

### 3.1 Savitch's theorem

### 3.2 PSPACE and strategies for game playing

## 4. $\mathcal{NL}$ -completeness


### 4.1 Certificate definition of $\mathcal{NL}$ : Read-once certificates


### 4.2 $\mathcal{NL} = \text{co}\mathcal{NL}$

See


 [Sanjeev Arora, Boaz Barak:](#)  
*Computational Complexity — A Modern Approach*,  
p. 82–88, Cambridge University Press: Cambridge–New York–Melbourne, 2009

Further references:

 Larry J. Stockmeyer, Albert R. Meyer:  
*Word problems requiring exponential time,*  
Proceedings of the 5th Symposium on Theory of Computing, p. 1–9 (1973)  
This paper contains some important PSPACE-completeness results.

 Albert R. Meyer, Larry J. Stockmeyer:  
*The equivalence problem for regular expressions with squaring requires exponential space,*  
Proceedings of the 13th Annual Symposium on Switching and Automata Theory,  
p. 125–129 (1972)  
This paper contains an EXPSPACE-completeness result.

And here an  $\mathcal{NL}$ -machine based proof for  $\mathcal{NL} = \text{co}\mathcal{NL}$ :

 Holenstein, Thomas  
*Complexity Theory,*  
p. 13–14, Script, ETH Zürich, 2010