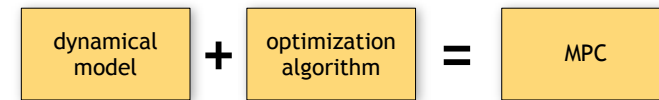


Conclusions

Conclusions

- **MPC** is a very rich control methodology, with a large set of variants to handle different problems (linear, nonlinear, decentralized, stochastic, ...) in different application domains (automotive, energy, water, aerospace, ...)



- **Explicit MPC** is very good for small-size MPC problems based on LTI models that require fast sampling and simple control code. **Theory: mature**
- **Hybrid MPC** very versatile MPC framework for complex problems involving logic constraints. **Theory: mature**
- Active areas of research in MPC:
 - **Decentralized and distributed MPC**
 - **Stochastic MPC**
 - **New applications of MPC**

Bibliography

General References

- [1] J.M. Maciejowski, *Predictive Control with Constraints*, Prentice Hall, Harlow, UK, 2002.
- [2] E.F. Camacho and C. Bordons, *Model Predictive Control*, Advanced Textbooks in Control and Signal Processing. Springer-Verlag, London, 2nd edition, 2004.
- [3] A. Bemporad, M. Morari, and N. L. Ricker, *Model Predictive Control Toolbox for Matlab – User’s Guide*, The Mathworks, Inc., 2004, <http://www.mathworks.com/access/helpdesk/help/toolbox/mpc/>.
- [4] A. Bemporad, *Hybrid Toolbox – User’s Guide*, Jan. 2004, <http://www.ing.unitn.it/~bemporad/hybrid/toolbox>
- [5] D.Q. Mayne, J.B. Rawlings, C.V. Rao, and P.O.M. Sokaert, “Constrained model predictive control: Stability and optimality,” *Automatica*, vol. 36, no. 6, pp. 789-814, June 2000.
- [6] J.B. Rawlings, “Tutorial overview of model predictive control,” *IEEE Control Systems Magazine*, pp. 38-52, June 2000.
- [7] A. Bemporad, “Model-based predictive control design: New trends and tools,” in *Proc. 45th IEEE Conf. on Decision and Control*, San Diego, CA, 2006.

Bibliography

MLD and HYSDEL Modeling

- [1] A. Bemporad, “Hybrid Toolbox – User’s Guide,” Dec. 2003, <http://www.dii.unisi.it/hybrid/toolbox>
- [2] F.D. Torrisi and A. Bemporad, “HYSDEL - A tool for generating computational hybrid models,” *IEEE Transactions on Control Systems Technology*, vol. 12, no. 2, pp. 235-249, Mar. 2004
- [3] A. Bemporad and M. Morari, “Control of systems integrating logic, dynamics, and constraints,” *Automatica*, vol. 35, no. 3, pp. 407-427, Mar. 1999.
- [4] A. Bemporad, “Efficient conversion of mixed logical dynamical systems into an equivalent piecewise affine form,” *IEEE Trans. Automatic Control*, vol. 49, no. 5, pp. 832-838, 2004.
- [5] A. Bemporad, G. Ferrari-Trecate, and M. Morari, “Observability and controllability of piecewise affine and hybrid systems,” *IEEE Trans. Automatic Control*, vol. 45, no. 10, pp. 1864-1876, 2000.
- [6] W.P.H.M Heemels, B. de Schutter, and A. Bemporad, “Equivalence of hybrid dynamical models,” *Automatica*, vol. 37, no. 7, pp. 1085-1091, July 2001
- [7] A. Bemporad, W.P.M.H. Heemels, and B. De Schutter, “On hybrid systems and closed-loop MPC systems,” *IEEE Trans. Automatic Control*, vol. 47, no. 5, pp. 863-869, May 2002.

Bibliography

Identification

- [8] A. Bemporad, A. Garulli, S. Paoletti, and A. Vicino, "A bounded-error approach to piecewise affine system identification," *IEEE Trans. Automatic Control*, vol. 50, no. 10, pp. 1567-1580, Oct. 2005 .
- [9] J. Roll, A. Bemporad, and L. Ljung, "Identification of piecewise affine systems via mixed-integer programming," *Automatica*, vol. 40, no. 1, pp. 37-50, 2004
- [10] G. Ferrari-Trecate, M. Muselli, D. Liberati, and M. Morari, "A clustering technique for the identification of piecewise affine systems," *Automatica*, vol. 39, no. 2, pp. 205-217, Feb. 2003.

Model predictive control

- [11] F. Borrelli, M. Baotic, A. Bemporad, and M. Morari, "Dynamic programming for constrained optimal control of discrete-time linear hybrid systems," *Automatica*, vol. 41, no. 10, Oct. 2005
- [12] A. Bemporad, M. Morari, V. Dua, and E.N. Pistikopoulos, "The explicit linear quadratic regulator for constrained systems," *Automatica*, vol. 38, no. 1, pp. 3-20, 2002.
- [13] A. Bemporad, F. Borrelli, and M. Morari, "Piecewise linear optimal controllers for hybrid systems," In *Proc. American Control Conference*, 2000, pp. 1190-1194.
- [14] A. Bemporad and N. Giorgetti, "Logic-based methods for optimal control of hybrid systems," *IEEE Trans. Autom. Control*, vol. 51, no. 6, pp. 963-976, 2006.
- [15] M. Lazar, M. Heemels, S. Weiland, A. Bemporad, "Stability of Hybrid Model Predictive Control," *IEEE Trans. Automatic Control*, vol. 51, no. 11, pp. 1813-1818, 2006.

Bibliography

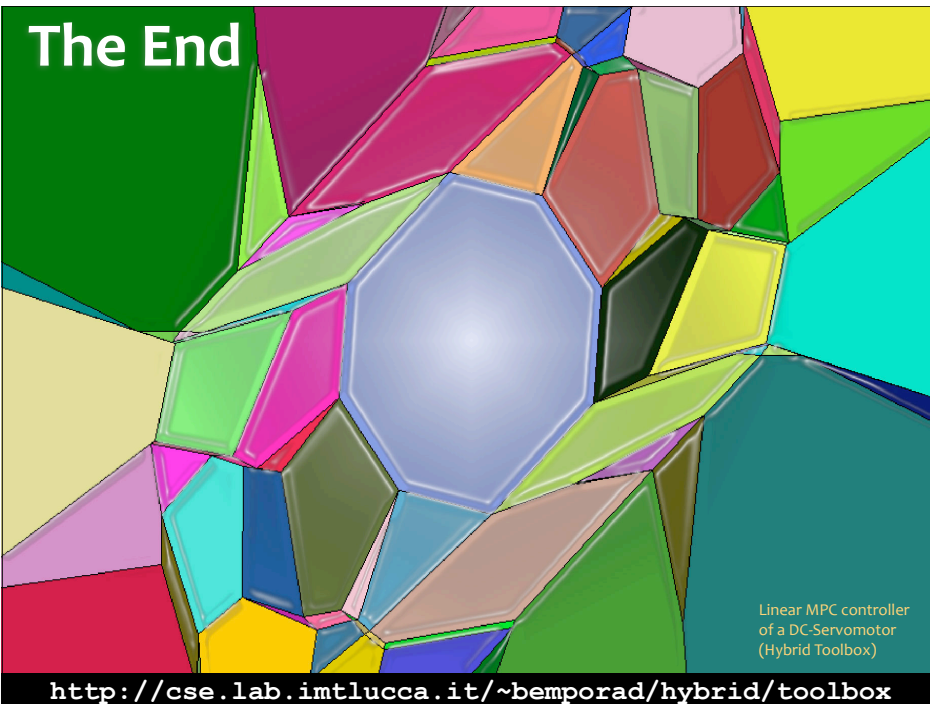
Reachability and observability

- [16] A. Bemporad, G. Ferrari-Trecate, and M. Morari, "Observability and controllability of piecewise affine and hybrid systems," *IEEE TAC*, vol. 45, no. 10, pp. 1864-1876, 2000.
- [17] A. Bemporad, D. Mignone, and M. Morari, "Moving horizon estimation for hybrid systems and fault detection," in *Proc. American Control Conf.*, 1999, Chicago, IL, pp. 2471-2475.
- [18] G. Ferrari-Trecate, D. Mignone, and M. Morari, "Moving horizon estimation for hybrid systems," *IEEE TAC*, vol. 47, no. 10, pp. 1663-1676, 2002.

Applications

- [19] F. Borrelli, A. Bemporad, M. Fodor, and D. Hrovat, "An MPC/Hybrid System Approach to Traction Control," *IEEE Control Syst. Tech.*, vol. 14, n. 3, pp. 541-552, 2006.
- [20] N. Giorgetti, G. Ripaccioli, A. Bemporad, I.V. Kolmanovsky, and D. Hrovat, "Hybrid model predictive control of direct injection stratified charge engines," *IEEE/ASME Transactions on Mechatronics*, vol. 11, no. 5, pp. 499-506, Aug. 2006.
- [21] N. Giorgetti, A. Bemporad, H. E. Tseng, and D. Hrovat, "Hybrid model predictive control application towards optimal semi-active suspension," *International Journal of Control*, vol. 79, no. 5, pp. 521-533, 2006.
- [22] A. Bemporad, P. Borodani, and M. Mannelli, "Hybrid control of an automotive robotized gearbox for reduction of consumptions and emissions," *LNCS 2623*, pp. 81-96, Springer-Verlag, 2003.

more on <http://cse.lab.imtlucca.it/~bemporad/publications>



The End

Linear MPC controller
of a DC-Servomotor
(Hybrid Toolbox)

<http://cse.lab.imtlucca.it/~bemporad/hybrid/toolbox>