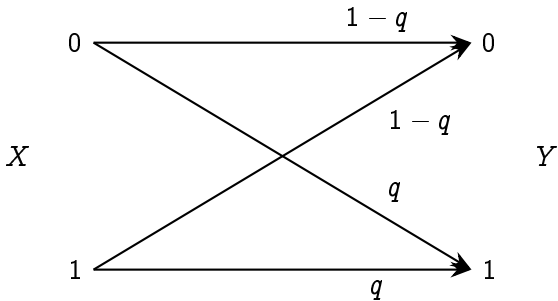


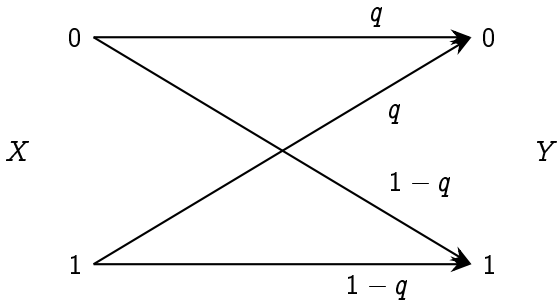


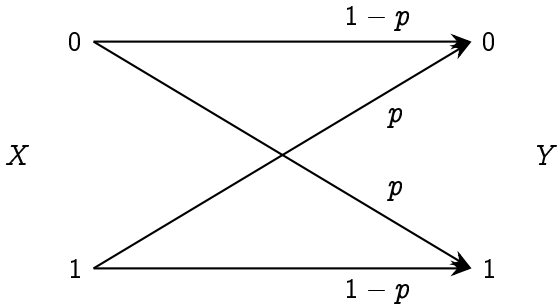


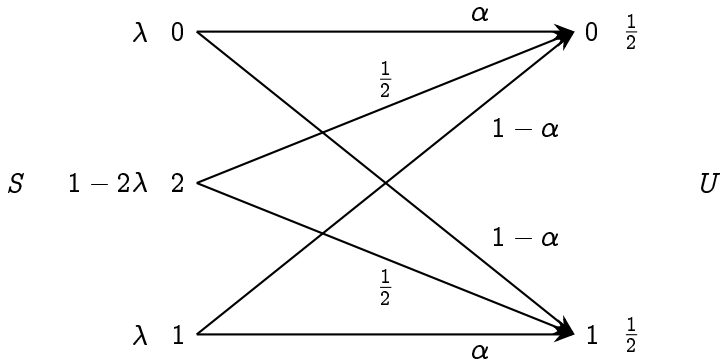


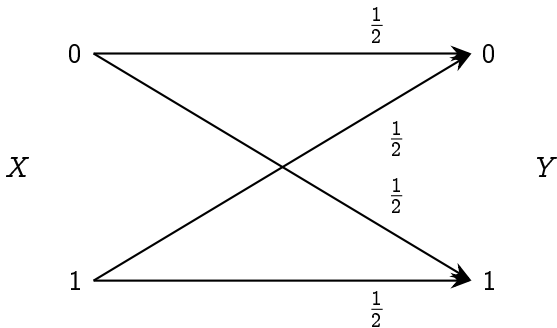


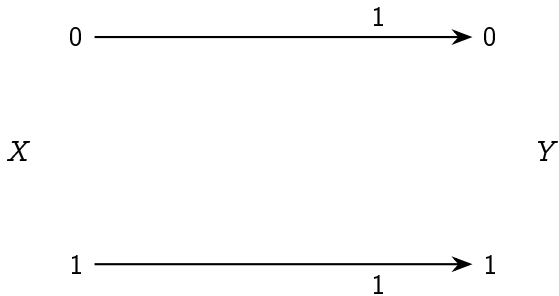


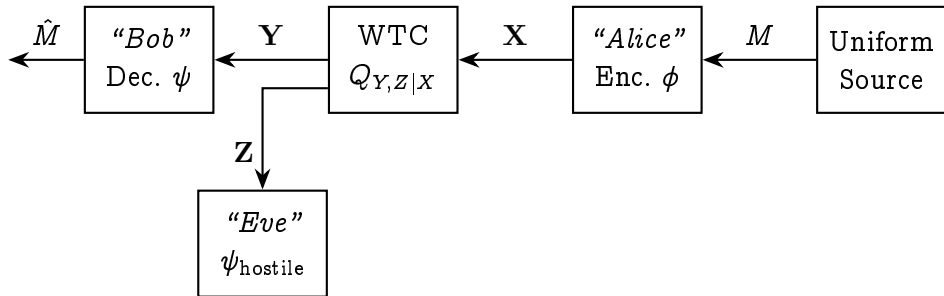


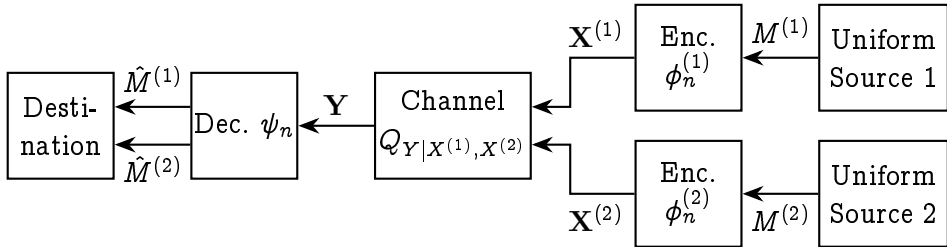


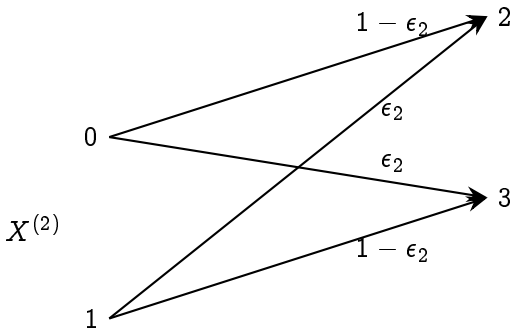
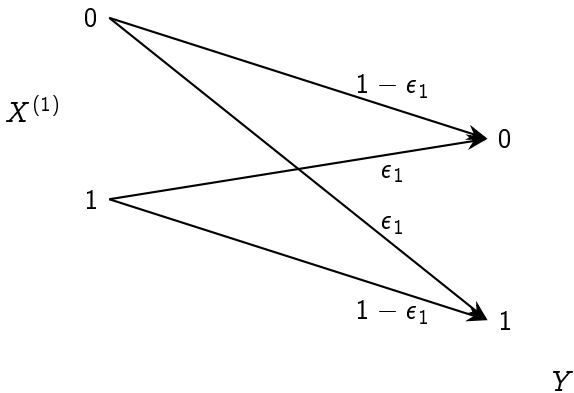


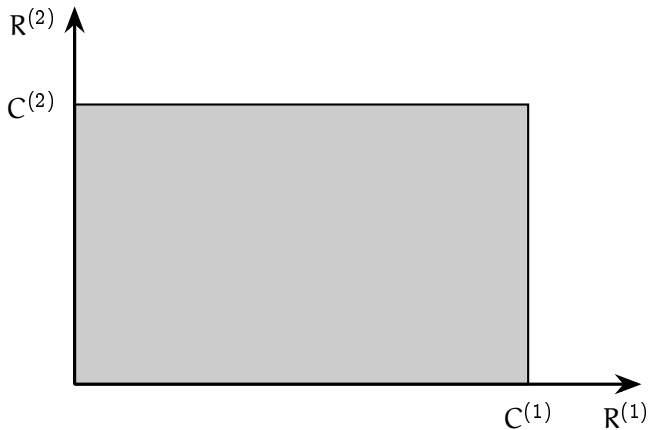


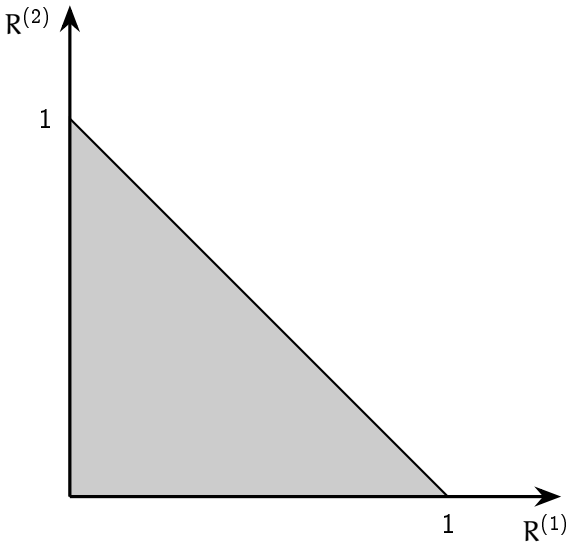




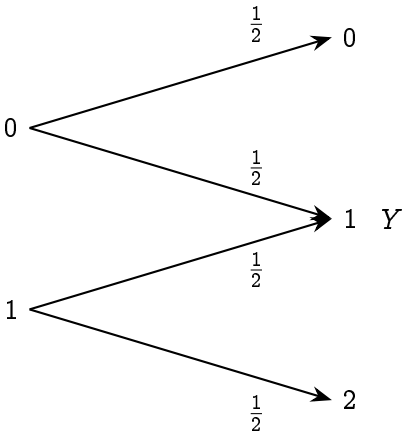


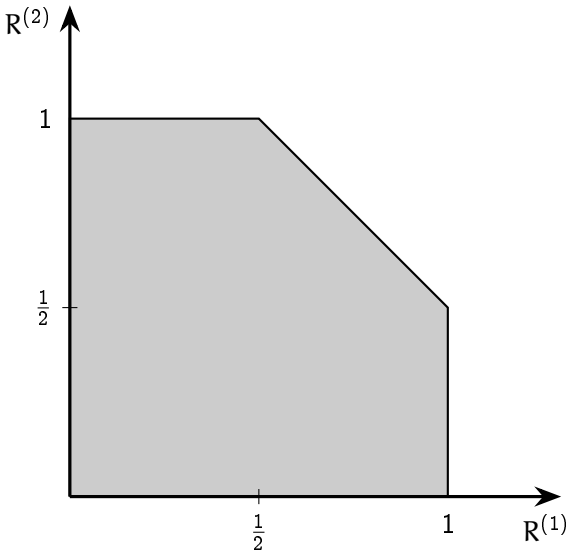


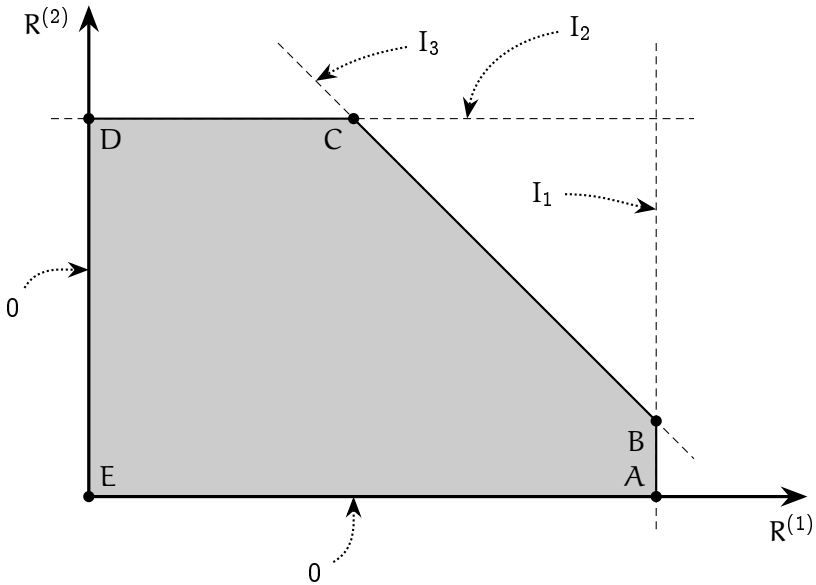


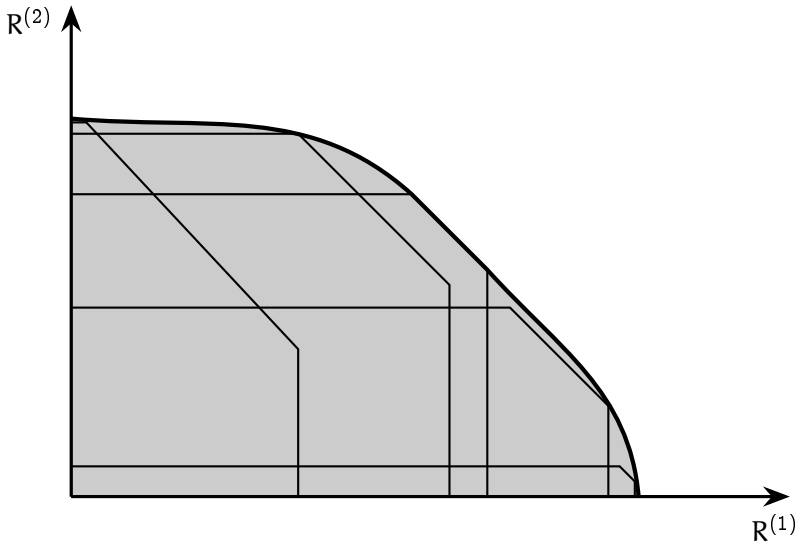


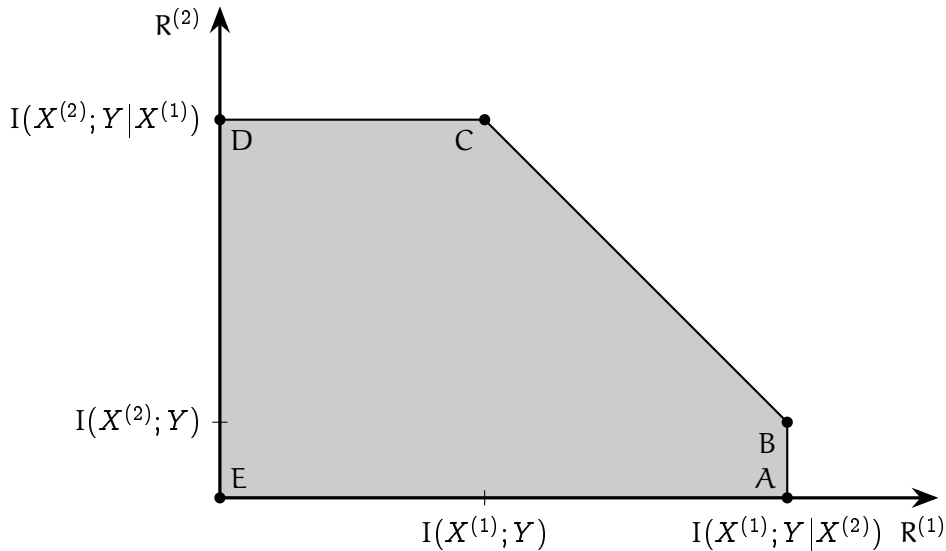
$X^{(2)}$

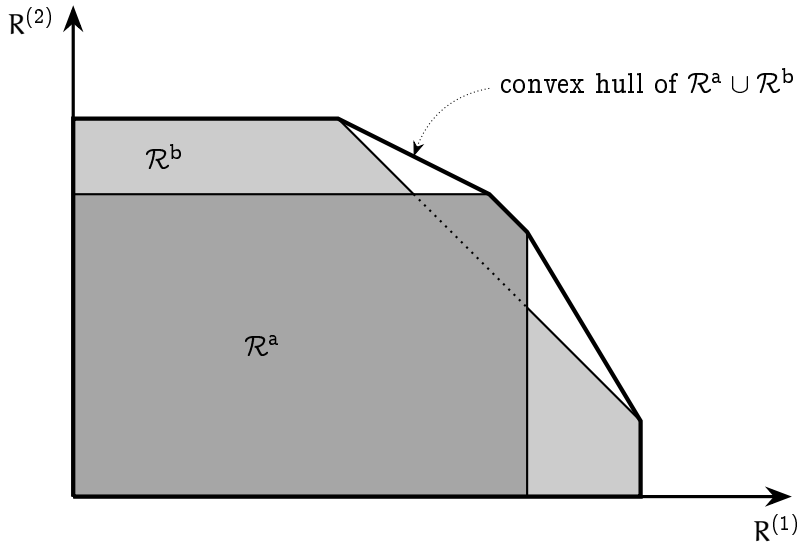


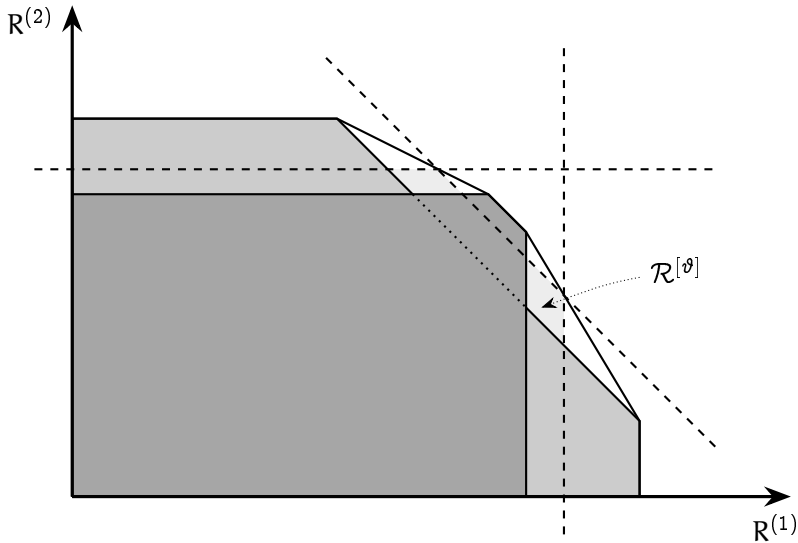


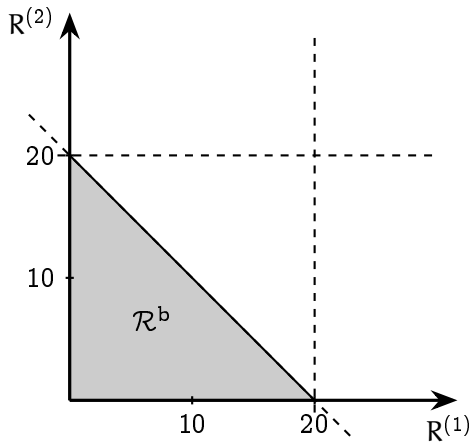
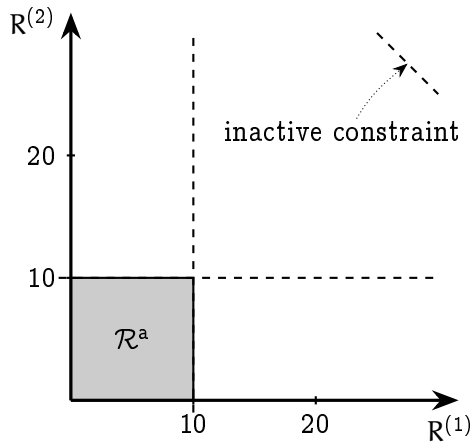


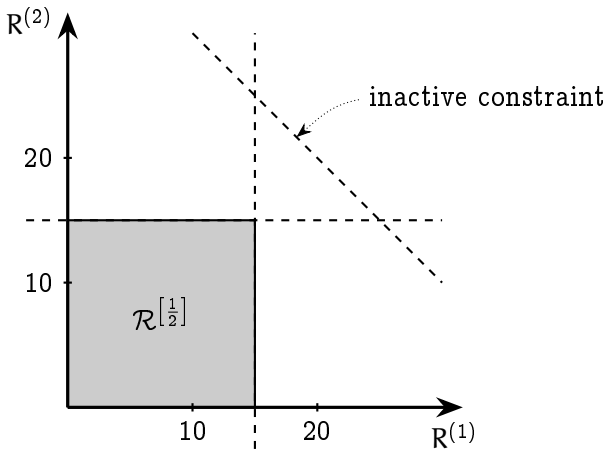


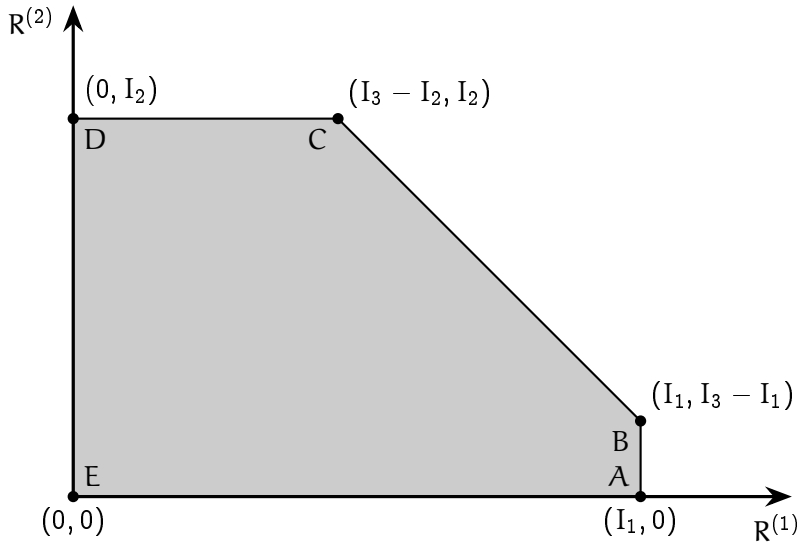


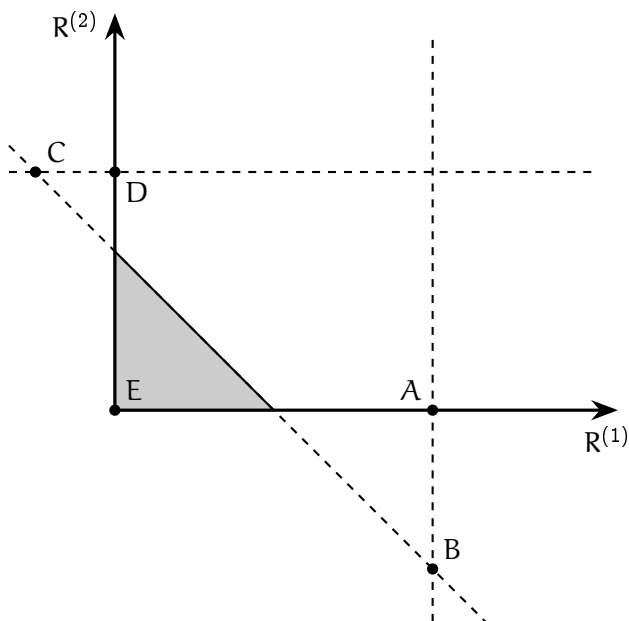
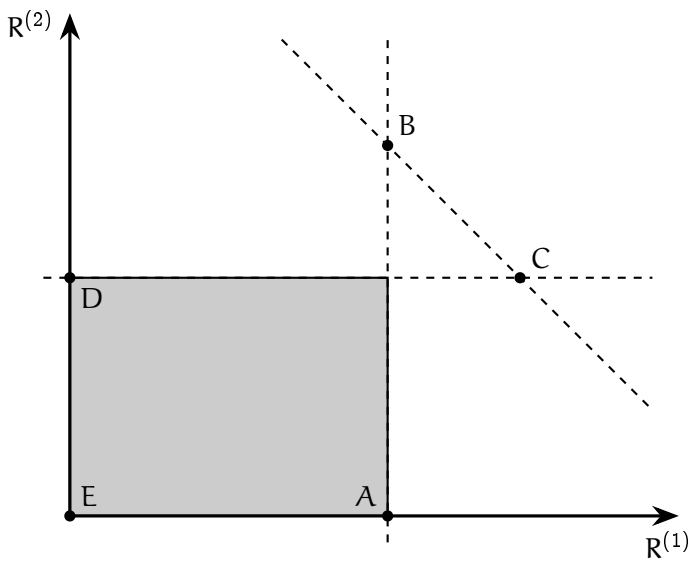


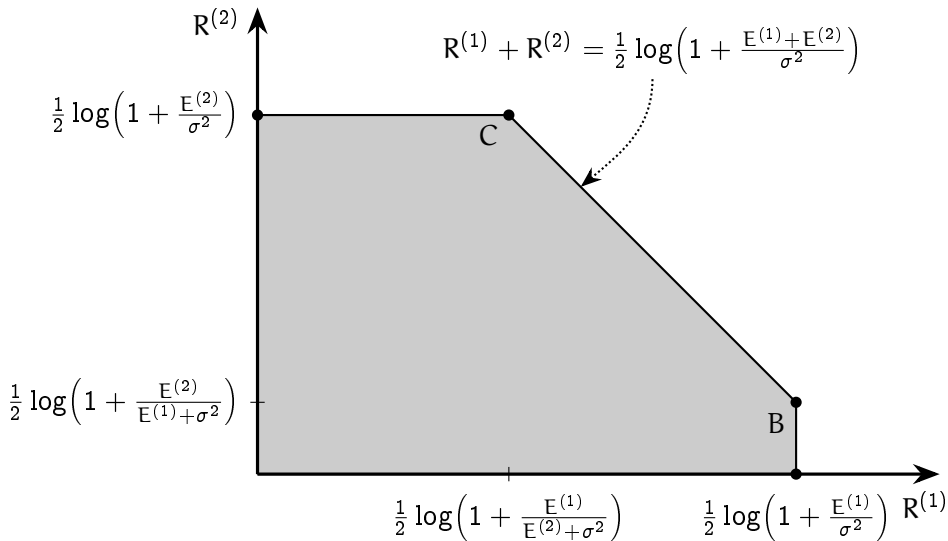


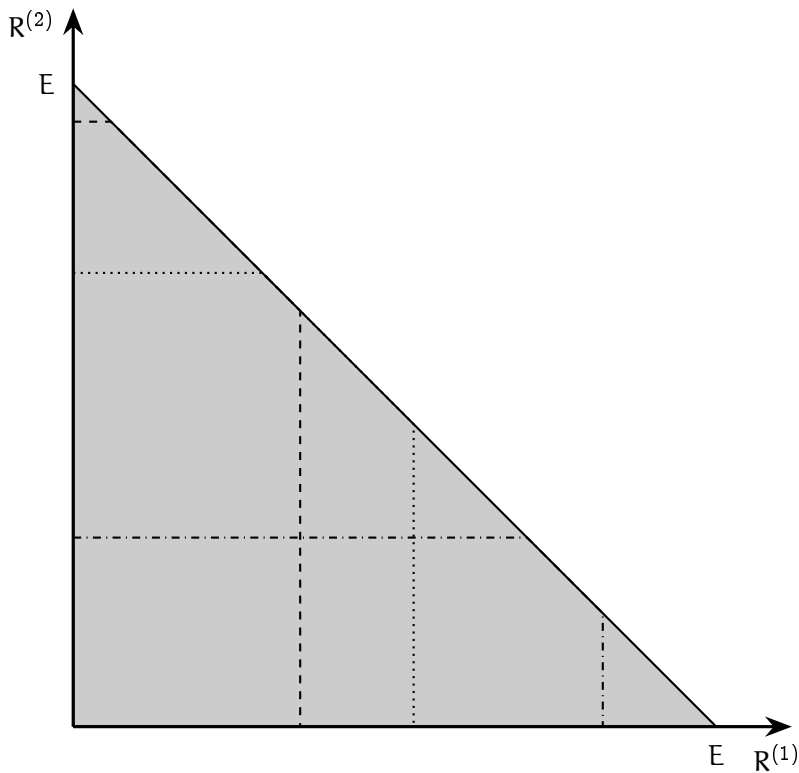


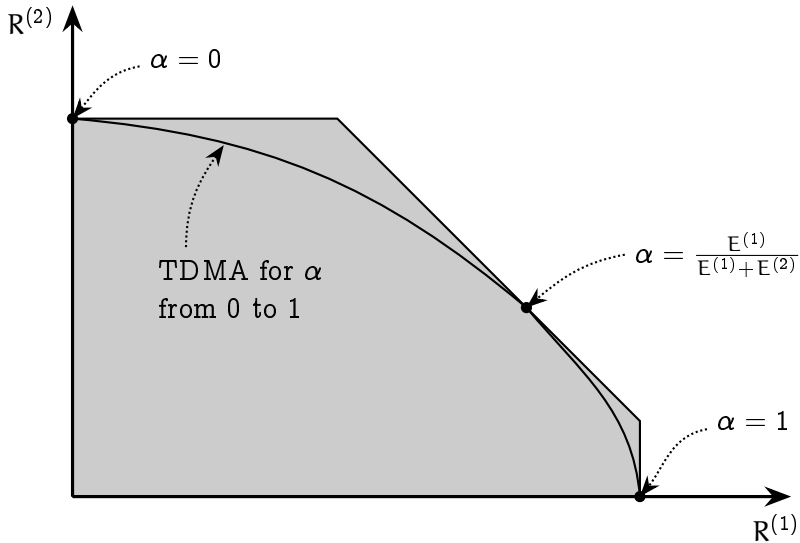


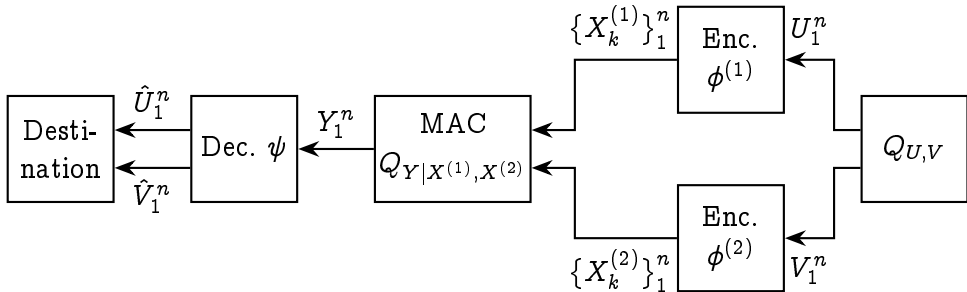


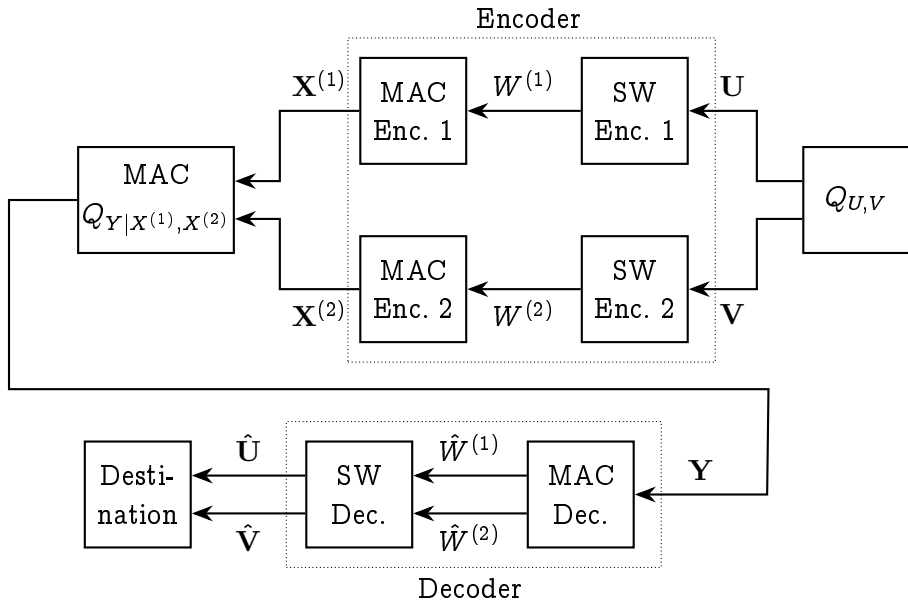


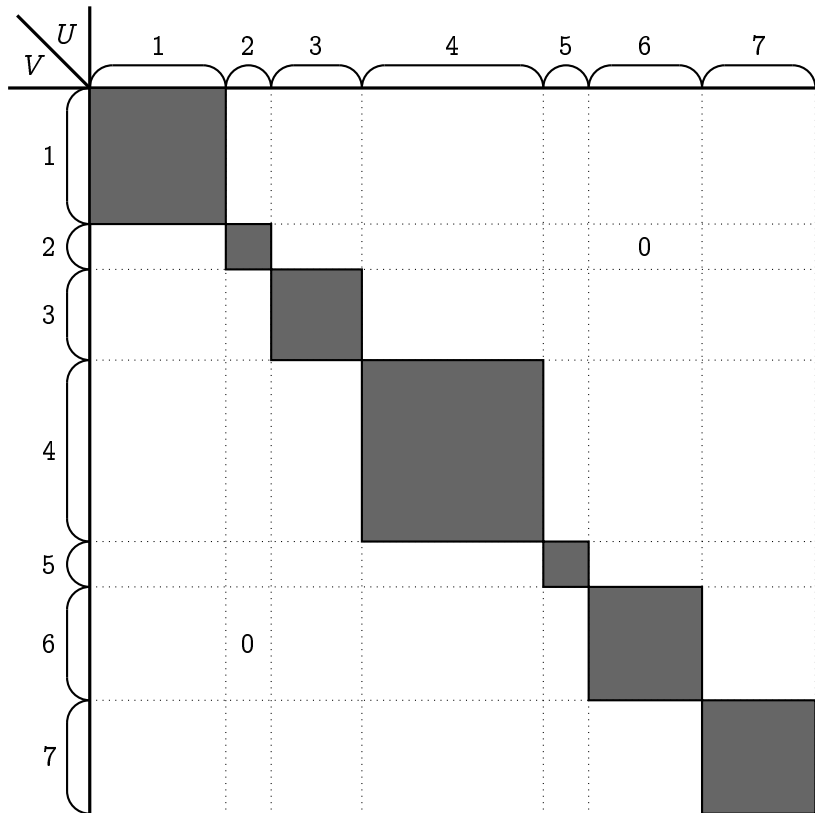


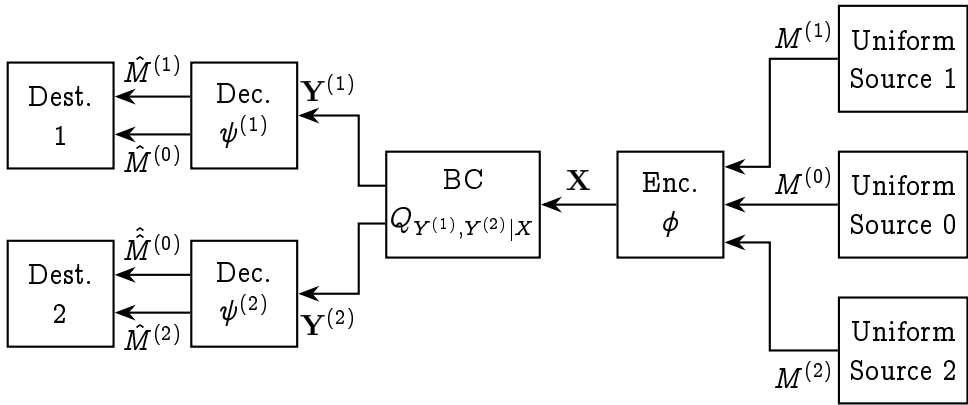


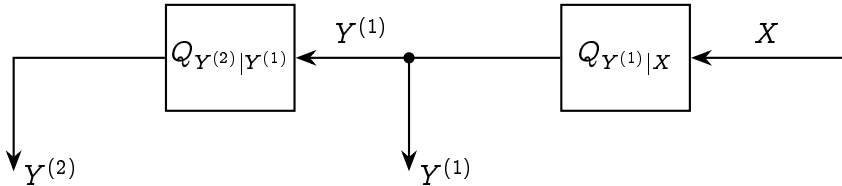


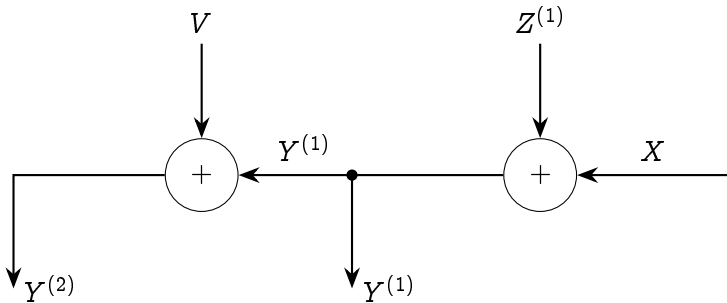


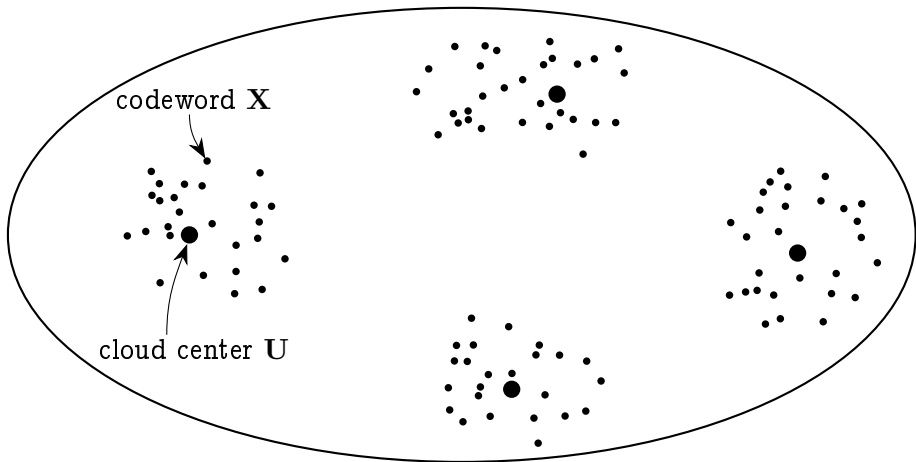


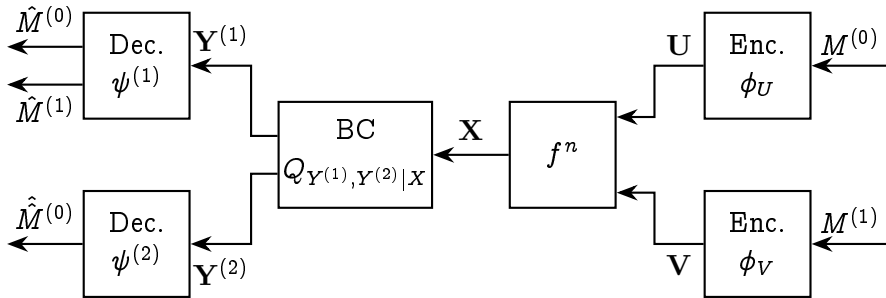


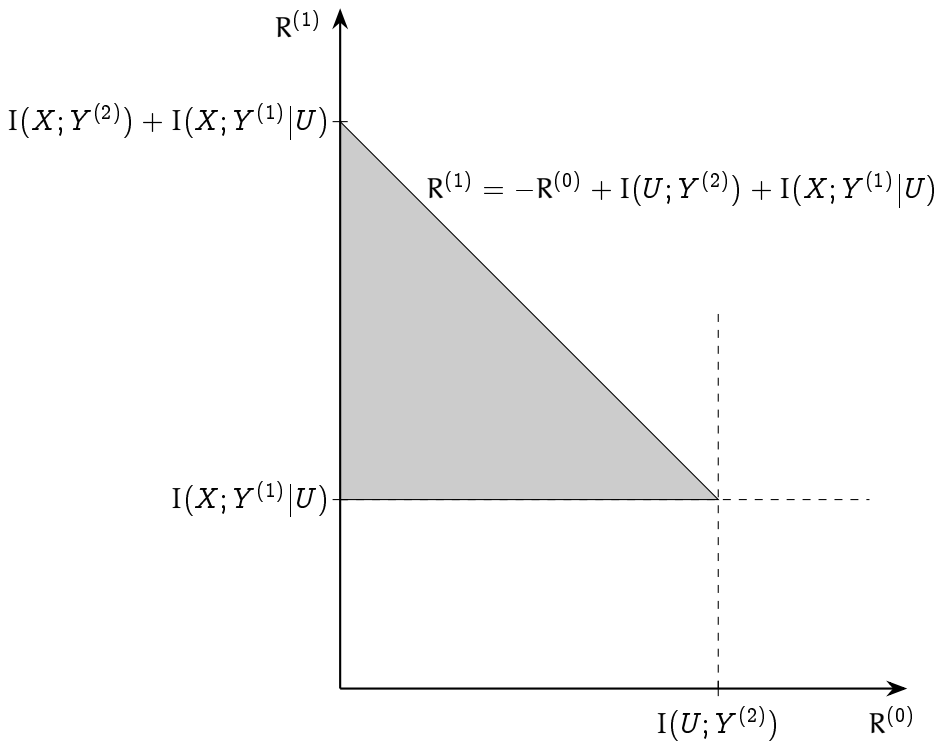






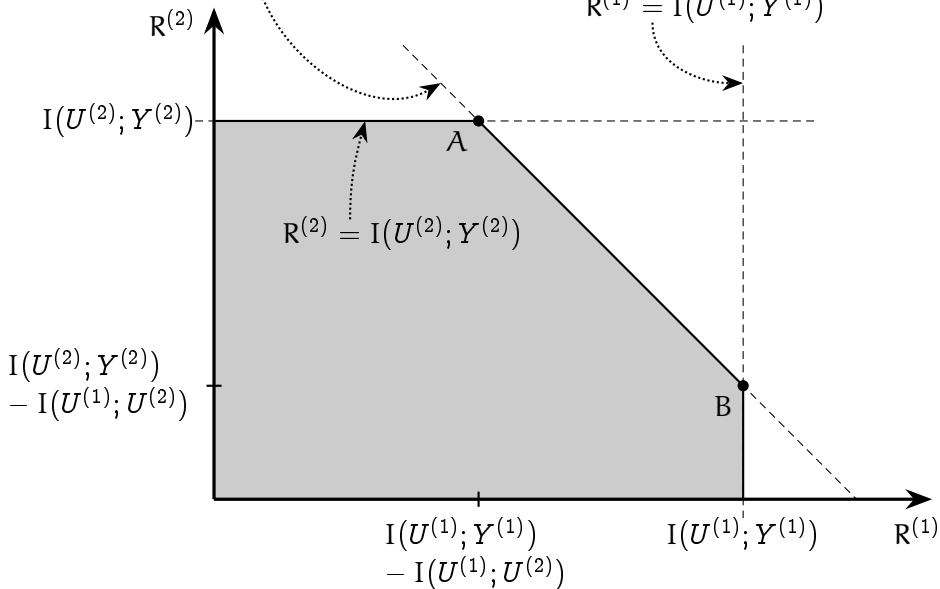


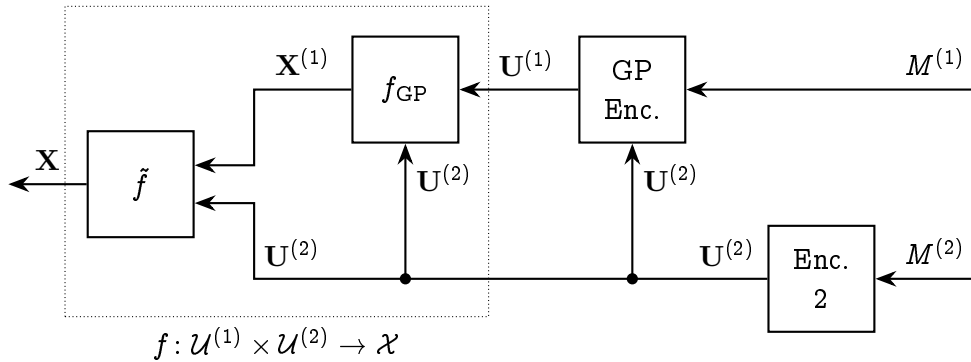


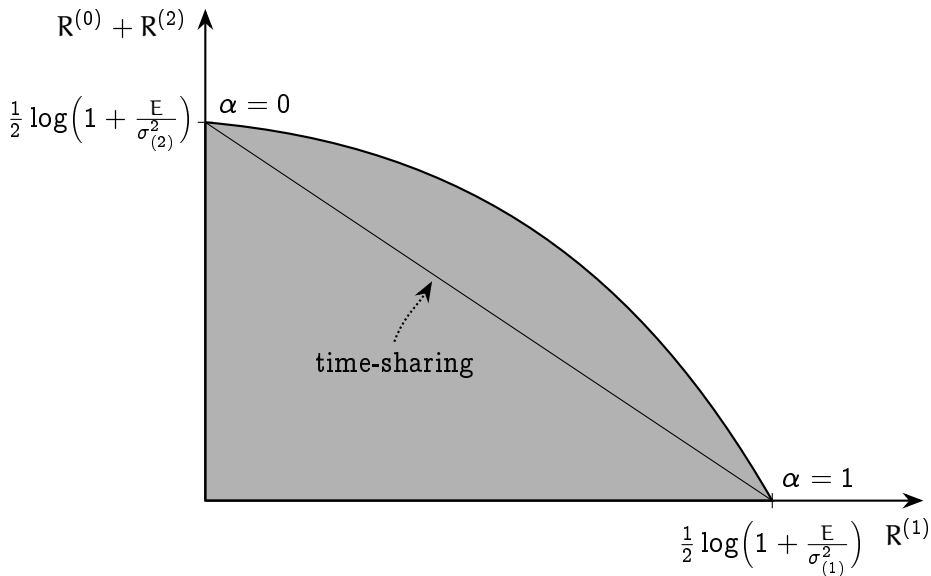


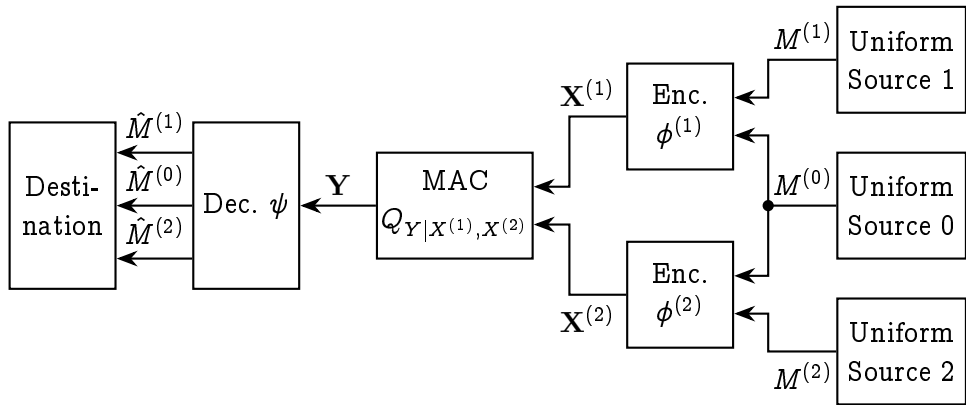
$$R^{(2)} = -R^{(1)} + I(U^{(1)}; Y^{(1)}) + I(U^{(2)}; Y^{(2)}) - I(U^{(1)}; U^{(2)})$$

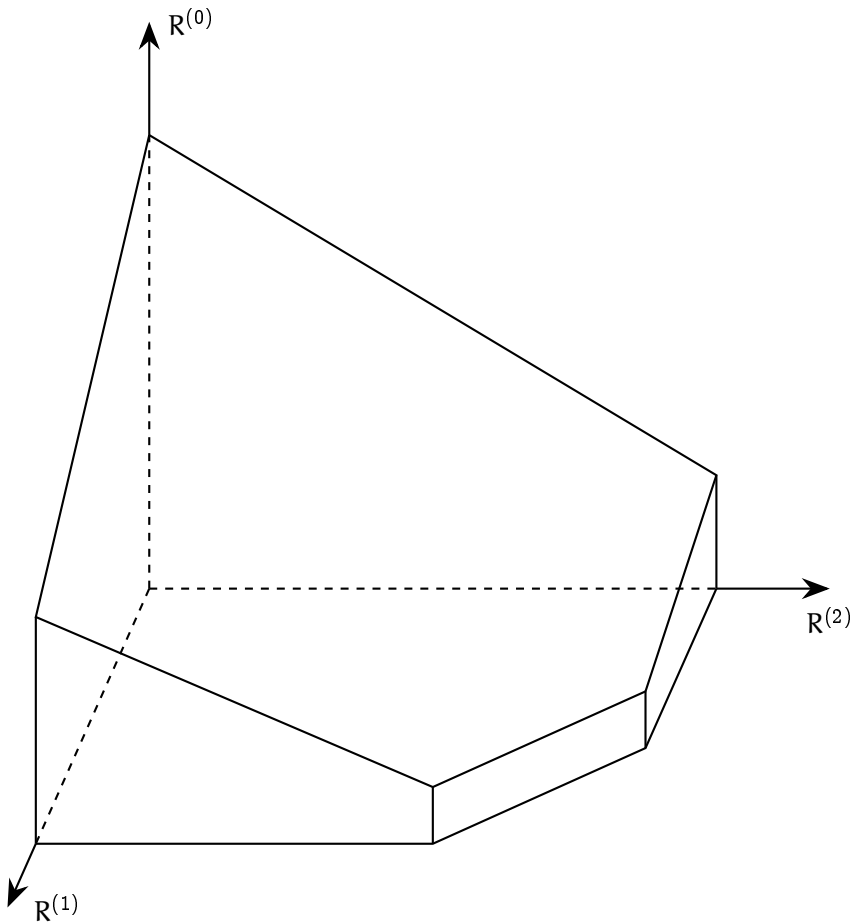
$$R^{(1)} = I(U^{(1)}; Y^{(1)})$$

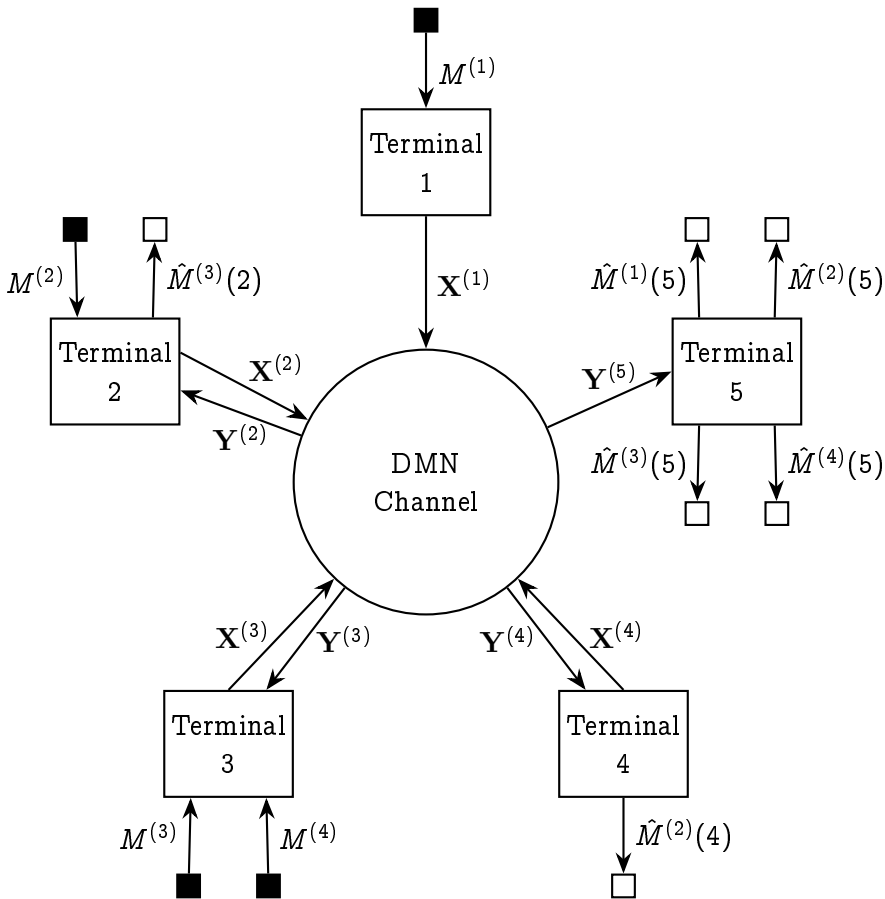


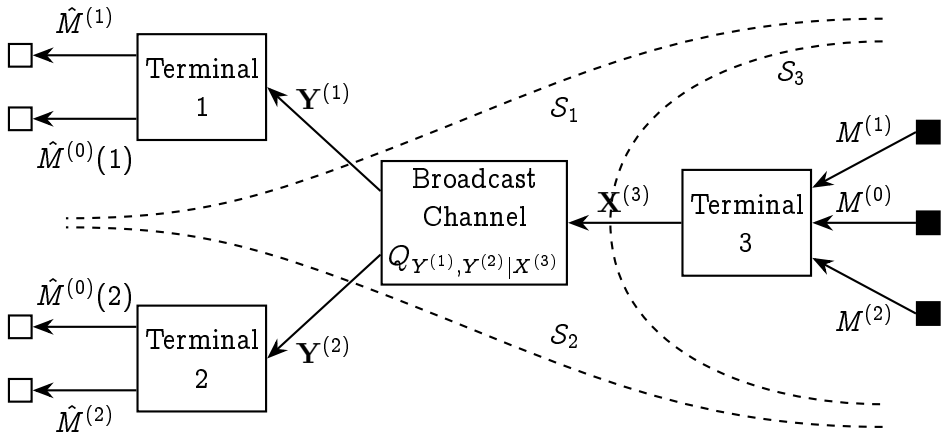


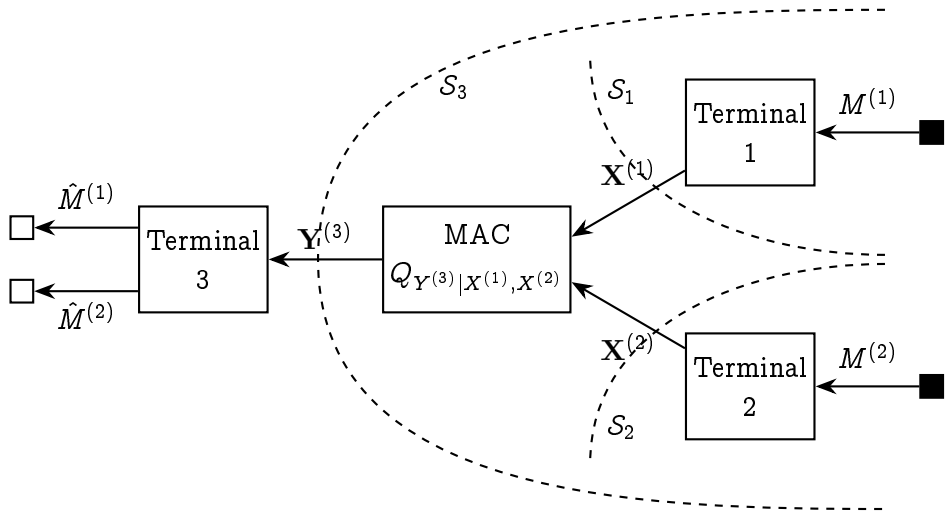


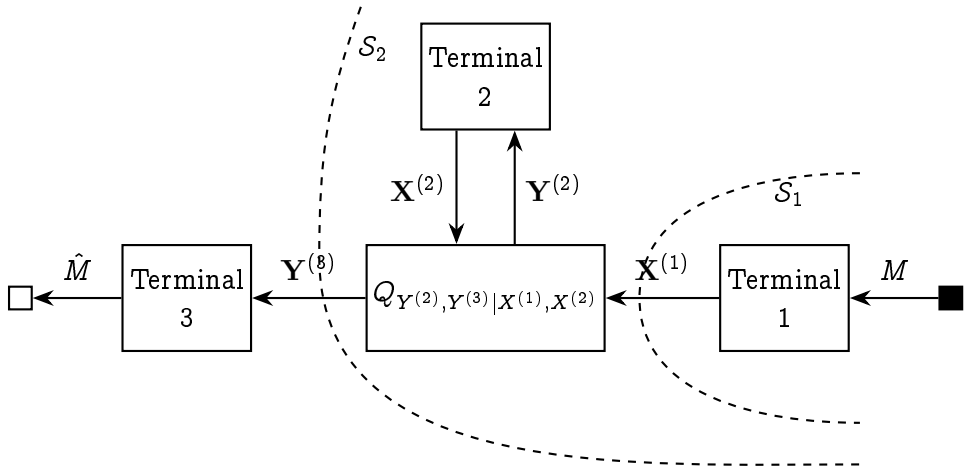


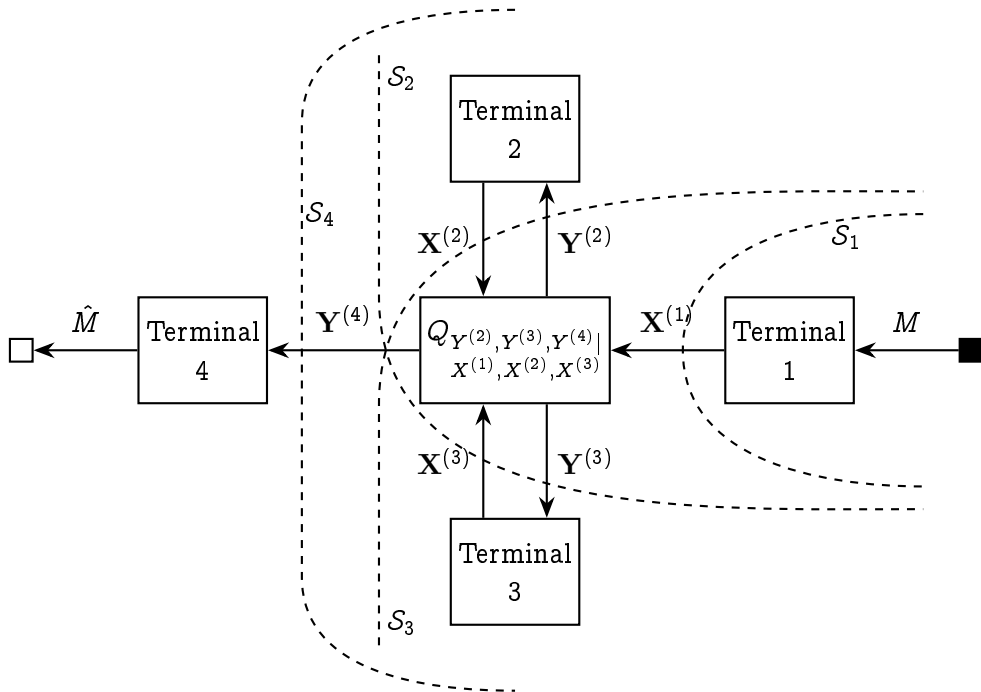


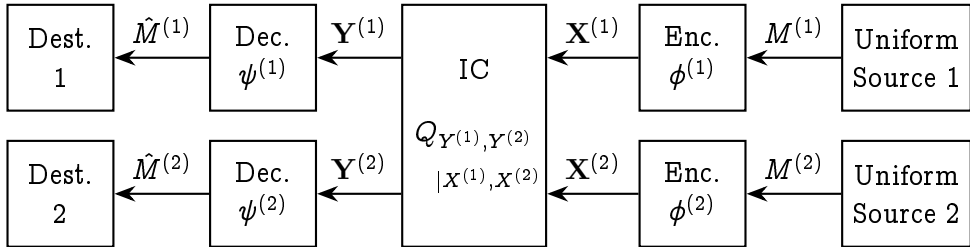


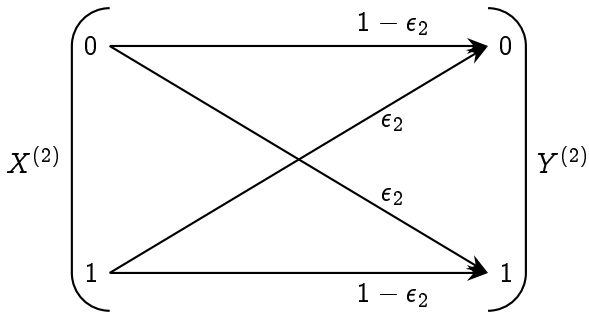
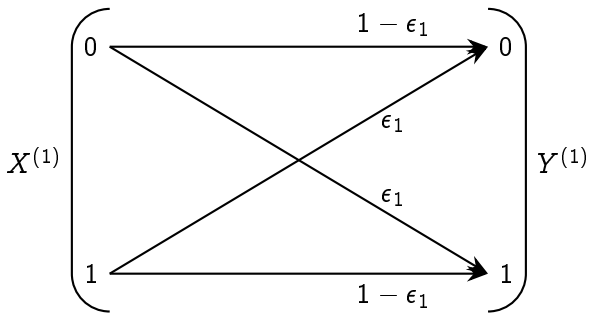


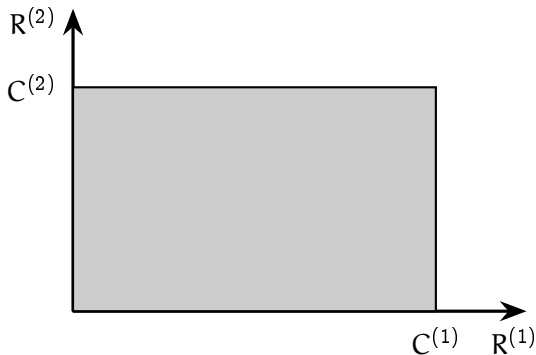


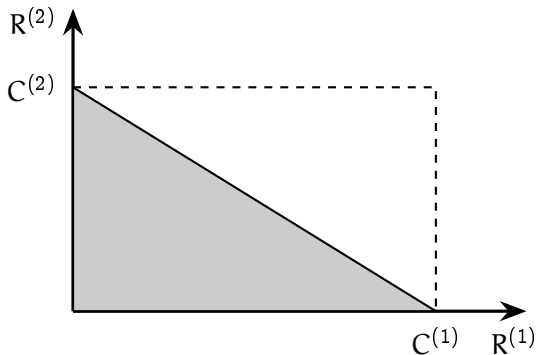


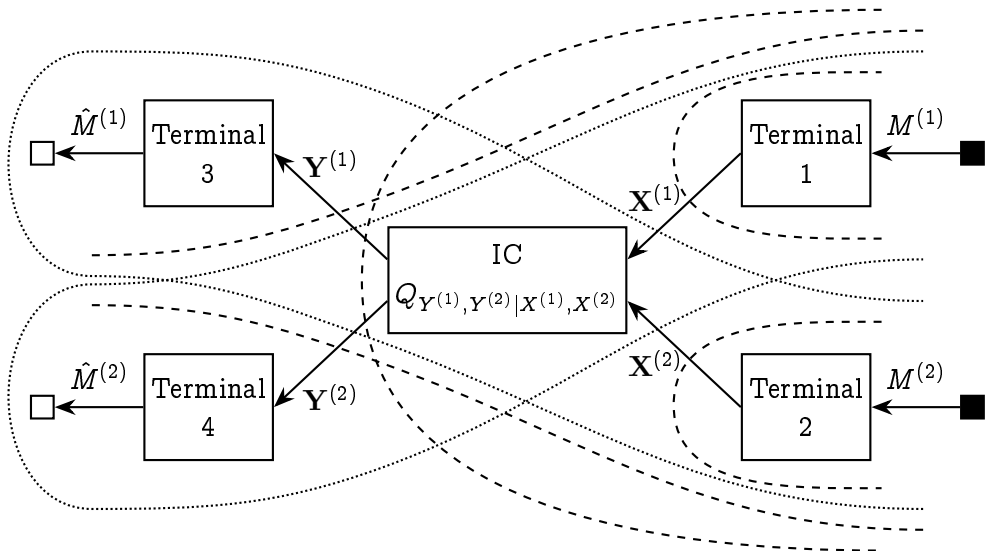




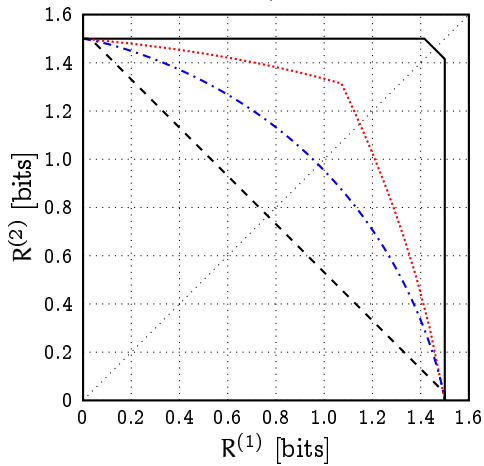




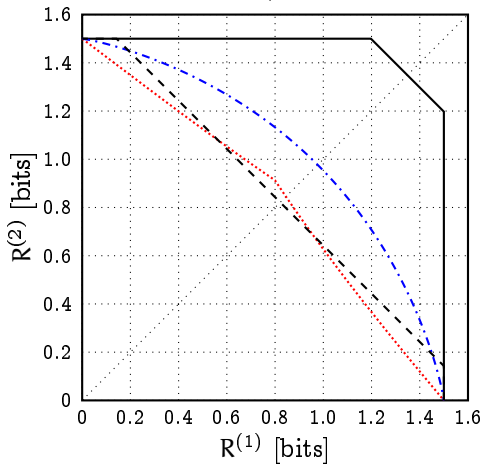




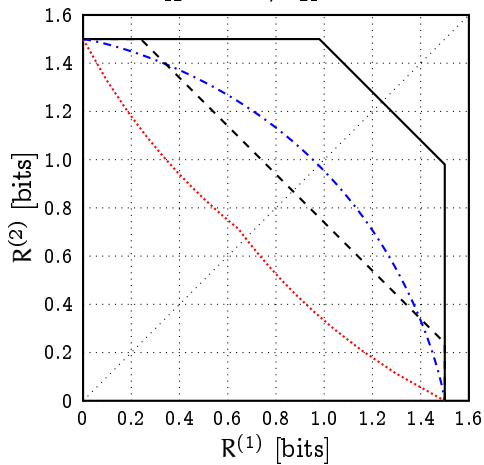
$$a_{12} = 0.15, a_{21} = 0.05$$



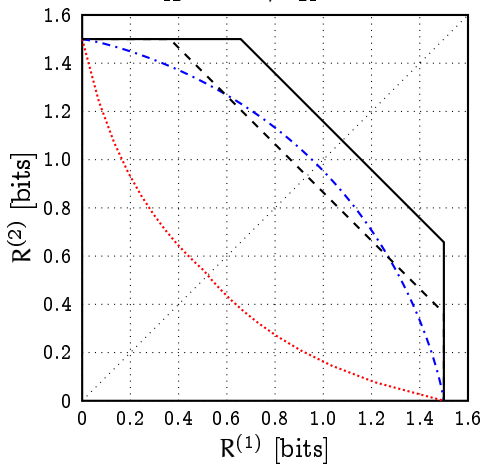
$$a_{12} = 0.35, a_{21} = 0.25$$



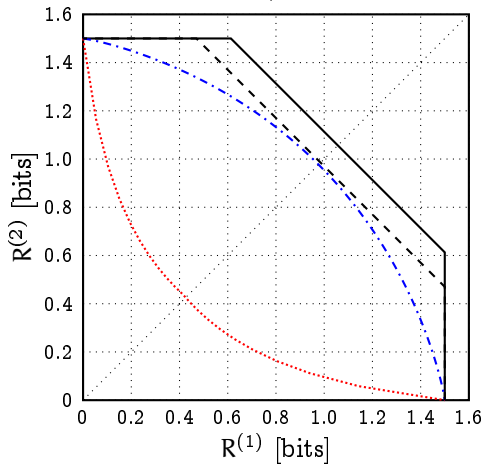
$$a_{12} = 0.55, a_{21} = 0.45$$



$$a_{12} = 0.85, a_{21} = 0.75$$



$$a_{12} = 1.15, a_{21} = 1.05$$



$$a_{12} = 2.15, a_{21} = 2.05$$

