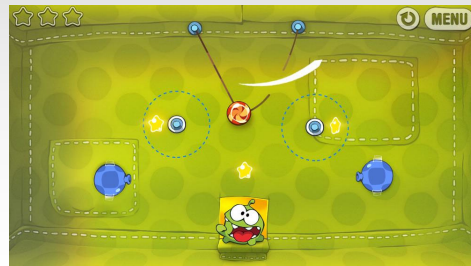


# CPSC 427

## Video Game Programming

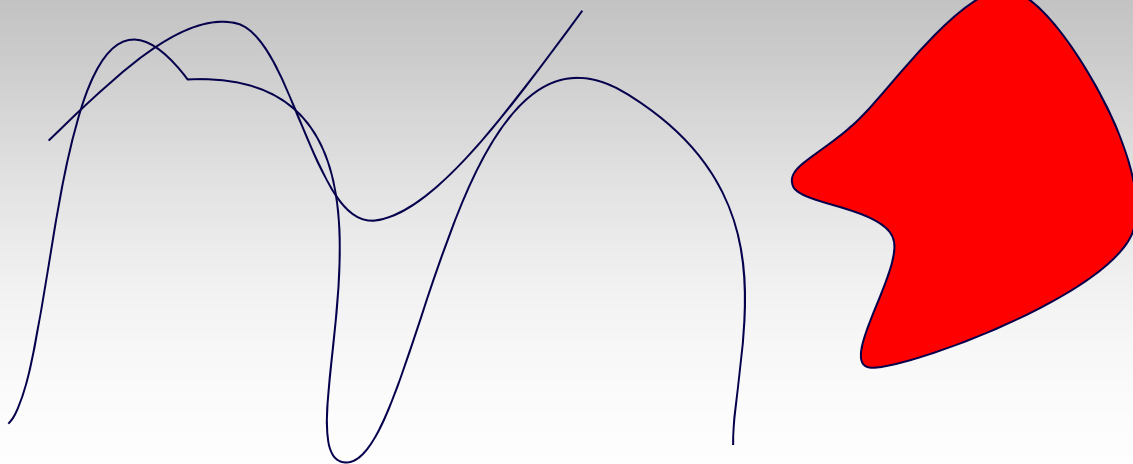


### Curves (basics)



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## Curves

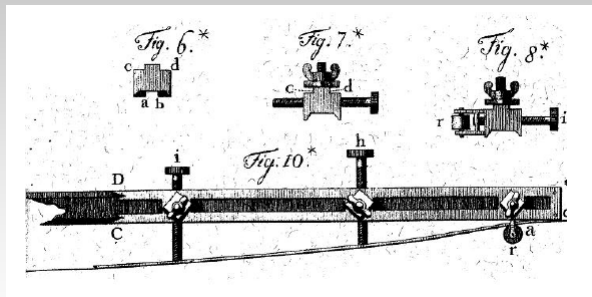


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# Splines – Free Form Curves

## Geometric meaning of coefficients (base)

- Approximate/interpolate set of positions, derivatives, etc..



**Will see one example**

# Splines – Free Form Curves

## Usually parametric

- $C(t)=[x(t),y(t)]$  or  $C(t)=[x(t),y(t),z(t)]$

## Description = basis functions + coefficients

$$C(t) = \sum_{i=0}^n P_i B_i(t) = (x(t), y(t))$$

$$x(t) = \sum_{i=0}^n P_i^x B_i(t)$$

$$y(t) = \sum_{i=0}^n P_i^y B_i(t)$$

- Same basis functions for all coordinates



## Hermite Cubic Basis

### **Geometrically-oriented coefficients**

- 2 positions + 2 tangents

**Require**  $C(0)=P_0$ ,  $C(1) = P_1$ ,  $C'(0)=T_0$ ,  $C'(1)=T_1$

### **Define basis function per requirement**

$$C(t) = P_0 h_{00}(t) + P_1 h_{01}(t) + T_0 h_{10}(t) + T_1 h_{11}(t)$$

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## Hermite Basis Functions

$$C(t) = P_0 h_{00}(t) + P_1 h_{01}(t) + T_0 h_{10}(t) + T_1 h_{11}(t)$$

**To enforce**  $C(0)=P_0$ ,  $C(1) = P_1$ ,  $C'(0)=T_0$ ,  $C'(1)=T_1$ , **basis should satisfy**

$$h_{ij}(t); i, j = 0,1, t \in [0,1]$$

curve	$C(0)$	$C(1)$	$C'(0)$	$C'(1)$
$h_{00}(t)$	1	0	0	0
$h_{01}(t)$	0	1	0	0
$h_{10}(t)$	0	0	1	0
$h_{11}(t)$	0	0	0	1

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## Hermite Cubic Basis

*Can satisfy with cubic polynomials as basis*

$$h_{ij}(t) = a_3t^3 + a_2t^2 + a_1t + a_0$$

*Obtain - solve 4 linear equations in 4 unknowns for each basis function*

$$h_{ij}(t); i, j = 0,1, t \in [0,1]$$

curve	C(0)	C(1)	C'(0)	C'(1)
$h_{00}(t)$	1	0	0	0
$h_{01}(t)$	0	1	0	0
$h_{10}(t)$	0	0	1	0
$h_{11}(t)$	0	0	0	1

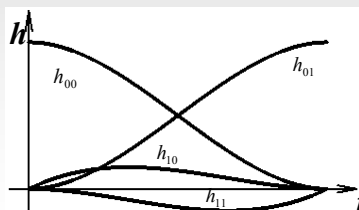
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## Hermite Cubic Basis

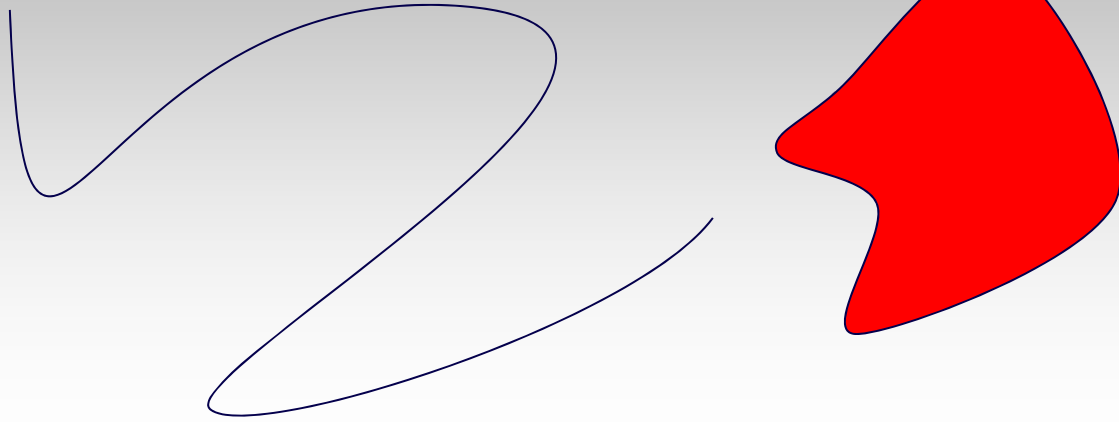
*Four polynomials that satisfy the conditions*

$$\begin{aligned}
 h_{00}(t) &= t^2(2t-3)+1 & h_{01}(t) &= -t^2(2t-3) \\
 h_{10}(t) &= t(t-1)^2 & h_{11}(t) &= t^2(t-1)
 \end{aligned}$$



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# Curves



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