Why does the solubility of a gas change with temperature?

1) For some gas/solvent mixtures, the dissolution process is exothermic. For example, for oxygen dissolving in water:

   $O_{2(g)}$ + nearly saturated aqueous solution ↔ saturated solution + heat

   In these cases, increasing temperature (heat content) shifts the equilibrium to the left, and results in less gas dissolved at saturation.

2) For other gas/solvent mixtures, dissolution is endothermic. For example, nitrogen dissolving in acetone:

   $N_{2(g)}$ + nearly saturated acetone solution + heat ↔ saturated solution

   In these cases, increasing temperature shifts the equilibrium to the right, and results in more gas dissolved at saturation.

3) Gas dissolution either absorbs or releases heat (or both at different temperatures) because of two opposing factors:

   a) Energy is required to disrupt the solvent-solvent interaction. This process absorbs heat (endothermic).

      Water is an unusual solvent because at room temperature water contains pockets with a network of hydrogen bonding. Therefore, energy absorbed to accommodate a gas is low.

   b) Energy is released as a result of gas-solvent interaction. This process releases energy (exothermic).

      Water tends to form bonds with gas molecules more readily than organic solvents do. Therefore, the energy released by this process is often greater for a gas dissolving in water than the amount released with a gas dissolves in another solvent.

Because of water's particular characteristics, gas dissolution in water is usually exothermic, and gas solubility decreases with increasing temperature. In many other common solvents, gas dissolution is endothermic, and increasing temperature increases gas solubility.