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subroutine jacobian(A,u,m,J)
  implicit none
  ! Evaluate the Jacobian  $F'(U)$ 
  integer, intent(in) :: m
  real(kind=8), intent(in), dimension(m, (m-1)**2) :: A
  real(kind=8), intent(in), dimension((m-1)**2) :: u
  real(kind=8), intent(out), dimension(m, (m-1)**2) :: J
  integer :: i
  real(kind=8) :: y, beta, lambda
  beta = 0.12_8
  lambda = 0.19_8
  J = A
  ! Calculates  $F'(U) = A - \text{diag}(G'(U))$ 
  do i=1, (m-1)**2
    y = 1.0_8 + beta*u(i)
    ! since J in banded format need mth row since take elements of diag
    J(m,i) = J(m,i) - lambda*exp(u(i)/y)/(y*y)
  end do
end subroutine jacobian
```