**传热与流体流动的数值计算**

**第一次小组作业**

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**1计算域与网格划分**

1.1计算域的离散和标记

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图1

在均匀网格下，

1.2节点标记

采用两种节点设置方式：内节点法与外节点法，如图2所示。

内节点法 外界点法

图2内节点法与外节点法示意图

**2精确解**

2.1 内节点法

*u*=0.1m/s

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x/m | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 |
| *φ* | 0.938792974955478 | 0.796390322009783 | 0.622459329450940 | 0.410019536043154 | 0.150544987205201 |

*u*=2.5m/s

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x/m | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 |
| *φ* | 0.999999999844698 | 0.999999974903890 | 0.999996273360022 | 0.999446915581920 | 0.917914998330945 |

2.2外节点法

*u*=0.1m/s

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| x/m | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
| *φ* | 1.00000000000000 | 0.871148750995143 | 0.713769480537255 | 0.521546006095625 | 0.286763724929193 | -2.220446049250313E-016 |

*u*=2.5m/s

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| x/m | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
| *φ* | 1.00000000000000 | 0.999999997952734 | 0.999999694111499 | 0.999954600077360 | 0.993262052512693 | 0.000000000000000E+000 |

**3中心差分格式**

3.1离散格式



其中，



3.2计算结果

3.2.1内节点法

*u*=0.1m/s

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x/m | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 |
| *φ* | 0.928106508489059 | 0.784319525467176 | 0.608579880080577 | 0.393786980810221 | 0.131262326936740 |

*u*=2.5m/s

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x/m | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 |
| *φ* | 1.03461538296215 | 1.10384614888645 | 0.942307692770598 | 1.31923076239005 | 0.439743587463350 |

3.2.2外节点法

*u*=0.1m/s

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| x/m | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
| *φ* | 1.00000000000000 | 0.871355462691058 | 0.714123250897895 | 0.521950548173644 | 0.287072801106621 | 0.000000000000000E+000 |

*u*=2.5m/s

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| x/m | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
| *φ* | 1.00000000000000 | 0.952492671472734 | 1.06334310627616 | 0.804692088064161 | 1.40821113912372 | 0.000000000000000E+000 |

**4上风格式**

4.1离散格式



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4.2计算结果

4.2.1内节点法

*u*=0.1m/s

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x/m | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 |
| *φ* | 0.925727866579483 | 0.777183599738449 | 0.598930479971904 | 0.385026736783287 | 0.128342245594429 |

*u*=2.5m/s

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x/m | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 |
| *φ* | 0.998639455734042 | 0.995918367202126 | 0.979591836213370 | 0.881632651497254 | 0.293877550499085 |

4.2.2外节点法

*u*=0.1m/s

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| x/m | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
| *φ* | 1.00000000000000 | 0.865620295922938 | 0.704364651430947 | 0.510857878521136 | 0.278649751606059 | 0.000000000000000E+000 |

*u*=2.5m/s

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| x/m | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
| *φ* | 1.00000000000000 | 0.999356913152929 | 0.995498392118419 | 0.972347266198836 | 0.833440512406237 | 0.000000000000000E+000 |

**5混合格式**

5.1离散格式



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5.2计算结果

5.2.1内节点法

*u*=0.1m/s

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x/m | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 |
| *φ* | 0.928106508489059 | 0.784319525467176 | 0.608579880080577 | 0.393786980810221 | 0.131262326936740 |

*u*=2.5m/s

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x/m | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 |
| *φ* | 1.00000000000000 | 1.00000000000000 | 1.00000000000000 | 1.00000000000000 | 0.333333333333333 |

5.2.2外节点法

*u*=0.1m/s

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| x/m | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
| *φ* | 1.00000000000000 | 0.871355462691058 | 0.714123250897895 | 0.521950548173644 | 0.287072801106621 | 0.000000000000000E+000 |

*u*=2.5m/s

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| x/m | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
| *φ* | 1.00000000000000 | 1.00000000000000 | 1.00000000000000 | 1.00000000000000 | 1.00000000000000 | 0.000000000000000E+000 |

**6三种格式的结果与精确解结果比较**

6.1内节点法

6.2外节点法

**7分析与讨论**

由6可知：

当速度为0.1m/s时，两类设置节点方法的计算结果都能逼近精确解的计算结果，但外节点法比内节点法能更好的逼近精确解；

当速度为2.5m/s时，两类设置节点方法的计算结果共同点为：中心差分离散格式在除边界点外与精确解计算结果差距较大，迎风格式在时，与精确解差距小，而混合格式能很好的逼近的精确解。不同点为：外节点法总体比内节点法更好的逼近精确解。

外节点法与精确解差距更小的原因分析：外节点法边界条件（节点1和6）直接给出具体值，与精确解没有误差；内节点法边界条件（节点1和5）的处理采取了一定近似，与精确解有误差，因此外节点法更准确。

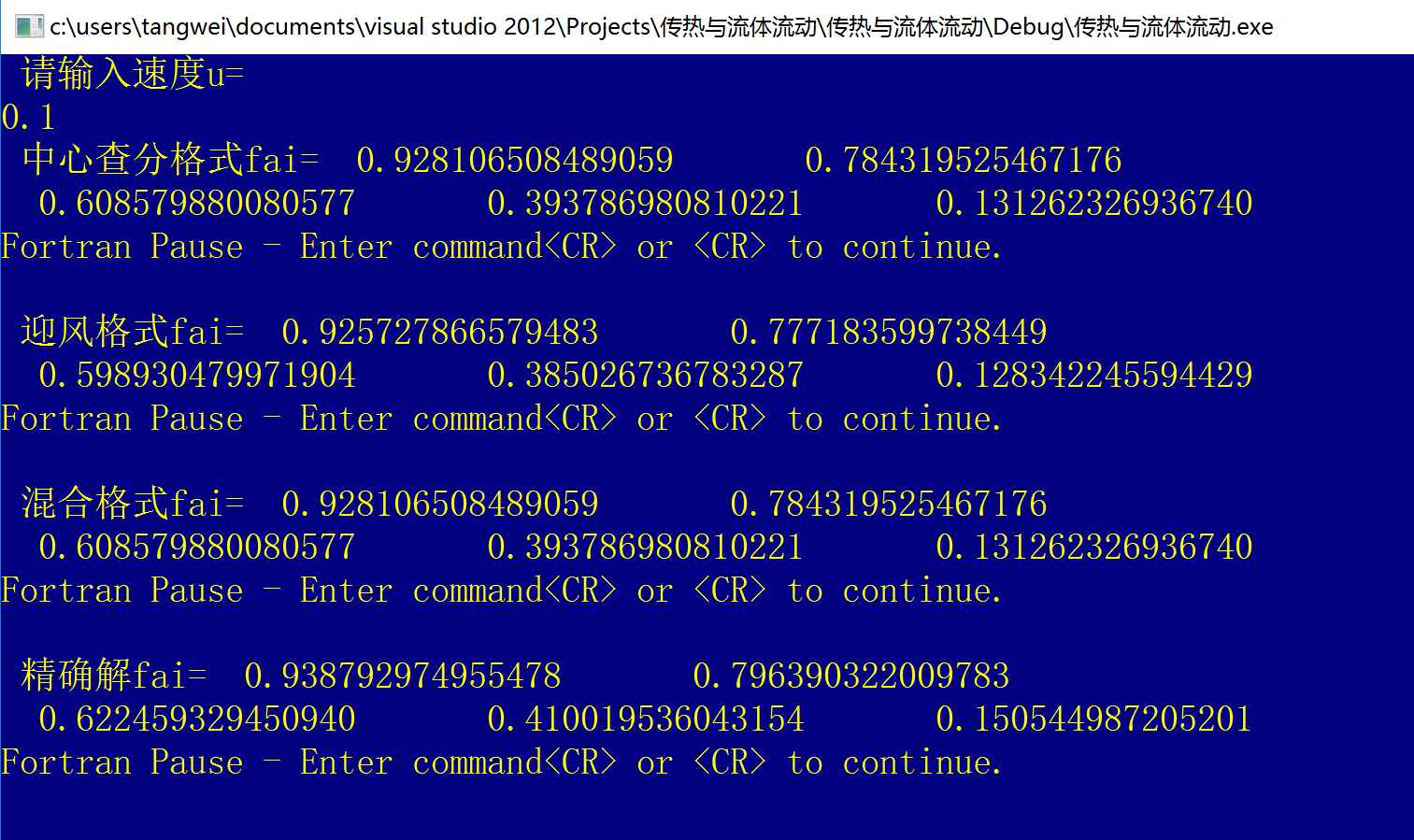
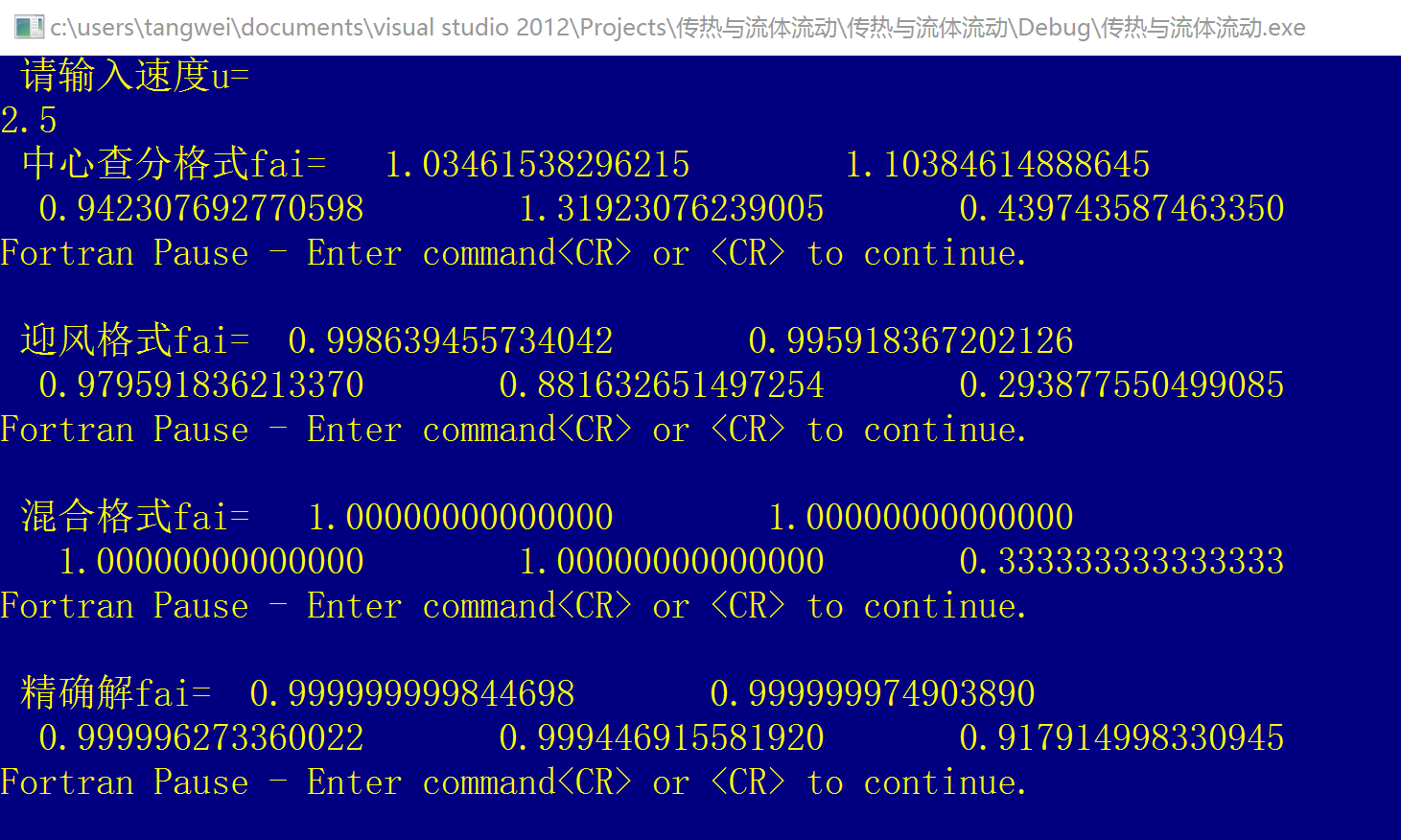
**8代码与运行结果**

8.1代码

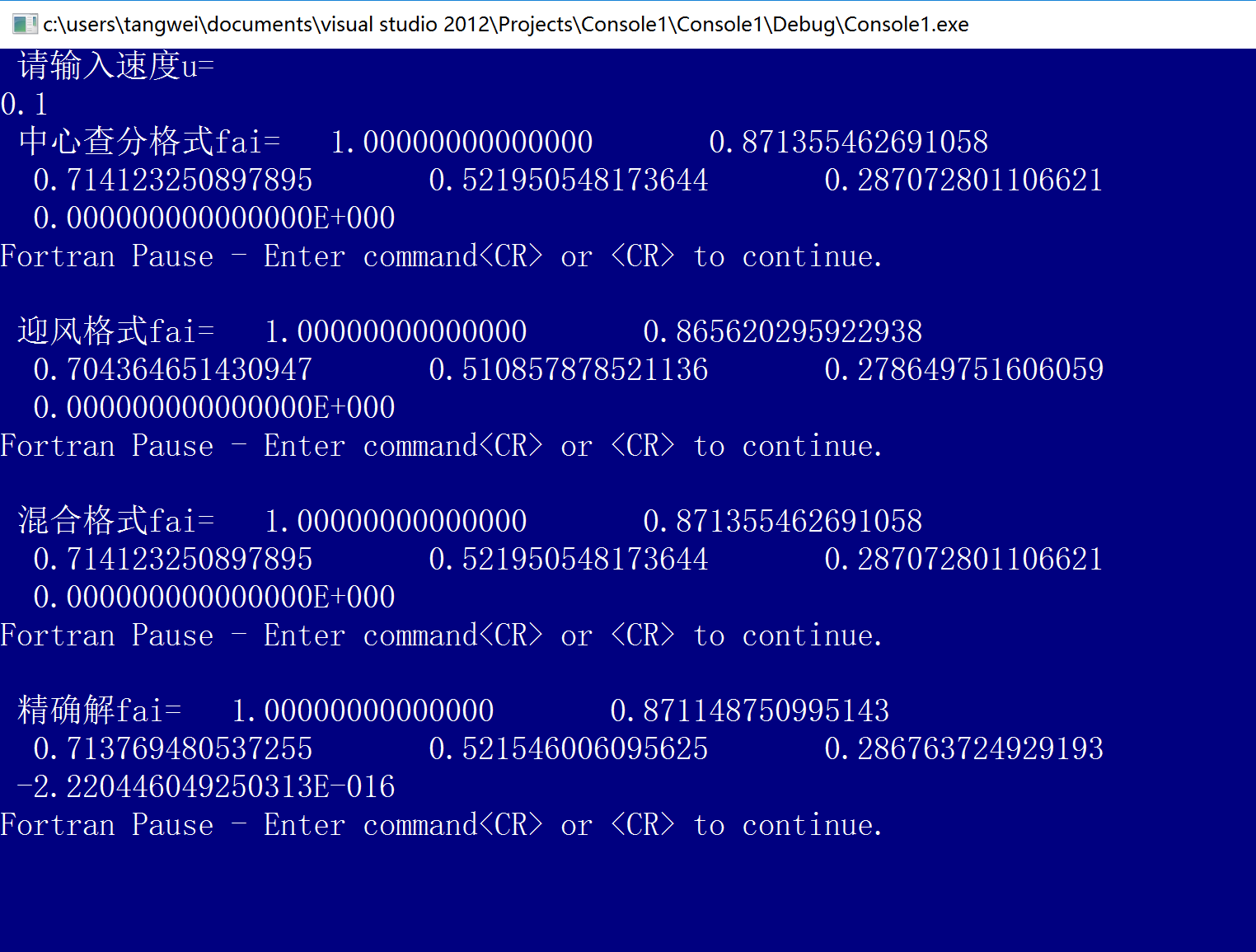
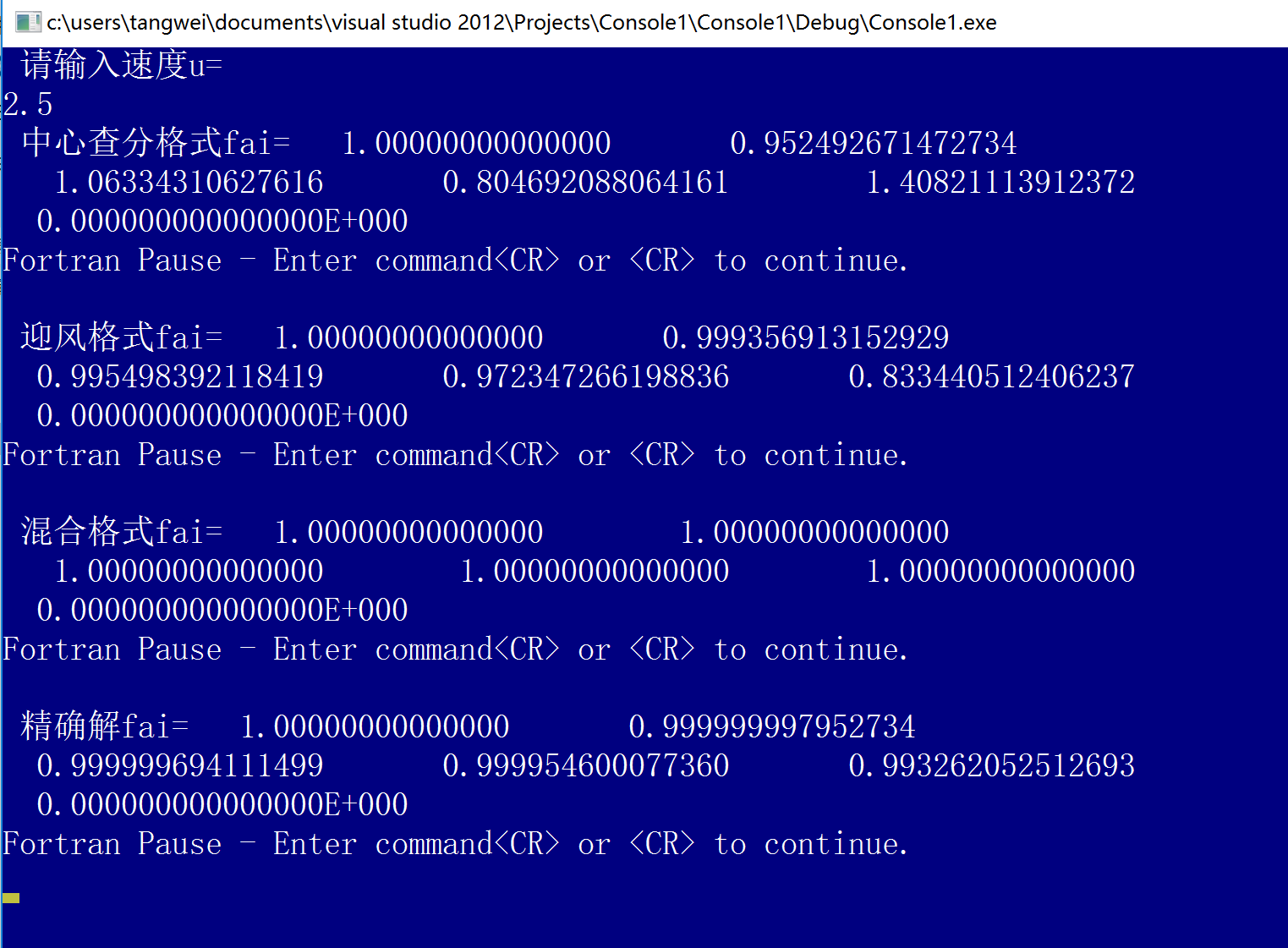
说明：点中心法代码和块中心法的代码附在压缩包中。

8.2运行结果截图

8.2.1 内节点法

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8.2.2 外节点法

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