方法、实践与素质并重

——浅谈浙江大学计算机图形学本科教学

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目 录

课程简介

课程目标

- 计算机图形学解决的基本问题
- 解决问题的基本原则和方法
- 开发计算机图形应用程序所需的基本编程技能
- 培养独立解决问题的习惯和能力

课程简介

课程设计


课程目标
针对性措施
课程培养能力和素养
两方面能力
一种素养
图形学基本方法
图形应用的编程能力
独立分析问题和解决问题素养
教学内容设计
教学方式设计
课程考核设计

课程简介

课程设计

❋ 教学内容设计

- ✓ 围绕图形的生成、处理和显示，讲述造型和显示的基本方法。

❋ 教学方式设计

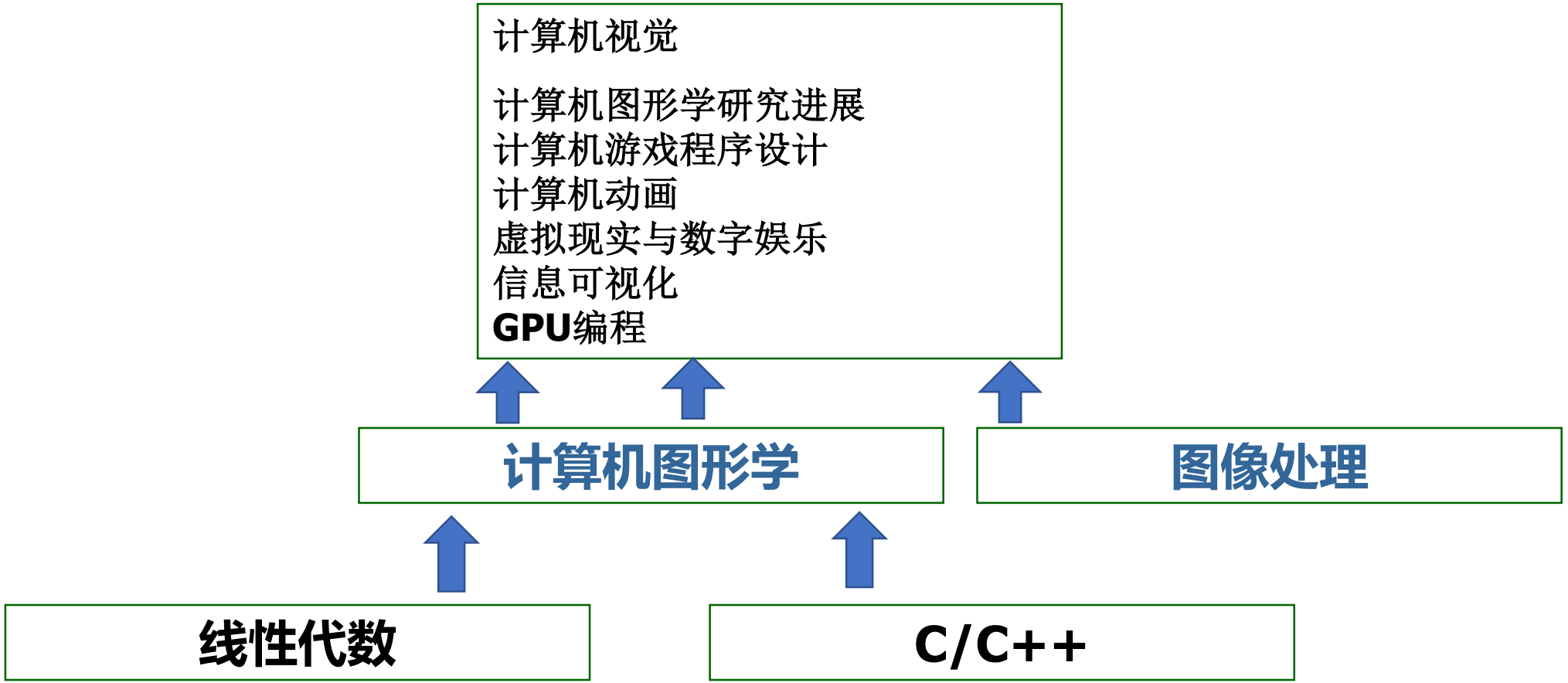
- ✓ 从需解决的问题出发，引导学生分析问题、解决问题，以培养学生发现问题、解决问题的工科思维能力。
- ✓ 32学时理论课+16学时实验课，以期做到方法与实践并重。

❋ 考核方式设计

- ✓ 课程最终成绩将按照“作业及课堂内测试30%+平时实验30%+大程40%”的方式评定。

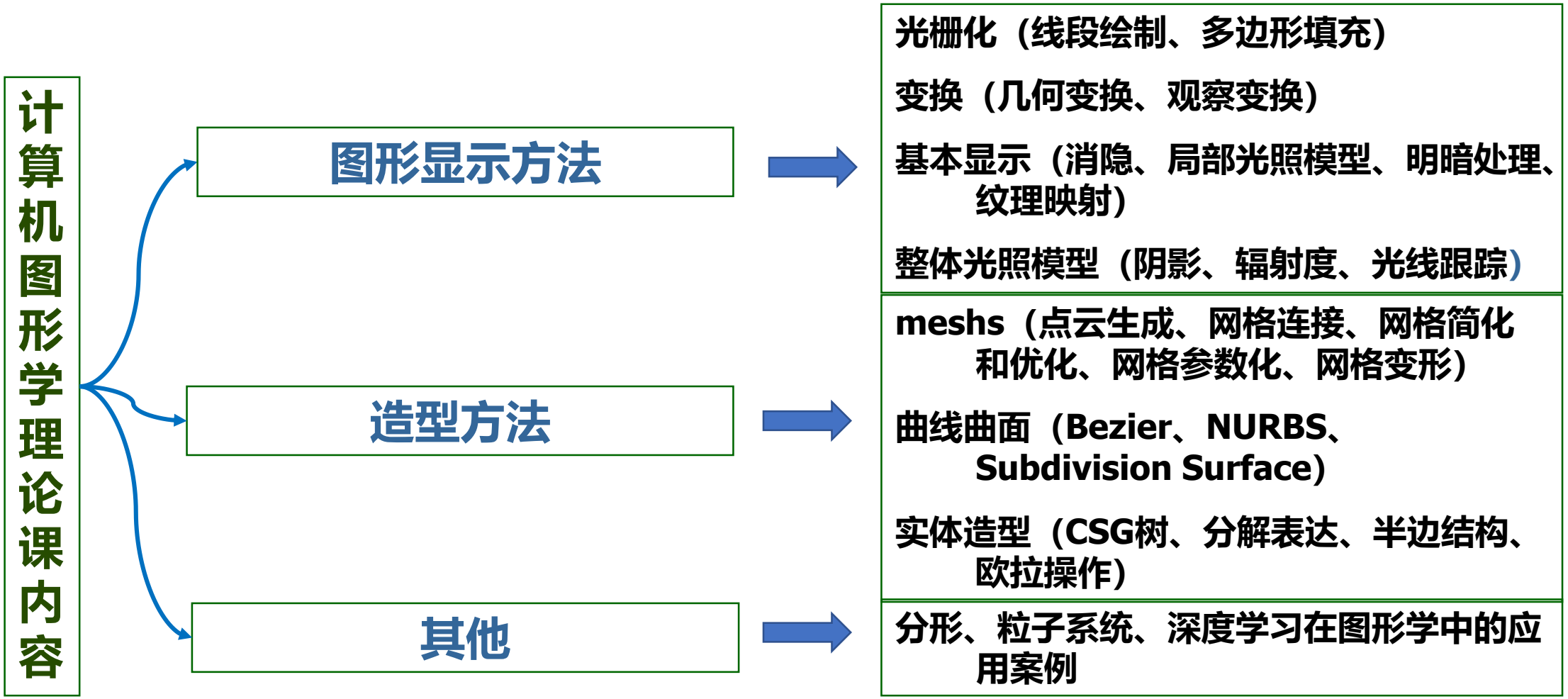
课程内容

计算机图形学在浙大计算机可视计算课程体系中的位置



课程内容

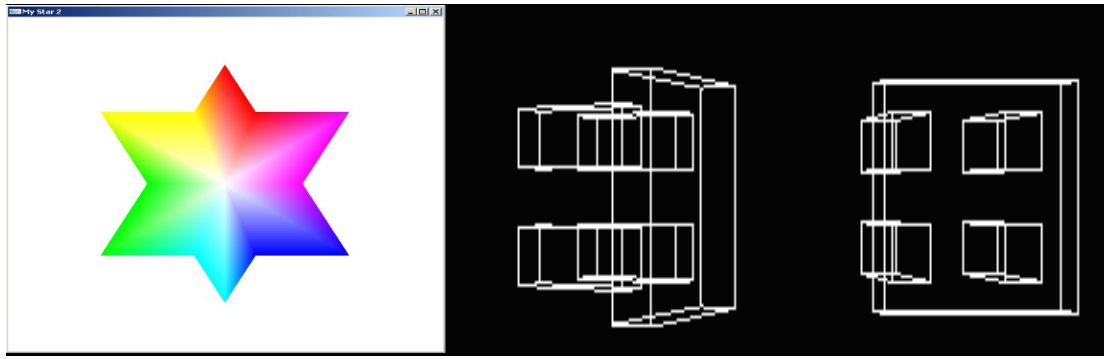
计算机图形学基本任务：造型、显示、处理（运动控制）、交互

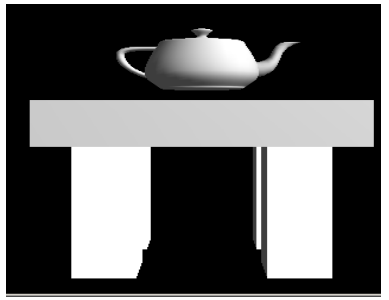


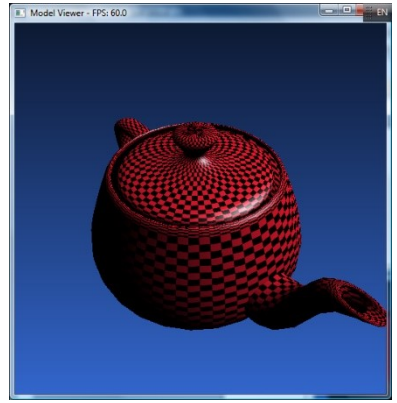
课程内容

计算机图形学实践内容

- 6个step by step的OpenGL编程实验
- 分组大程







课程内容

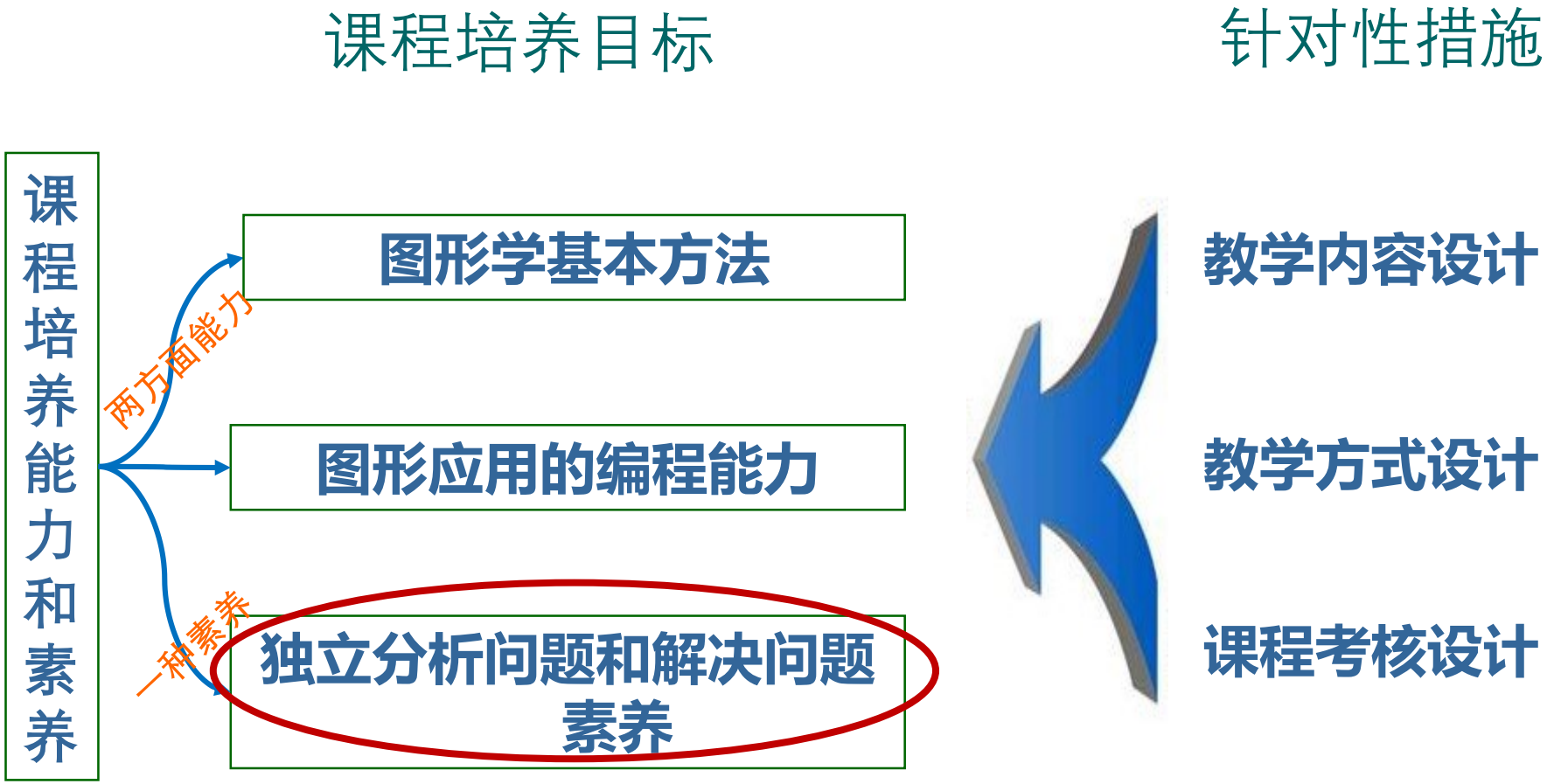
计算机图形学实践内容

1. 具有NURBS曲面建模能力
2. 漫游时可实时碰撞检测
3. 光照明模型细化，可任选实现实时阴影、caustic、全局光照（光子跟踪）、辐射度等
4. 采用移动平台实现
5. 构建完整三维游戏，具有可玩性。

分组大程

课程特色与案例

课程设计

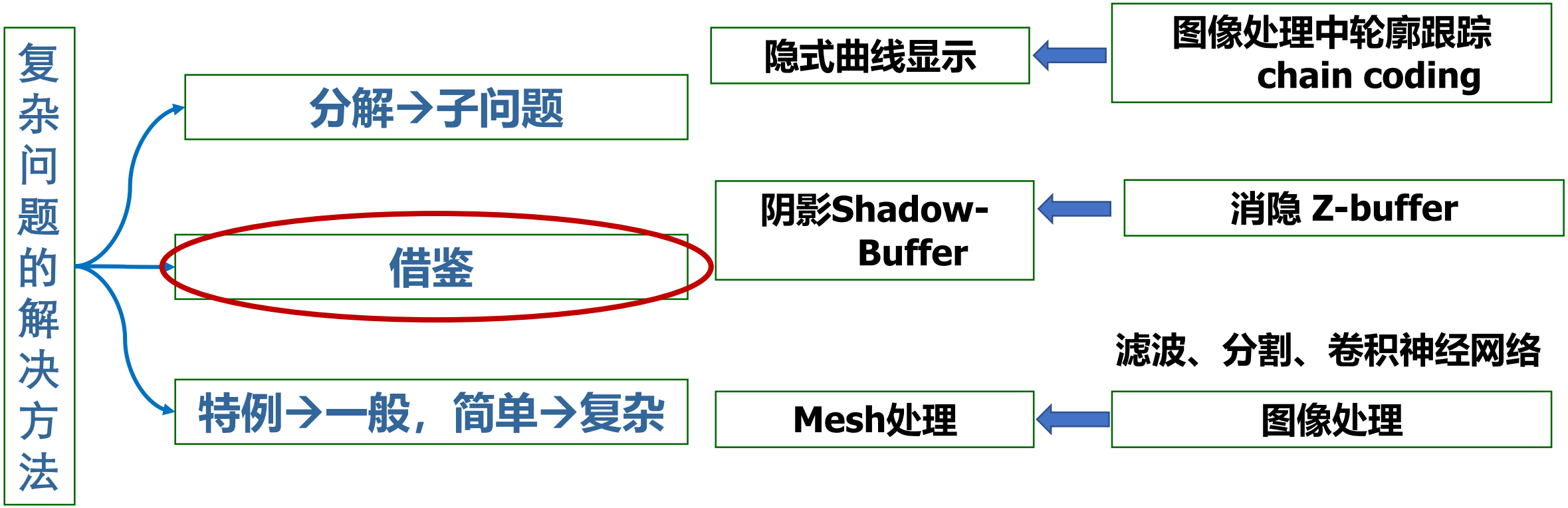


课程特色与案例

独立分析问题和解决问题素养

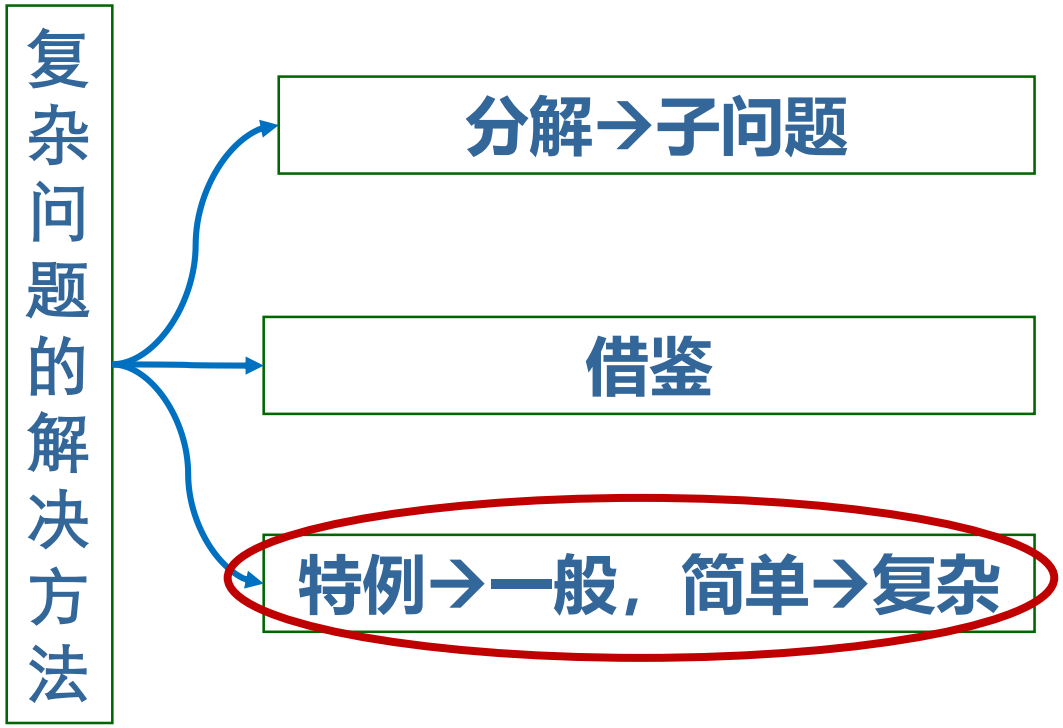
课程特色与案例

独立分析问题和解决问题素养

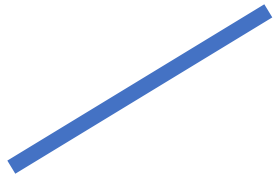


课程特色与案例

独立分析问题和解决问题素养



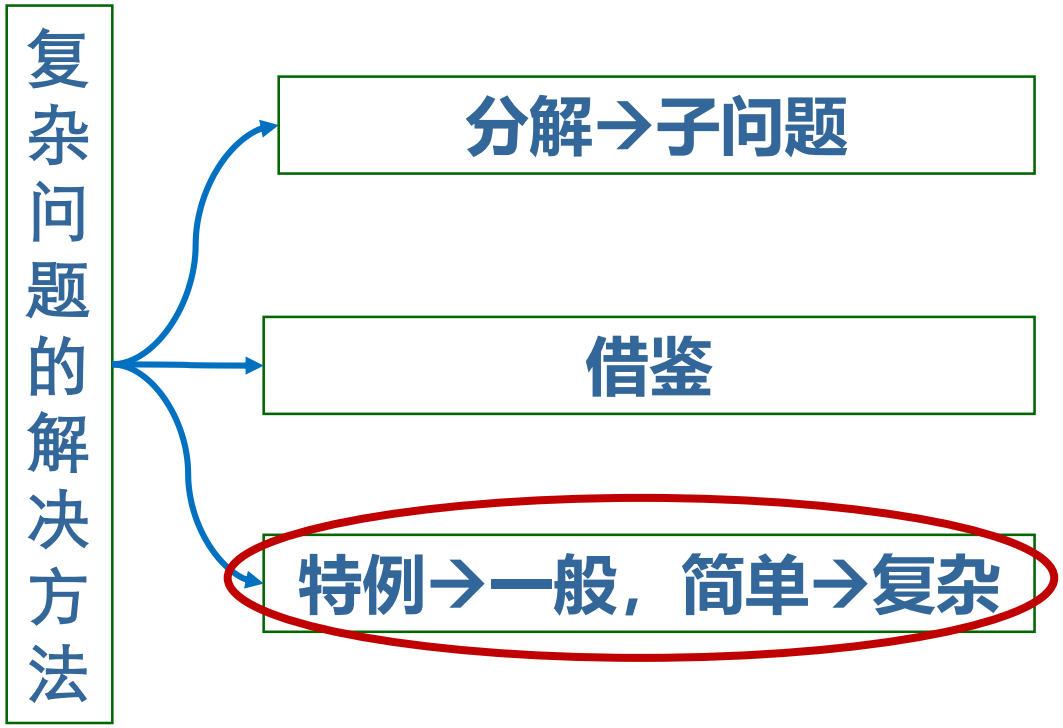
- 三维物体的表示
- 1. How to represent a 3 dimensional point ?
- Point3D {
  double x;
  double y;
  double z;
  }



2. How to represent a line segment?

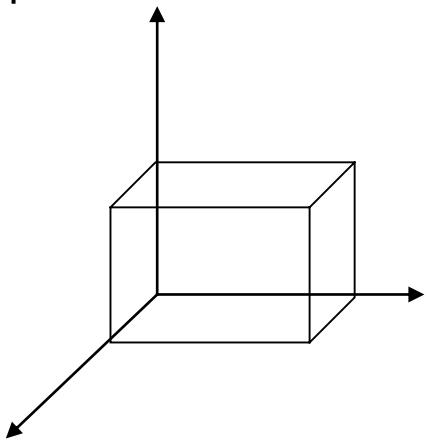
课程特色与案例

独立分析问题和解决问题素养



- 三维物体的表示

3. How to represent a cube?



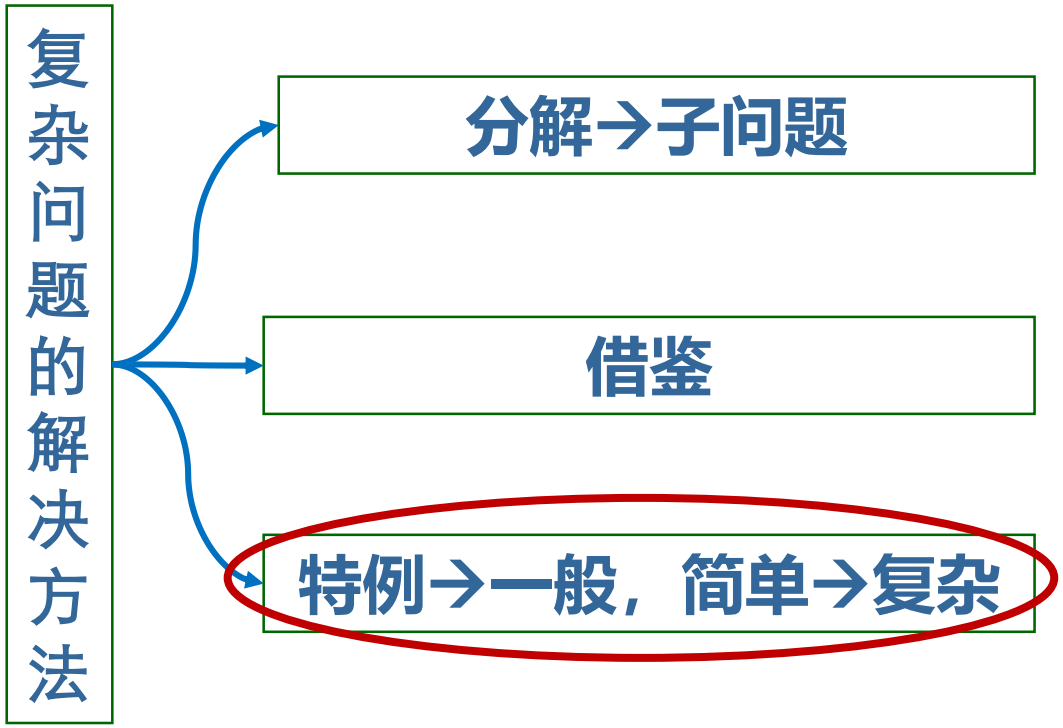
4. Hc k?

pot ?

bit model ?

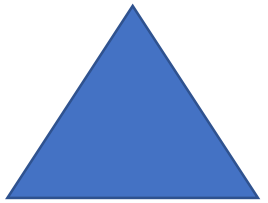
课程特色与案例

独立分析问题和解决问题素养



- 三维物体的表示

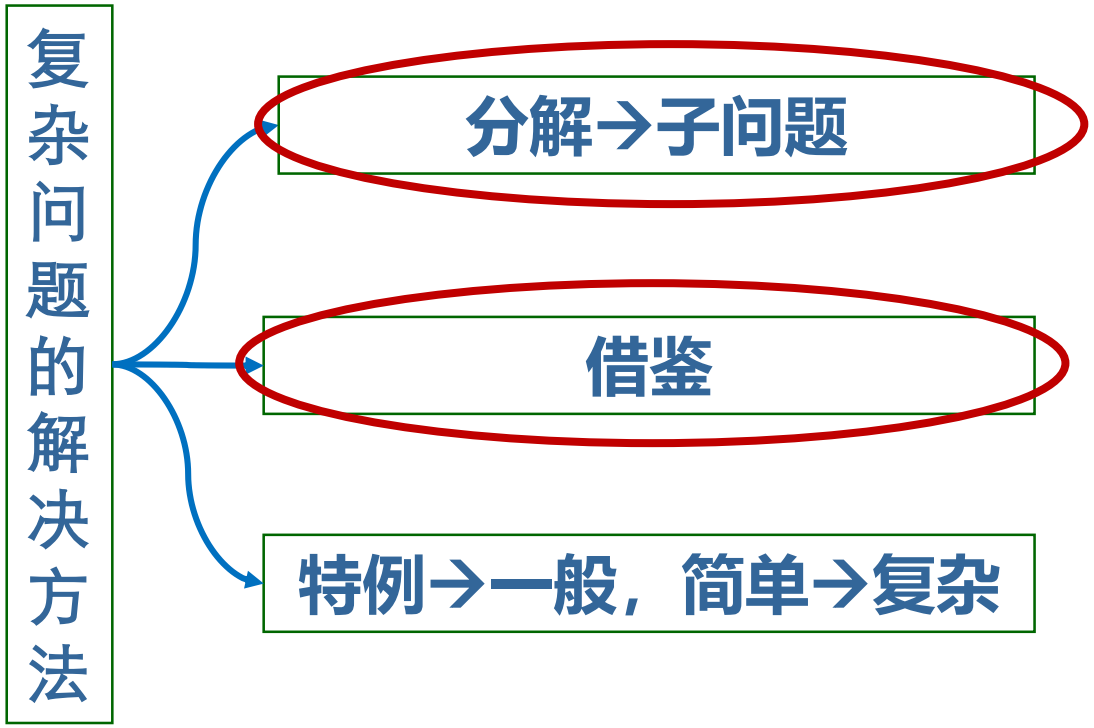
3. How to represent a polygon?



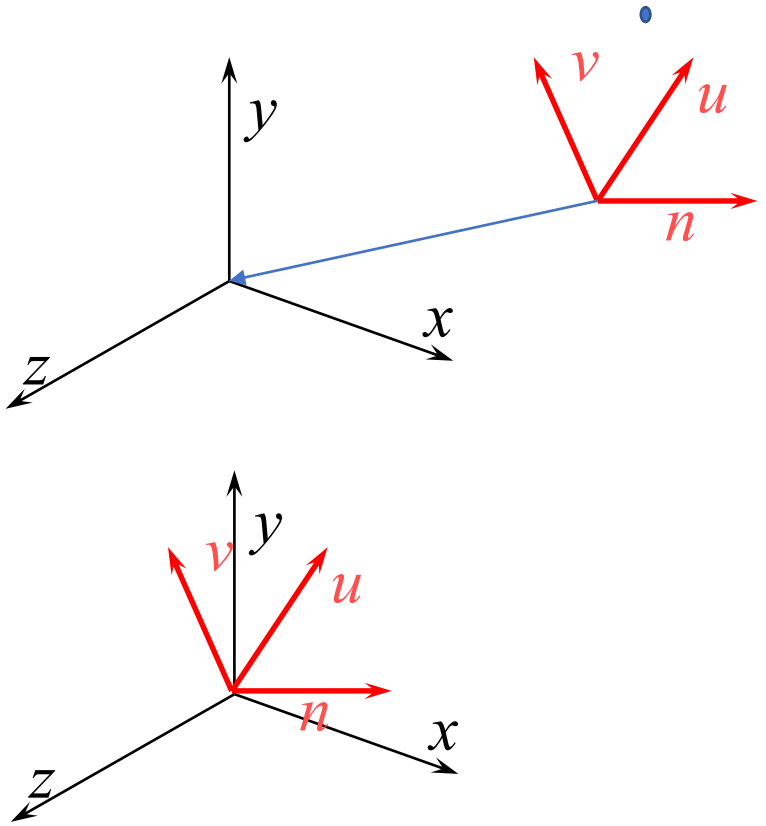
4. How t dron?

课程特色与案例

独立分析问题和解决问题素养



- 观察变换



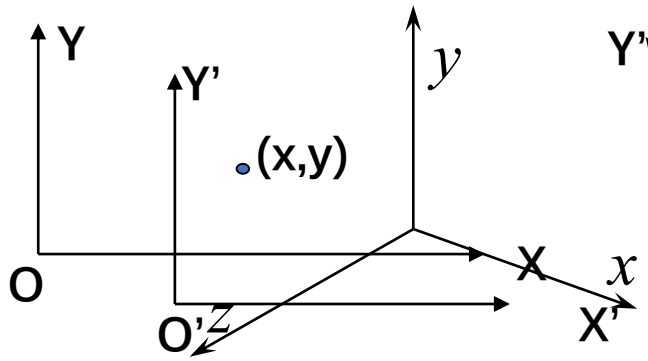
课程特色与案例

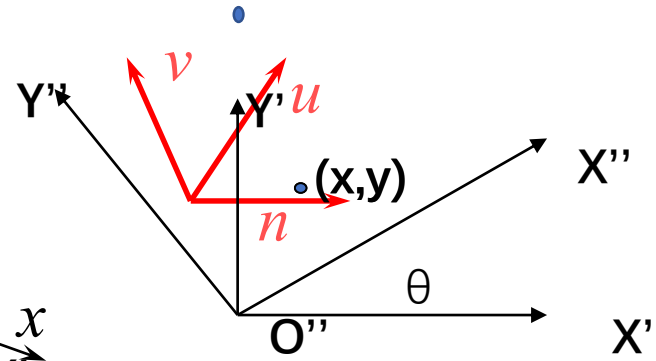
独立分析问题和解决问题素养

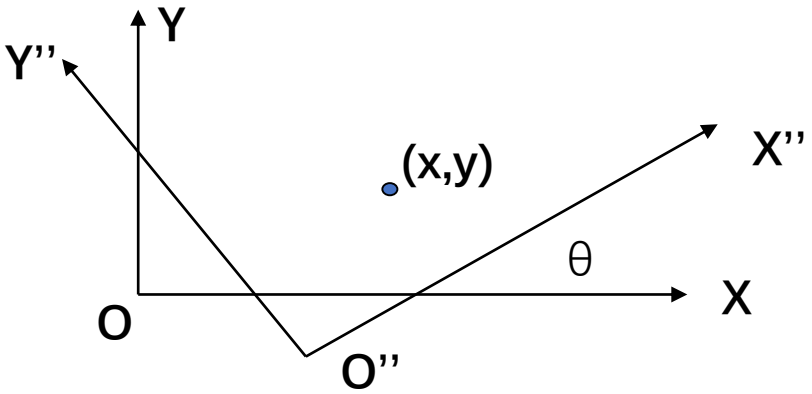
复杂问题的解决方法

- 分解→子问题
- 借鉴
- 特例→一般，简单→复杂

- 观察变换

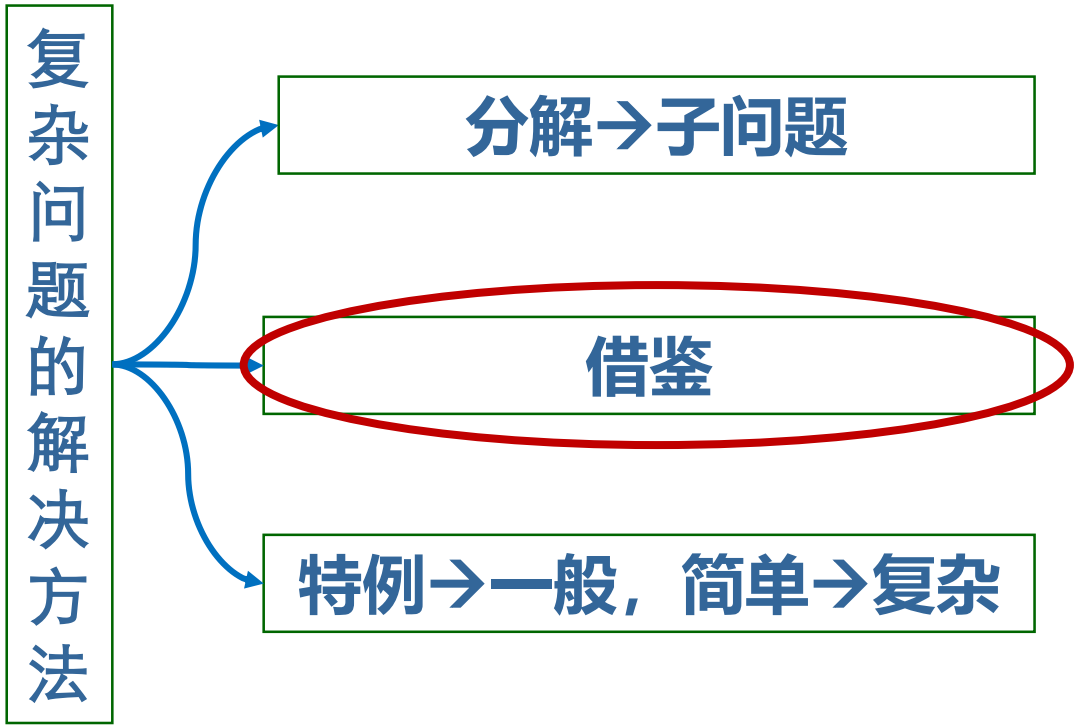






课程特色与案例

独立分析问题和解决问题素养



- DDA

Uses differential equation of the line

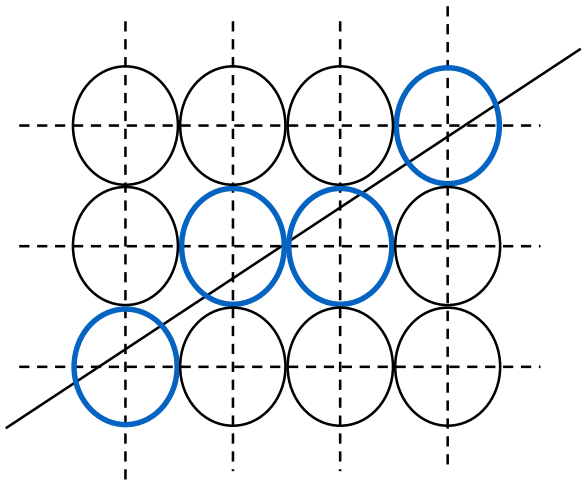
$$y_i = m \cdot x_i + c$$

$$where, \quad m = \frac{y2 - y1}{x2 - x1}$$

Incrementing X-coordinate by 1

$$x_i = x_{i\_prev} + 1$$

$$y_i = y_{i\_prev} + m$$

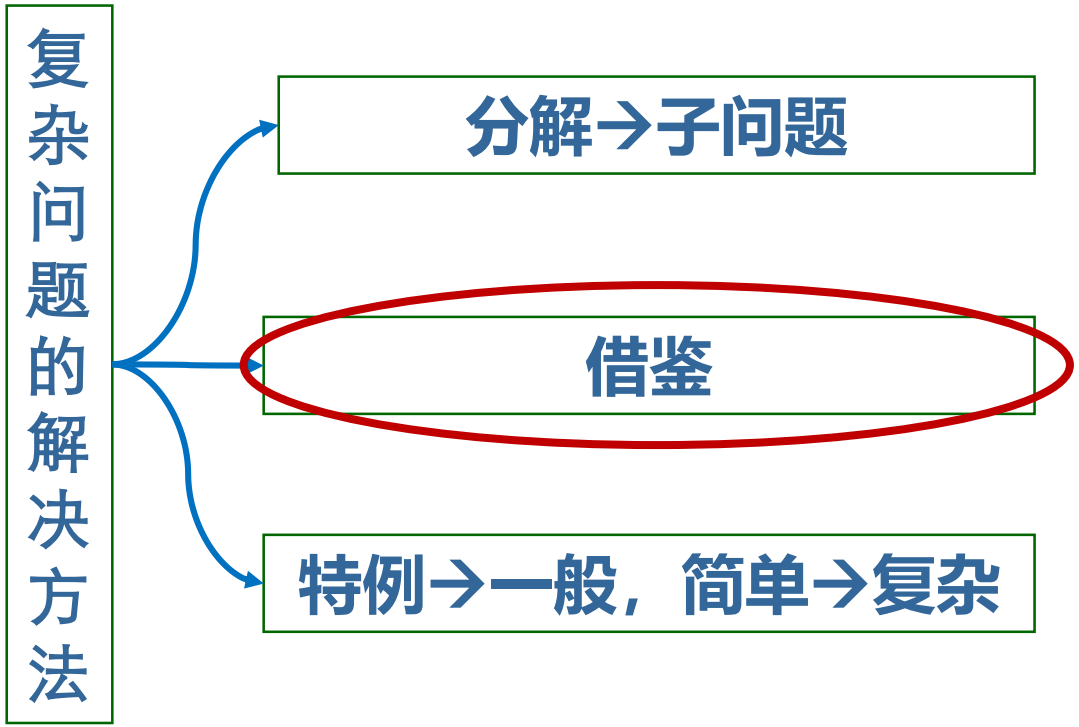


Discussion1: What makes it faster?

This is an *Incremental algorithm*， i.e. at each step it makes incremental calculations based on the calculations done during the preceeding step

课程特色与案例

独立分析问题和解决问题素养



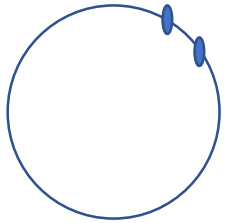
- Bresenham Line Drawing

$$P_{i+1} = 2x_{i+1}dy - 2y_{i+1}dx + 2dy + (2b-1)dx,$$

$$note\ that\ x_{i+1} = x_i + 1$$

$$P_{i+1} = P_i + 2dy - 2(y_{i+1} - y_i)\ dx$$

If we calculate the sample points (xi, yi) on $\theta = i * \Delta\theta$, $i=0,1,2,3,\ldots$. to get



$$x_i = x_c + r \cdot \cos(i * \Delta\theta)$$

$$y_i = y_c + r \cdot \sin(i * \Delta\theta)$$

Then we can connect them by line segments to draw a circle.

$$X_{i+1} = r \cdot \cos(\theta_i + \Delta\theta)$$

$$= r\cos\theta_i \cos\Delta\theta - r\sin\theta_i \sin\Delta\theta$$

$$= x_i \cos\Delta\theta - y_i \sin\Delta\theta$$

This is an *Incremental algorithm*， i.e. at each step it makes incremental calculations based on the calculations done during the preceeding step

课程特色与案例

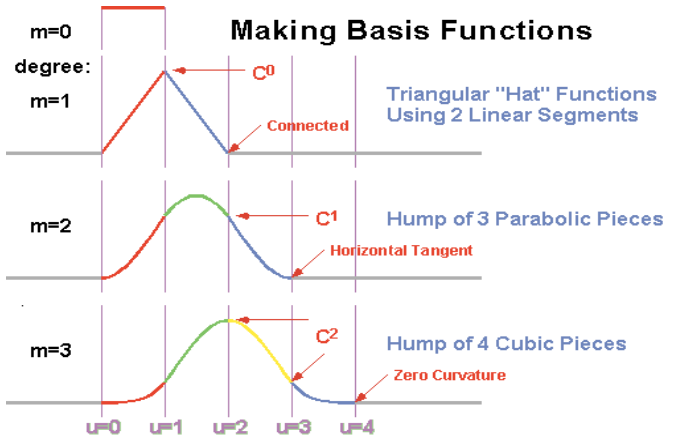
从问题、目标出发，引出方法

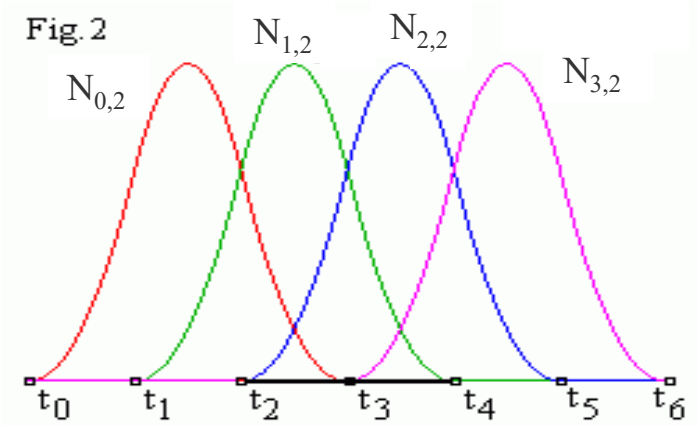
NURBS curve $C(u)=\sum_{i=0}^{n} P_i N_{i,p}(u) \qquad a \le u \le b$

B-spline basis: $U=\{u_i\}_{i=-\infty}^{\infty}$

$$N_{i,0}(u)=\begin{cases}1 & u_i \le u < u_{i+1}\\ 0 & else\end{cases}$$

$$N_{i,p}(u)=\frac{u-u_i}{u_{i+p}-u_i}N_{i,p-1}(u)+\frac{u_{i+p+1}-u}{u_{i+p+1}-u_{i+1}}N_{i+1,p-1}(u),$$

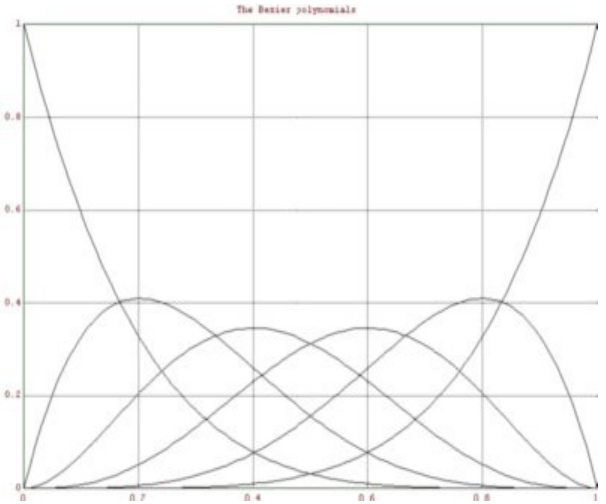


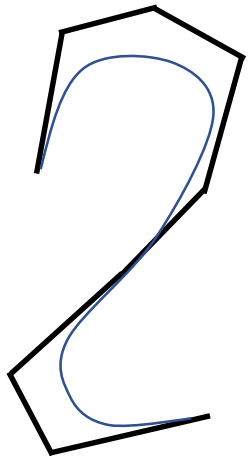


- disadvantages of Bézier curve:

It's global. A control point influences the whole curve.

$$\boldsymbol{C}(t)=\sum_{i=0}^{n}\boldsymbol{P}_i B_{i,n}(t), \quad t\in[0,1]$$





课程特色与案例

从问题、目标出发，引出方法

Bézier curve

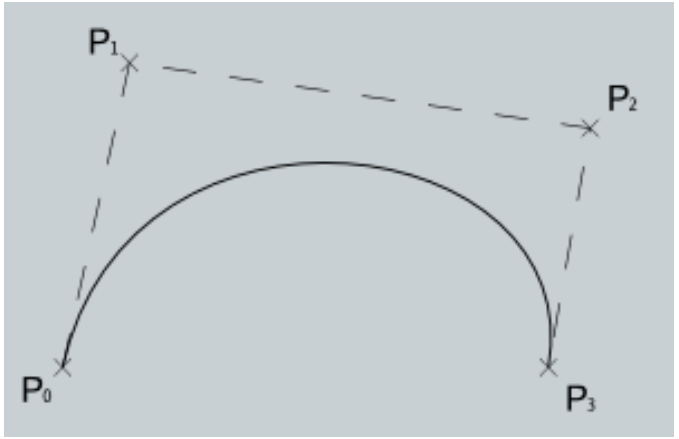
$$\boldsymbol{C}(t)=\sum_{i=0}^{n}\boldsymbol{P}_i B_{i,n}(t),\quad t\in[0,1]$$

where, P_i (i=0,1,…,n) are control points.

$$B_{i,n}(t)=C_n^i t^i(1-t)^{n-i},t\in[0,1]$$ **Bernstein basis**

$$\begin{cases}\mathrm{X}(\mathrm{t})=\sum_{i=0}^{n}x_i B_{i,\mathrm{n}}(t)\\ \mathrm{Y}(\mathrm{t})=\sum_{i=0}^{n}y_i B_{i,n}(t)\end{cases}$$

$$\boldsymbol{C}(t)=\begin{pmatrix}\mathbf{X(t)}\\ \mathbf{Y(t)}\end{pmatrix},\quad \boldsymbol{P}_i=\begin{pmatrix}x_i\\ y_i\end{pmatrix}$$



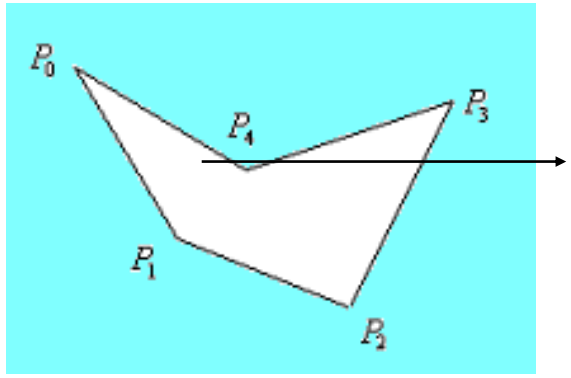
$$\begin{cases}\mathrm{X}(\mathrm{t})=\sum_{i=0}^{n}a_i t^i\\ \mathrm{Y}(\mathrm{t})=\sum_{i=0}^{n}b_i t^i\end{cases}$$

$$1,\ t,\ t^2,\ t^3,\ t^4$$

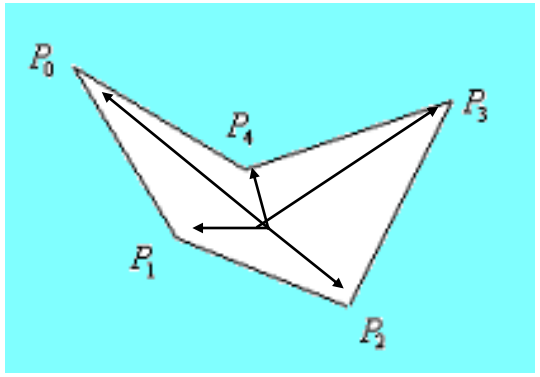
$$B_{i,n}(t)=C_n^i t^i(1-t)^{n-i},t\in[0,1]$$

课程特色与案例

从问题、目标出发，引出方法



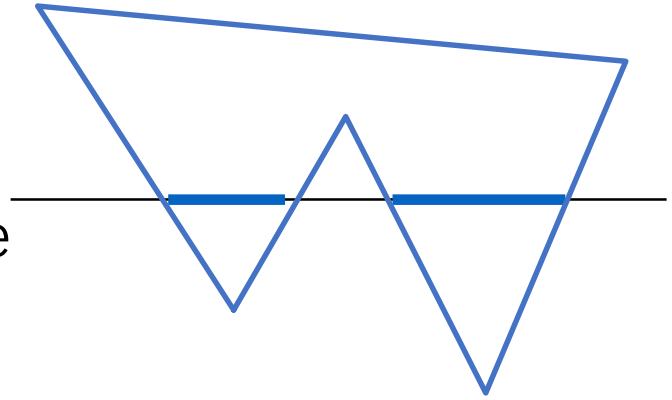
even-odd test



winding number test

Scan Line Method

From top to down



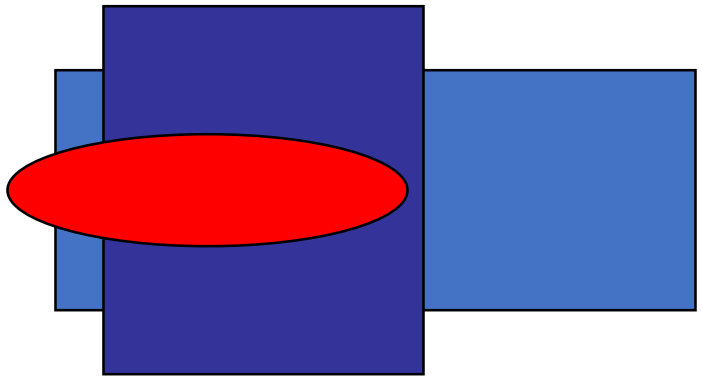
- Proceeding from left to right
  the intersections are paired and
  intervening pixels are set to the
  specified intensity
- Algorithm
  - Find the intersections of the scan line with all the edges in the polygon
  - Sort the intersections by increasing X-coordinates
  - Fill the pixels between pair of intersections

Discussion 5 : How to speed up,
or how to avoid calculating intersection

课程特色与案例

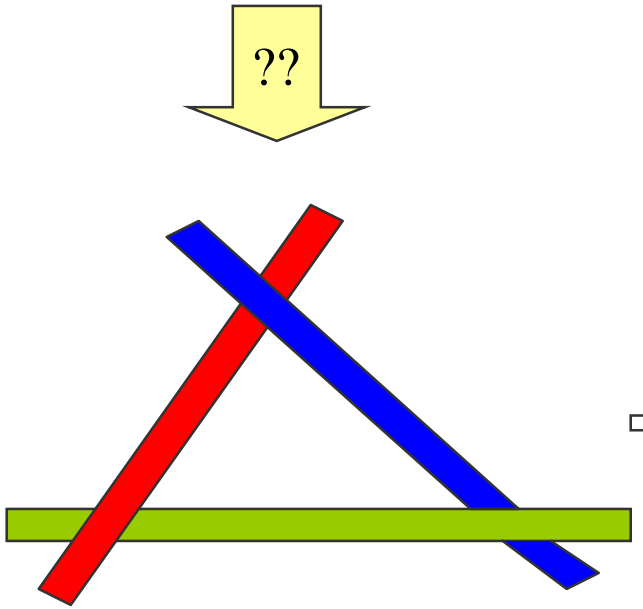
从问题、目标出发，引出方法

Hidden Surface Removal



Painter's Algorithm：

From back to Front

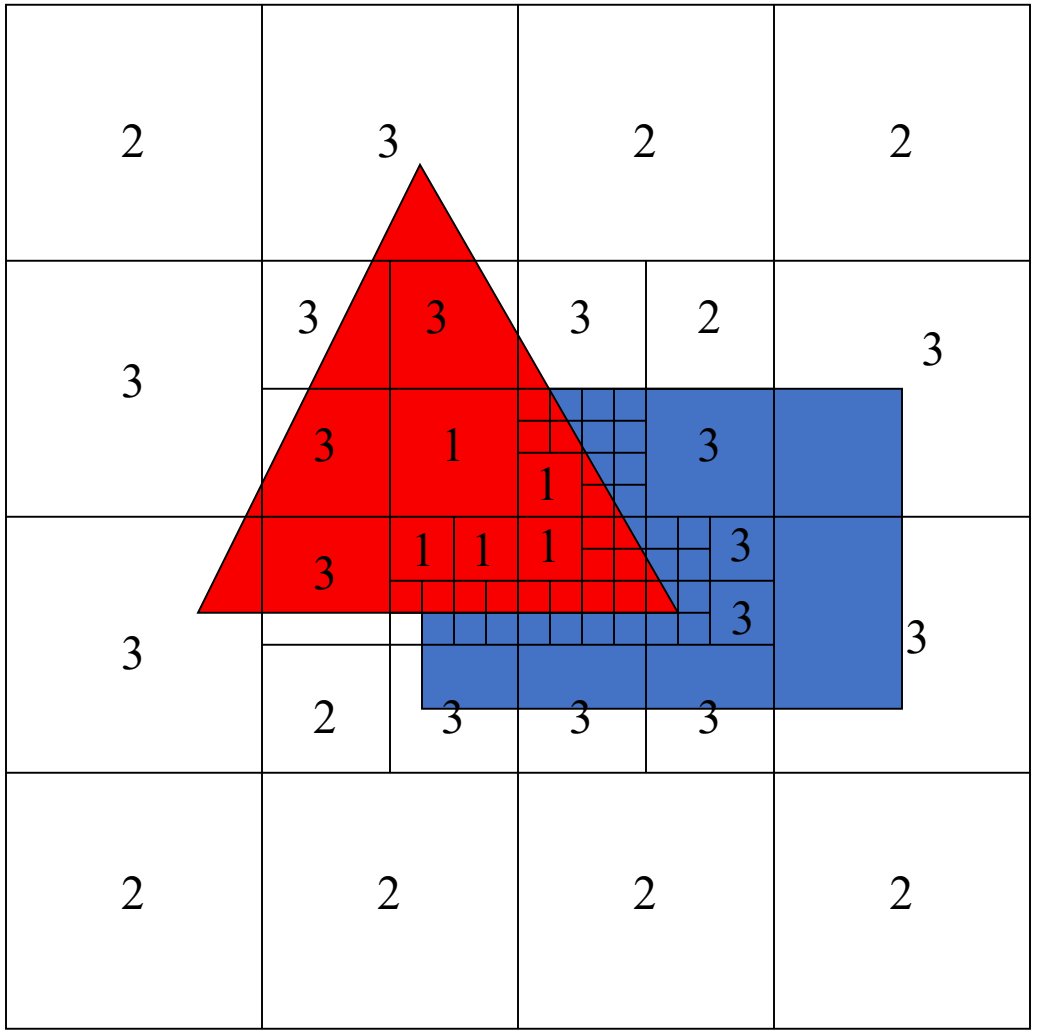


Area Sorting

Clipping

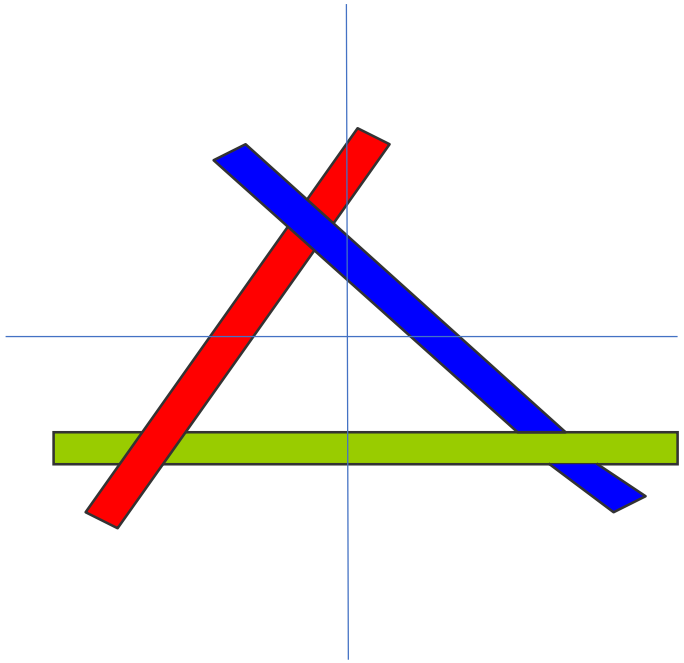
课程特色与案例

从问题、目标出发，引出方法



Warnock's Algorithm

- Regions labeled with case used to classify them:
  - One polygon in front
  - Empty
  - One polygon inside, surrounding or intersecting
- Small regions not labeled

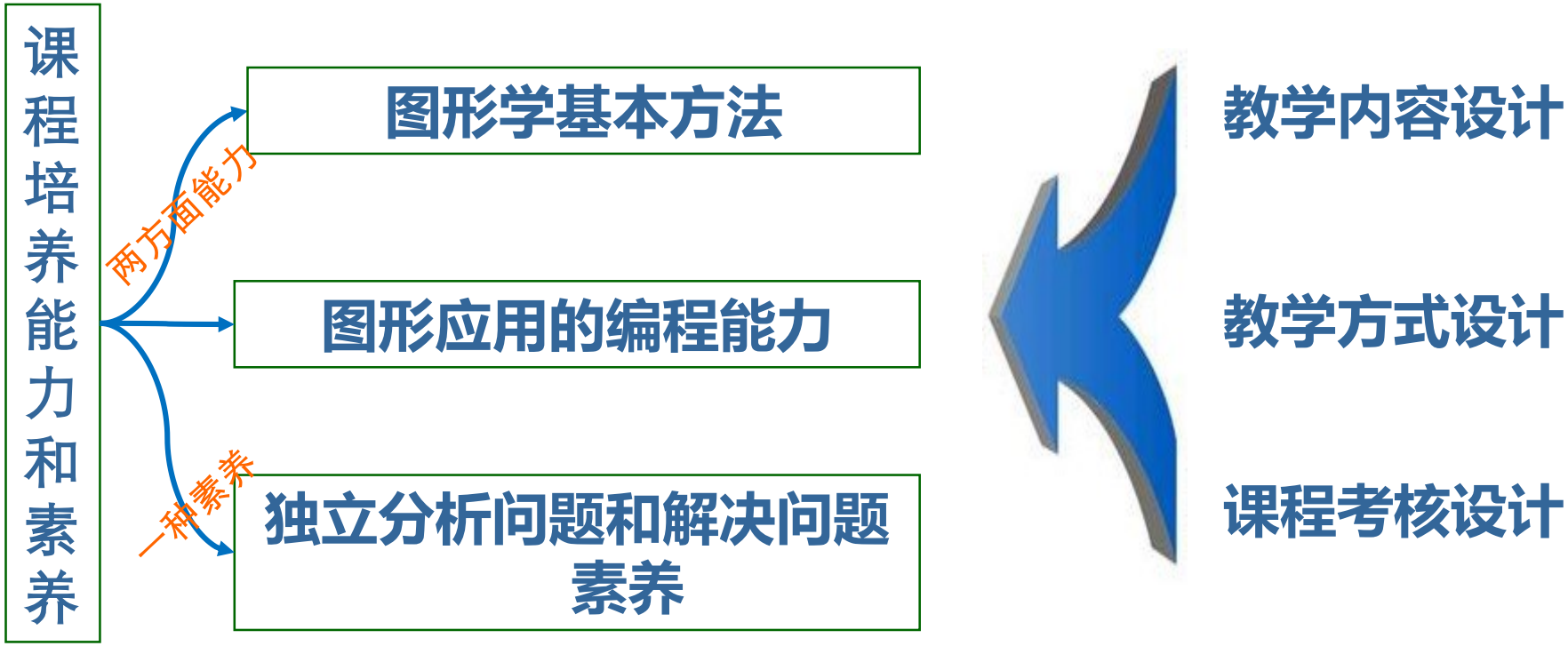


总结

课程设计

课程培养目标

针对性措施



感谢各位专家指导！